

ဘာသာပြန်အမှီးလေ့လာချက်

ကြည်ကြည်မိုး*

နိဒါန်း

မြန်မာစာပေတွင် စာပေ၊ ဘာသာ ဟူသော အဓိကကဏ္ဍ (၂)ပိုင်း ရှိသည်။ ဤတွင် စာပေ၌ သုတစာပေ၊ ရသစာပေ ဟူ၍ ထပ်မံခွဲခြားနိုင်သည်။ ဘာသာမှာကား သဒ္ဒါ၊ ကျောက်စာ၊ Linguistics တို့ကိုဆိုလိုသည်။ ဤတွင်စာပေမှ ရသစာပေဟူသည် ရသကိုးပါးကို ဖော်ပြပေးနိုင်သော ဝတ္ထု၊ ကဗျာ၊ ပြဇာတ်တို့ကို ဆိုလိုသည်။ ဤ (၃)မျိုးမှ အတွေ့ရအများဆုံးလည်းဖြစ်၊ လူအများ၏ သဘာဝနှင့် လည်း ဆက်စပ်နီးနွယ်နေသည့် ဝတ္ထုများအကြောင်းကို လေ့လာကြည့်ပါမည်။ ဝတ္ထုတွင် သမိုင်းနောက်ခံဝတ္ထု၊ ရာဇဝင်ဝတ္ထု၊ ဖြစ်ရပ်မှန်ဝတ္ထု၊ ဘာသာပြန်ဝတ္ထု၊ အမှီးဝတ္ထု၊ ကာလပေါ်ဝတ္ထု၊ ဒဏ္ဍာရီဝတ္ထု၊ နန်းတွင်းဝတ္ထု၊ ဇာတကဝတ္ထု၊ စိတ်ကူးယဉ်ဝတ္ထု စသည်ဖြင့် စုံလှပေသည်။ ၎င်းတို့အနက်မှ အမှီးဝတ္ထုများသည် မြန်မာစာပေလောကတွင် ခေတ်တစ်ခေတ်အဖြစ် ရပ်တည်နိုင်ခဲ့သည်ကို တွေ့ရသည်။ ဤသို့သော အမှီးဝတ္ထုများသည် နိုင်ငံခြားဝတ္ထုများကို ဘာသာပြန်ပြီးမှ မှီးရသည်ဖြစ်သော်လည်း နိုင်ငံခြားဝတ္ထုဟု မထင်ရအောင် မြန်မာဆန်နေသော ကြောင့် အမှီးဝတ္ထုဟု သိသူပင်မများဘဲ ပင်ကိုရေးဝတ္ထုဟုထင်သူ များလှကြောင်း တွေ့ရသည်။ အမှီးဝတ္ထု သဘောသဘာဝအရ ဘာသာပြန်ဝတ္ထုနှင့် သဘောတရားမတူဘဲ ဘာသာပြန်ပြီးမှ မှီးရသည့်တိုင်အောင် မြန်မာဆန်နေ ခြင်းပင်ဖြစ်သည်။ ဤအမှီးဝတ္ထုများကြောင့်လည်း မြန်မာစာပေ လောကတွင် ရှေးဝတ္ထုများကခွဲထွက်လာသည့်ကာလပေါ်ဝတ္ထုများ ပေါ်ပေါက်လာခြင်းဖြစ် ပေသည်။ ဤသည်ကို လေ့လာနိုင်ရန် အမှီးဝတ္ထု သမိုင်းတစ်ကွက်ကို အနည်းငယ် လှစ်ကြည့် ရင်းဖြင့် "ရတနာပုံအမှီးဝတ္ထု" ကို အလေ့လာခံအဖြစ် ဆန်းစစ်တင်ပြထားပါသည်။

၁။ ဘာသာပြန်သမိုင်းလေ့လာချက်

ရှေးက ယုံတမ်းဉာဏ်ကို အခြေခံသည့် သဘာဝလွန်တန်ခိုးရှင် ဇာတ်ဆောင်များဖြင့် ဖန်တီး ခဲ့သော ဒဏ္ဍာရီဝတ္ထုများ ပေါ်ထွန်းခဲ့ရာမှ (၁၉၀၂) ခုနှစ်တွင် ဦးဘိုးဇော် တိုက်ရိုက်ဘာသာပြန်သော ရော်ဘင်ဆင်ခရူးဆိုး (Robinson Crusoe) ဝတ္ထုစပေါ်လာခဲ့ရာ မြန်မာစာဖတ်ပရိသတ်များအား ဒိဋ္ဌဓမ္မ လောကကြီးနှင့် ထိတွေ့စေခဲ့သည်ဟု ဆိုရပေမည်။ ထို့နောက်မှ (၁၉၀၄)ခုနှစ် ၌ ဂျိမ်းလှကျော် ဘာသာပြန်မှီငြမ်းပြုခဲ့သည့် "မောင်ရင်မောင် မမယ်မ" ဟူသော မြန်မာဆန်သည့် မြန်မာ့ဟန်ဝတ္ထု ပေါ်လာသောအခါ ရှေးက ရိုးရိုးဘာသာပြန် "ရော်ဘင်ဆင်ခရူးဆိုး" ကို ကျော်သွားကာ တစ်နိုင်ငံလုံး ၏ ရင်ကို ဆွဲဆောင်ယူငင်နိုင်ခဲ့သည်။ မြန်မာ့ကာလပေါ်ဝတ္ထု (novel) ၏ အစကနဦး ဖြစ်ခဲ့သည်ဟု

* ဒေါက်တာ၊ ဒုတိယပါမောက္ခချုပ်၊ မန္တလေးနိုင်ငံခြားဘာသာတက္ကသိုလ်

ဆိုရမည်ဖြစ်သည်။ စင်စစ် "မောင်ရင်မောင် မမယ်မ" ဝတ္ထုသည်လည်း ဂျိမ်းလှကျော်၏ ပင်ကိုရေးဝတ္ထု မဟုတ်ဘဲ (Alexander Dumas) ၏ "The Count of Monte Cristo" ဝတ္ထုကို ဇာတ်လမ်းကျောရိုးသာယူ၍ ဇာတ်အိမ် အချို့ကို ပြင်ဆင်ပြောင်းလဲပြီး မြန်မာဆန်အောင် ဖန်တီးထားသော ပထမဦးဆုံး အမှီးဝတ္ထုတစ်ပုဒ်ဖြစ်သည်။ မည်သို့ပင်ဆိုစေ ဒိဋ္ဌဓမ္မလောကကို ဖော်ကျူးပြသနေသော ကာလပေါ်ဝတ္ထုဆန်းဖြစ်၍ လူအများက ထူးခြားစွာ လက်ခံလာကြခြင်း ဖြစ်ဟန်တူသည်။ အဘယ့်ကြောင့်ဆိုသော် ရှေးယခင်က ဘုရားဟောဇာတ်ကများကို အခြေခံ၍ ရေးသားကြသော ဇာတ်ကစာပေများ၊ ယုံတမ်းညာဏ်ကို အခြေခံ၍ သဘာဝလွန်တန်ခိုးရှင်များဖြင့် ဖန်တီးထားသောဝတ္ထု (Fiction) များ၊ နန်းတွင်းသူ နန်းတွင်းသားများ၏ ဘုန်း၊ လက်ရုံး၊ အချစ်ရေးတို့ကိုသာ ရေးခဲ့သောဝတ္ထုများ စသည်တို့သာ ရှိခဲ့ရာမှ ယခုကဲ့သို့ နိုင်ငံခြားဝတ္ထုများကို ဘာသာပြန်ရာမှ အမှီးအဖြစ် ဖန်တီးတတ်လာသော အမှီးဝတ္ထုရေးဟန်များပြောင်မြောက် လာမှုကြောင့် မြန်မာစာပေတွင် ကာလပေါ်ဝတ္ထု၏ အခန်းကဏ္ဍ တစ်ခုအဖြစ် မှတ်တိုင် စိုက် နိုင်ခဲ့ခြင်းဖြစ်ပေသည်။ ထိုမှ ဆရာရွှေဥဒေါင်း၊ ပီမိုးနင်းတို့က အမှီးဝတ္ထုများကို ဆက်လက် ဖန်တီးရေးသားလာခဲ့ကြ လေတော့သည်။

၂။ သုတေသနမေးခွန်း

- (၁) ကာလပေါ်ဝတ္ထုဟု အဘယ့်ကြောင့် ခေါ်ကြသနည်း။
- (၂) ဘာသာပြန်နှင့် အမှီးတို့၏ ကွာခြားချက်များကားအဘယ်နည်း။
- (၃) အမှီးဝတ္ထုများသည် သက်ဆိုင်ရာမူရင်းဝတ္ထု၏ အတိုင်းအတာအတိုင်း ထပ်တူရှိပါသလား။

၃။ စာပေလေ့လာတွေ့ရှိချက်

၃.၁ ဘာသာပြန်နှင့် အမှီးဟူသည်

စင်စစ်အမှီးသည် ဘာသာအရင်ပြန်ပြီးမှ မှီးရခြင်းဖြစ်သည်။ သို့သော်လည်းဘာသာပြန်နှင့် အမှီးကား ကွာခြားလှသည်။ ဘာသာပြန်ရာတွင် တိုက်ရိုက်ဘာသာပြန်ခြင်း၊ ဆီလျော်အောင် ဘာသာပြန်ခြင်းဟု ယေဘုယျအားဖြင့် တွေ့ရသည်။

“တိုက်ရိုက်ဘာသာပြန်ခြင်း ဆိုသည်မှာ မူရင်းဇာတ်တွင် ပါဝင်သော လူမျိုးတို့၏ နာမည်၊ အလေ့အထ၊ အမူအရာ၊ အသုံးအနှုန်း တို့ကိုလည်းယူ၊ လူ့သဘောဇာတ်သဘောကိုလည်းယူ၍ ဇာတ်မူရင်းအတိုင်းဘာသာပြန်ရာတွင် ဘာသာပြန်သူ၌ ဘာသာပြန်နိုင်သောသတ္တိအပြင် တိုင်းရင်းသားတို့၏ သဘောသက်ဝင်အောင် ညှိနှိုင်းတတ်သောသတ္တိလည်း လိုအပ်လှပေသည်။

ဆီလျော်အောင်ဘာသာပြန်ခြင်း ဆိုသည်မှာ မူရင်းဇာတ်တွင်ပါဝင်သော လူမျိုးတို့၏ အမည်၊ အလေ့အထ၊ အမူအရာ အသုံးအနှုန်းတို့ကိုပယ်၊ လူ့သဘောဇာတ်သဘောကိုသာ ယူပြီးနောက်၊

တိုင်းရင်းသားတို့၏ နာမည်၊ အလေ့အထ၊ အမူအရာ အသုံးအနှုန်းတို့နှင့် တွဲစပ်၍ ဘာသာပြန်ခြင်း ဖြစ်သည်။ တိုက်ရိုက်ဘာသာပြန်ခြင်းမှာ translation ကို ဆိုလိုကာ၊ ဆီလျော်အောင်ဘာသာပြန်ခြင်း မှာ adaptation ကို ဆိုလိုပါသည်။" (စာ၊ ၂၃၊ ဘာသာပြန်သဘော၊ ဘာသာပြန်စာပေစာတမ်းများ (ပထမတွဲ))

ထို့ကြောင့် တိုက်ရိုက်ဘာသာပြန်ရာတွင် မူလနိုင်ငံ၊ အမည်၊ ဇာတ်လမ်း၊ ယဉ်ကျေးမှု စသည်တို့အားလုံး အတိုင်း ဘာသာပြန်ရခြင်းဖြစ်ပြီး၊ ဆီလျော်အောင်ဘာသာပြန်ခြင်းမှာကား ဇာတ်လမ်းနှင့် လူသဘာဝကိုသာယူပြီး ဓလေ့စရိုက်၊ ယဉ်ကျေးမှု၊ အသုံးအနှုန်းတို့ကို ဘာသာပြန်သူ၏ နိုင်ငံ၊ လူမျိုးအတိုင်း ဆီလျော်အောင်ပြုပြင်ပြောင်းလဲပစ်ခြင်းကို ဆိုလိုပေသည်။ ဆီလျော်အောင် ဘာသာပြန်ခြင်းသည် တစ်နည်းအားဖြင့် အမှီးပြုခြင်း အမှီးဝတ္ထုဖန်တီးခြင်းပင် ဖြစ်ပေသည်။ အများအားဖြင့် ဆီလျော်အောင်ဘာသာပြန်ခြင်းကို အမှီးဝတ္ထုများ၌သာ တွေ့နိုင်သည်။ အဘယ့်ကြောင့်ဆိုသော် သုတ (သိပ္ပံ၊ ဝိဇ္ဇာ၊ လူမှုသိပ္ပံ) စာပေတို့၌ တိကျမှန်ကန်မှုရှိရန်လိုခြင်း၊ သတင်းများ၌လည်း တိကျမှန်ကန်ရန် အရေးကြီးခြင်း စသည်တို့ကြောင့် မူရင်းအတိုင်း အတိအကျပြန်ရန်လိုသော်လည်း ရသစာပေ(ဝတ္ထု)များကို မှီးရာတွင်မူ ဘာသာပြန်မှီးသူ၏ ဓလေ့စရိုက်၊ ယဉ်ကျေးမှုနှင့် လိုက်ဖက်အောင် ပြောင်းလဲဖန်တီးခွင့် ရှိလေသည်။ သို့သော် မည်သို့ပင် ဆီလျော်အောင်ပြောင်းလဲဖန်တီးထားစေကာမူ မူရင်းအဘော်၊ ဇာတ်လမ်း၊ လူသဘာဝကိုကား မပျောက်အောင်ယူရခြင်း ဖြစ်ပေရာ ပင်ကိုရေးနှင့် တူသွား၍ ပိုမိုစွဲမက်ဖွယ်လည်း ကောင်းသည်ကို တွေ့ရသည်။

ထို့ကြောင့်လည်း (၁၉၀၂)ခုနှစ် တွင် ပေါ်ခဲ့သော "ရော်ဘင်ဆင်ခရူးဆိုး" ဝတ္ထုသည် တိုက်ရိုက် ဘာသာပြန်ထားသဖြင့် မြန်မာစာဖတ်ပရိတ်သတ်ကိုသာမန်မျှသာ ဆွဲဆောင်နိုင်ခဲ့ပြီး (၁၉၀၄)ခုနှစ် တွင် ပေါ်ခဲ့သည့် "မောင်ရင်မောင် မမယ်မ" အမှီးဝတ္ထုကား မြန်မာ့ရေမြေသဘာဝ ယဉ်ကျေးမှုအတိုင်း ပြောင်းလဲဖန်တီးထား၍ မြန်မာလူထု၏ ရင်ကို ထိခတ်ဆွဲဆောင်နိုင်ခဲ့ကြောင်း တွေ့ရခြင်းဖြစ်သည်။

ထို "မောင်ရင်မောင် မမယ်မ" အမှီးဝတ္ထုပေါ်ပြီးနောက်မှ ချဉ်ပေါင်ရွက်သည်မောင်မိုင်း၊ စပယ်ပင်၊ ရွှေပြည်စိုး၊ မှာတော်ပုံ၊ မောင်စံသူမဖွားသိုက် စသော ပင်ကိုရေးဝတ္ထုများ ပေါ်လာခဲ့ခြင်းသည်လည်း အမှီးဝတ္ထုဖန်တီးခဲ့ခြင်း၏ အကျိုးကျေးဇူး ဖြစ်ပေသည်။

ထို့နောက်မှ အင်္ဂလိပ်စာတတ်သူ ပီမိုးနင်း၊ ဆရာရွှေဥဒေါင်းတို့က အင်္ဂလိပ်ဝတ္ထုများကို ဘာသာပြန်မှီးကာ မြန်မာပရိသတ် ထဲသို့ အမှီးဝတ္ထု မြောက်များစွာသွတ်သွင်းခဲ့သည်။ ဆရာတို့၏ အမှီးဖန်တီးမှုပညာစွမ်းကြောင့် ယနေ့တိုင် နိုင်ငံခြားဝတ္ထုမှ မှီးထားကြောင်း သိသူနည်းလှပြီး မြန်မာပင်ကိုရေးဝတ္ထုများဟု ထင်နေသူများ ရှိနေခြင်းဖြစ်သည်။

သာမကအားဖြင့် ဆရာရွှေဥဒေါင်း၏ "စုံထောက်မောင်စံရှား" ဝတ္ထုများသည် အင်္ဂလိပ် စာရေးဆရာကြီး ဆာအာသာကိုနင်ဒိုင်း (Sir Arthur Conan Doyle) ၏ ရှားလော့ဟုမ်း (Sherlock Holmes) ဝတ္ထုများကို ဆီလျော်အောင် မှီးခဲ့ခြင်းဖြစ်သည်။ ဆက်၍ ရူပနန္ဒီ၊ ရူပကလျာဏီ၊ ဝင်္ကန္တ၊ ပထမဆရာသိန်း စသော အမှီးဝတ္ထုများ ထွက်ရှိခဲ့သည်။ ဆရာကြီးရွှေဥဒေါင်း၏ အမှီးဖန်တီးမှု

ကောင်းလွန်း၍ ယနေ့တိုင် မြန်မာပင်ကိုရေးဝတ္ထုအဖြစ် ထင်ယောင်နေခဲ့ကြခြင်းဖြစ်သည်။ ဤစာတမ်းတွင် ဆရာကြီး၏ အမှီးဝတ္ထုတစ်ပုဒ်ဖြစ်သော “ရတနာပုံ” ဝတ္ထုမှ ဆရာကြီး၏ မှီးကွက်တချို့ကို လေ့လာခြင်းဖြင့် ဆရာကြီး၏ အမှီးဖန်တီးမှုပညာကို သုံးသပ်ပါမည်။

၃၊ ၂ ဇာတ်လမ်းအကျဉ်းလေ့လာချက်

ရတနာပုံမန္တလေးမြို့တော်ရှိ စီဗီလင်းတွင် ပင်စင်စားစစ်ကဲကြီး ဦးထင်ကျော်သည် မိတဆိုးသမီးလေး ခင်စိန်ကြည်ကို အလွန်သနားချစ်ခင်အလိုလိုက်ခဲ့သူ ဖြစ်သော်လည်း ငွေအသုံးအစွဲကြမ်းသဖြင့် အကြွေးများတင်နေသူဖြစ်သည်။ ထို့ကြောင့် ထိုအိမ်ကို တိတ်တဆိတ် ပေါင်ထားရာမှ ရှေ့နေ ကိုထွန်းမြတ်က လာဝယ်ရာ သမီးမသိအောင် တိတ်တဆိတ်ရောင်းခဲ့ပြီး နောက် ကွယ်လွန်ခဲ့ပြီး ခင်စိန်ကြည် ဒုက္ခရောက်ခဲ့သည်။ ခင်စိန်ကြည် ကို စမြင်ကတည်းက မေတ္တာသက်ဝင်ခဲ့သော ကိုထွန်းမြတ်က ခင်စိန်ကြည်ကို လက်ထပ်ယူခဲ့သည်။ ကလေး (၃)ယောက် ရပြီးမှ ခင်စိန်ကြည်ကကိုထွန်းမြတ်ကို မိမိရီ ဆိုသူနှင့် အထင်လွဲနေခိုက် ပိုမိုစိတ်ထိခိုက်အောင် ပိုမို အထင်လွဲစိတ်နာအောင် အနားမှကပ်၍ အမျိုးမျိုးကုန်းချောသိမ်းသွင်းနေသော ရုပ်ချောငွေပေါကာ ကြာကူလီလုပ်တတ်သည့်မောင်သက်ညွန့်နှင့် လိုက်ပြေးသွားတော့သည်။ မောင်သက်ညွန့် အကျင့်မကောင်းမှန်းသိချိန်၌ ကွာရှင်း၍ ခင်စိန်ကြည် မီးလောင်မှုဖြစ်ပြီး ရုပ်ပျက်သွားရာမှ ယခင်အိမ်ထောင် ကိုထွန်းမြတ်နှင့် သားသမီးများကို လွမ်းဆွတ်ပြီး ဆရာမဟန်ဆောင်၍ မိမိအိမ်ဟောင်းသို့ ပြန်သွားခဲ့သည့်ဇာတ်လမ်းဖြစ်သည်။ လူသတ်မှုတစ်ခုကိုပါ ဇာတ်လမ်းဆင် ထည့်ထားပြီးလူသတ်တရားခံမဟုတ်ဘဲဝရမ်းပြေးဖြစ်နေသည့် မိမိရီ၏အစ်ကို ကိစ္စအတွက် မိမိရီနှင့်ရှေ့နေမောင်ထွန်းမြတ်တို့ တိတ်တဆိတ်တွေ့ဆုံတိုင်ပင်ခဲ့ ကြရပုံကိုမြှုပ်ကွက် အဖြစ်တွေ့ရသည်။ နောက်ဆုံး၌ လူသတ်တရားခံမှာ မောင်သက်ညွန့်ဖြစ်နေခဲ့သည်။ ခင်စိန်ကြည် သည် သားသမီးစိတ်၊ ခင်ပွန်းဟောင်းကို နောက်အိမ်ထောင်နှင့် တစ်အိမ်တည်း နေ့စဉ်မြင်နေရသော စိတ်တို့ကြောင့် နှလုံးရောဂါဖြင့် ကွယ်လွန်သွားခဲ့သည်။ ဇာတ်လမ်းမှာ အလွမ်းဖြင့် အဆုံးသတ် ထားသော်လည်း လောကီလူလောကတွင် ဖြစ်လေ့ဖြစ်ထ ရှိသော အဖြစ်အပျက်များဖြင့် ဖန်တီးထားခြင်း၊ ခင်စိန်ကြည် စိတ်ညစ်အောင် အတူနေယောင်းမ ဒေါ်ဝွမ်းပုံ၏ တဖျစ်တောက်တောက် ပြောဆိုခြင်းတို့နှင့် တန်ဆာဆင်ထား၍ ယုတ္တိရှိပြီး မြန်မာပင်ကိုရေးဝတ္ထုဟု ထင်ရလောက်အောင် မြန်မာဆန်နေခဲ့ကြောင်း တွေ့နိုင်ပါသည်။

၃၊ ၃ အမှီးအချို့ကို ထုတ်နုတ်လေ့လာချက်

မူရင်း အင်္ဂလိပ်ဝတ္ထု ‘အိစလင်း’ (East Lynne) ကို (၁၈၆၁)ခုနှစ်တွင် ထုတ်ဝေခဲ့ပြီး အခန်းပေါင်း (၆၂)ခန်း ပါဝင်ကာ စာမျက်နှာမှာ (၄၉၇)မျက်နှာ ဖြစ်သည်။ အမှီးဝတ္ထုတွင်မူ (၃၂)ခန်းသာပါပြီး ၂၀၂၂ ပုံနှိပ်ခြင်းအရ စာမျက်နှာ (၃၇၄) မျက်နှာ ဖြစ်သည်။ (၁၉၁၇)တွင် အခန်းဆက်အဖြစ် စတင် ခဲ့ပြီး (၁၉၅၃)ခုနှစ်တွင်မှလုံးချင်းအဖြစ် ပထမအကြိမ်ထုတ်ဝေခဲ့သည်။

အမှီးသဘာဝအတိုင်း ဇာတ်လမ်းကျောရိုးကို ယူထားပြီး မူလဇာတ်လမ်း၏ အဘော်ကို မပျောက်အောင် ဖန်တီးရေးဖွဲ့ထားသော်လည်း မလိုအပ်သော ဇာတ်ကွက်အချို့ကို ပျောက်ပြီး

မှီးခဲ့ကြောင်း တွေ့ရသည်။ သို့သော် ဇာတ်လမ်းကို မထိခိုက်ရလေအောင် အရေးပါသည့် ဇာတ်လမ်း ဇာတ်ကွက်များကိုမူ ချန်လှပ်ခြင်းမရှိဘဲ ဆီလျော်အောင်ပြုခဲ့သည်။ သာဓက အားဖြင့်

မူရင်းတွင် ရှေ့နေကာလိုင်းက အစ္စဘယ်ဟူသော မြို့စားကြီးသမီးကို မေတ္တာသက်ဝင် သနားကာ လက်ထပ်ယူခဲ့ပြီး အစ္စဘယ်တို့အိမ် ‘အိစလင်း’ အိမ်ကိုဝယ်ခဲ့သူဖြစ်၍ ထိုအိမ်တွင်ပင် ဆက်နေကြသကဲ့သို့ အမှီးတွင်လည်း ထို့အတူ ဖြစ်သည်။

မူရင်းတွင် အစ္စဘယ်နှင့် ကာလိုင်းစတွေ့ခန်း၌ အစ္စဘယ်ဖခင်က "Well, is she not a handsome girl?" ဟု သူ့သမီး မလှဘူးလားမေးရာ ကာလိုင်းက "I never saw a face half so beautiful." (page 7, East Lynne, 1961) ဟူ၍ သူ့တစ်ဝက်လောက်လှတာတောင် မမြင်ဖူးဘူးဟု ပြောခဲ့သည်။ မြန်မာတို့တွင် ဖခင်က သူစိမ်းယောက်ျားကို ဤသို့ မေးလေ့မေးထမရှိသဖြင့် အမှီးတွင် ဤအချက်ကို ပြောင်းပြီး ခင်စိန်ကြည်ကို ရုတ်တရက်မြင်လိုက်ရသောကိုထွန်းမြတ်အား "ရုတ်တရက် နေ၏အလင်းကို မြင်ရသဖြင့် ဟဒယနှလုံးရွှင်ပြုံးစွာ ရှိဘိသကဲ့သို့" (စာ-၆၊ ရတနာပုံ၊ ၂၀၂၀) ဟုလည်းကောင်း "ရူပါရုံ၌ မနောဓာတ်ငြိတွယ်လျက်နေသည်ဖြစ်သောကြောင့် ဇီဝှာရုံအရသာကို မခံစားနိုင်ဘဲ ရှိရကား စားဖွယ်အမျိုးမျိုး၏ အရသာကို ချိုသည် ချဉ်သည်ဟု မပြောနိုင်လောက် အောင်ပင် ရှိပေ၏။" (စာ-၈၊ ရတနာပုံ၊ ၂၀၂၂) ဟုလည်းကောင်း မြန်မာဆန်ဆန်ပေါ်လွင်အောင် ဖန်တီးထားသည်။

မူရင်းတွင် လယ်ဗီဆင်၏ လူရှုပ်လူပွေဖြစ်ပုံ၊ မာယာများတတ်ပုံကို "He spoke in a tone of thrilling gentleness, gratifying to the ear, but dangerous to the heart" (page 12, East Lynne, 1961) ဟု ဇာတ်ကြောင်းပြောသူက ရေးခဲ့သည်။ အမှီးတွင်မူ ခင်စိန်ကြည် နှင့် မောင်သက်ညွန့် တို့ ဆပ်ကပ်ပွဲတွင် ဆုံကြသည်။ ခင်စိန်ကြည် ဦးလေး ဝတ်လုံတော်၏ဇနီး မသိန်းရင်၏ မောင်ဝမ်းကွဲဖြစ်သူ လူပွေမောင်သက်ညွန့်နှင့် မိတ်ဆက်ပေးရာ မောင်သက်ညွန့်က "ယခုမှပဲမြင်ရ ... မြင်မြင်ချင်း မောင်နှမအရင်းလိုပဲ အောက်မေ့မိပါတယ်" (စာ-၁၆-၁၇၊ ရတနာပုံ၊ ၂၀၂၂) ဟုပြောပုံဖြင့်လည်းကောင်း၊ ဇာတ်ကြောင်းပြောသူနေရာမှ "မိမိစွမ်းအားရှိသလောက် သွယ်ဝိုက်၊ မြှောက်ပင့်၊ နားထောင်သူ ဘဝင်မြင့်အောင် အဆင်သင့်ကြံဖန်၍ပြောရာ..." (စာ-၁၇၊ ရတနာပုံ၊ ၂၀၂၂) ဟုလည်းကောင်း၊ မောင်သက်ညွန့်မကောင်း ကြောင်း ကိုအခြားဇာတ်ဆောင်များ က အပြန်အလှန် ပြောကြပုံထည့်ခြင်းဖြင့် လည်းကောင်း ဖန်တီးသွားသည်။

မူရင်းတွင် အစ္စဘယ်အား ရှေ့နေကာလိုင်း စတွေ့သည့်နေ့၌ နတ်သမီးလေးထက် လှကြောင်း၊ ပုလဲရတနာဝတ်ဆင်ထားကြောင်း၊ ဆံပင်အတွန့်ခွေလေးများက လည်ပေါ်ဝဲကျ နေကြောင်း ဆိုထားပြီး အမှီးတွင်မူ ‘ဆံပင်ကို ဖဲကြိုးအပြာကလေးဖြင့် ကပိုကရီစည်းပြီး အသားအေးစေရုံမျှသာလျှင် သနပ်ခါးအရည်ကျဲကလေးကို မသိမသာလိမ်းလျက် စူရတီပွင့်ထိုး အပြာတစ်ပတ်ရစ်လုံချည်လေးကို လက်တစ်ဖက်နှင့် မခွဲတရို့မပြီးလျှင်’ ဟူ၍ မြန်မာဆန်စေခဲ့သည်။ (စာ၊ ၆၊ ရတနာပုံ၊ ၂၀၂၂။)

မူရင်းတွင် မြို့စားသားအဖ စိန်ဂျူးဘုရားရှိခိုးကျောင်းသို့ တက်မည်ဆို၍ ဝက်စလင်းမြို့၌ ဘာဘရာအပါအဝင်လူအများက ဝတ်ကောင်းစားလှများ ဝတ်လာကြသော်လည်း အစ္စဘယ်က 'မြက်ဦးထုပ်' ဆောင်းကာ အလှမပြင်ဘဲ ရိုးရိုးပဲလာသည်ဟု ဆိုထားပြီး အမှီးတွင် နန်းဦးတိုက်သို့ ဥပုသ်စောင့်သွားကြစဉ် မိမိရီ အပါအဝင် မိန်းမပျိုများအားလုံး ခင်စိန်ကြည်ထက်သာအောင် ဝတ်စားလာကြသော်လည်း 'ခင်စိန်ကြည်သည် တိုက်သရက်ထည် လုံချည်အပြာကလေးနှင့် ပဒုမ္မာအင်္ကျီဒီဘီချကို ဝတ်လျက် ပိုးအနက်ထီးကလေး ကို ကပိုကရိုကိုင်ပြီးလျှင်' ဟု ဖန်တီးထားသည်။ (စာ- ၅၅၊ ရတနာပုံ၊ ၂၀၂၂။)

မူရင်းတွင်အစ္စဘယ်မီးဖွားပြီးကာစအားနည်းနေချိန်အိမ်ဖော်များပြောသောစကားကိုကြားပြီး ကာလိုင်းနှင့်ဘာဘရာကိုသံသယဖြစ်သွားကာ 'o Archibald ! Archibald ! she uttered, don't marry her! I could not rest in my grave.' (page141, East Lynne, 1861) ဟုပြောခဲ့သည်ကို အမှီးတွင် 'ခင် များသေသွားလို့ရှိရင် သူ့မယူပါနဲ့နော်၊သူ့များယူရင် ခင်ဖြင့်ကလေး အတွက် စိတ်ချနိုင် မှာမဟုတ်ဘူး'(စာ-၁၄၈၊ရတနာပုံ၊၂၀၂၂) ဟုပြောပုံကမြန်မာဆန်ပြီးသဘာဝကျနေပေသည်။

ထို့ပြင် မူရင်းတွင် 'လယ်ဗီဆင်' ဟူသော မိန်းမရှုပ်သည့် ဗီလိန် ဇာတ်ဆောင်သည် သူပိုးပန်းနေသူအဖီထံ မြင်းစီး၍လာသော်လည်း အမှီးတွင် မောင်သက်ညွန့်သည် မန္တလေးမြို့တွင် နေသူပီပီ ပိုးပန်းနေသူမအေးမြင့်ထံစက်ဘီးစီး၍လာကြောင်း ပြောင်းထားသည်။

မူရင်းတွင် မစ္စတာကာလိုင်းအစ်မ 'ကော်နီ' က အရက်စည်များထားသောမြေအောက်ခန်းသို့ သွားကာ စည်ပေါက်နေသည်ထင်၍ ဆင်းကြည့်ရင်း အအေးပတ်ကြောင်း တွေ့ရသည်။ အမှီးတွင်မူ ဤအခန်းကို ရှေ့နေမောင်ထွန်းမြတ်၏ အစ်မ မဂျမ်းပုံသည် နှမ်းမနဲစားမိ၍ ဖျားချင်သလိုလို ဖြစ်ကြောင်း မြန်မာဆန်အောင် ရေးဖွဲ့ထားသည်။

မူရင်းတွင် အစ္စဘယ်နေမကောင်းသောကြောင့် ကမ်းခြေမြို့တစ်မြို့၌ အနားယူရန်သွားပုံကို အမှီးတွင် ခင်စိန်ကြည် နေမကောင်းဖြစ်ရာ မိတ္ထီလာမြို့သို့ သွားအနားယူရကြောင်း ပြောင်း ထားသည်။ (ထိုစဉ်က တီဘီရောဂါသည်တို့ မိတ္ထီလာကို သွား၍ နားလေ့ရှိကြ။)

တစ်ဖန် မူရင်းတွင် မစ္စတာကာလိုင်းက အစ်မဖြစ်သူ ကော်နီလီယာ အတွက် ပြင်သစ်ရှောစောင်တစ်ထည် ဝယ်လာရာ (၁၈ ဂီနီ) ပေးရသည်ဟု ဖော်ပြထားသည်။ ဤသည်ကို အမှီးတွင် မောင်ထွန်းမြတ် ရန်ကုန်သို့သွားစဉ် ဖဲပဝါဝယ်လာရာ ရွှေဒင်္ဂါးတစ်ပြား ပေးရကြောင်း ဆိုသွားသည်။ ငွေကြေးအသုံးများတွင်ပါ မြန်မာဆန်အောင်ပြောင်းလဲဖန်တီးရခြင်းကို တွေ့နိုင်သည်။

ထို့အတူ မူရင်း၌ မောင်ဆီဗင်မြို့စားကြီး ကွယ်လွန်ပြီးနောက် သမီး အစ္စဘယ်အား မြို့စားသစ်ဖြစ်သူဦးလေးအိမ်သို့ပို့ရာ ခရီးစရိတ်အဖြစ် မြို့စားသစ်က (၃ ပေါင်) ပေးခဲ့သည်။ ဤသည်ကို အမှီးတွင် ဝတ်လုံတော်ရ ဦးသာဒင်က တူမခင်စိန်ကြည်ကို ငွေစက္ကူ ၁၀ ကျပ်တန် တစ်ရွက်ပေးပုံဖြင့် ငွေကြေးကို ဆီလျော်အောင်ပြောင်းလဲဖန်တီးထားသည်ကို တွေ့ရသည်။

မူရင်း နှင့် အမှီး စိုးငြိမ်းမှုအကျဉ်းချုပ်

မူရင်း	အမှီး
အိစလင်း East Lynne Mrs. Henery Wood (၁၈၆၁)	ရတနာပုံ(အခန်းဆက်ဝတ္ထုရှည်အဖြစ်စပေါ်) ရွှေဥဒေါင်း(၁၉၁၇)
အင်္ဂလန်၊ အိစလင်းအိမ်၊ Earl of Mount Severn မြို့စားကြီး Willian Vane	မြန်မာ၊ မန္တလေး၊ စီမီလိုင်း၊ အငြိမ်းစားစစ်ကဲကြီး ဦးထင်ကျော်
ကာလိုင်း၊ အစ္စဘယ်၊ လယ်ဗီဆင်၊ ဘာဘရာ၊ ရစ်ချတ်၊ ကော်နီလီယာကာလိုင်း၊ အေဖီ စသည့် ဇာတ်ဆောင်ပေါင်း (၇၇)ယောက်	ကိုထွန်းမြတ်၊ ခင်စိန်ကြည်၊ မောင်သက်ညွန့်၊ မိမိရီ၊ မောင်သာချို၊ ဒေါ်ဂျမ်းဘုံ၊ မအေးမြင့် စသည့် ဇာတ်ဆောင်ပေါင်း (၄၄)ယောက်
ငွေသုံးကြမ်း၊ အိမ်ပေါင်ထားရာက တိတ်တဆိတ်ရောင်းရ၊ သမီးဖြစ်သူ အစ္စဘယ်ကို အလိုလိုက်	ငွေသုံးကြမ်း၊ အိမ်ပေါင်ထားရာက တိတ်တဆိတ်ရောင်းရ၊ သမီးဖြစ်သူ ခင်စိန်ကြည်ကို အလိုလိုက်
လယ်ဗီဆင်က အေဖီ ဆီ မြင်းစီး၍လာ	မောင်သက်ညွန့်က မအေးမြင့်ဆီ စက်ဘီးဖြင့်လာ
လယ်ဗီဆင်သတ်ခဲ့သည့် လူသတ်မှုကို ဘာဘရာအစ်ကို ရစ်ချတ်အားပုံချသည့်မြှုပ်ကွက်	မောင်သက်ညွန့်သတ်ခဲ့သည့် လူသတ်မှုကို မိမိရီအစ်ကို မောင်ဘချိုအား ပုံချသည့်မြှုပ်ကွက်
အစ္စဘယ်နေမကောင်း၍ ကမ်းခြေသွားနားရ	ခင်စိန်ကြည်နေမကောင်း၍ မိတ္ထီလာသွားနားရ
အစ္စဘယ် - ရထားမှောက်၍ ရုပ်ပျက်သွား	ခင်စိန်ကြည် - မီးလောင်၍ ရုပ်ပျက်သွား
အစ္စဘယ် ရုပ်ပျက်ပြီး ကလေးများကို လွမ်း၍ ဆရာမအသွင်ဖြင့် ပြန်လာ	ခင်စိန်ကြည် ရုပ်ပျက်ပြီး ကလေးများကို လွမ်း၍ ဆရာမအသွင်ဖြင့် ပြန်လာ
လယ်ဗီဆင် လူသတ်မှုပေါ်	မောင်သက်ညွန့် လူသတ်မှုပေါ်
ကာလိုင်းက ဘာဘရာနှင့် လက်ထပ်	မောင်ထွန်းမြတ်က မိမိရီနှင့် လက်ထပ်
အစ္စဘယ် နှလုံးရောဂါဖြင့် ကွယ်လွန်	ခင်စိန်ကြည် နှလုံးရောဂါဖြင့် ကွယ်လွန်

ခြုံငုံသုံးသပ်ချက်

တိုက်ရိုက်ဘာသာပြန်ခြင်းနှင့် ဆီလျော်အောင်ပြန်ခြင်းတို့၏ ကွာခြားချက်ကို ဤ အမှီးဝတ္ထုများကို ကြည့်၍ သိနိုင်သည်။ တိုက်ရိုက်ပြန်ခြင်းမှာ မူလအတိုင်း အမည်နာမ၊ ဇာတ်လမ်း၊ လူသဘာဝ၊ ယဉ်ကျေးမှုအတိုင်းပြန်ရ၍ အမှီးမှာကား ဇာတ်လမ်း၊ လူသဘာဝ၊ အဘော် ကိုသာယူ၍ အမှီးဖန်တီးသူနိုင်ငံ၏ ဓလေ့စရိုက်၊ ယဉ်ကျေးမှု၊ ဇာတ်ဆောင်အမည်၊ ကာလဒေသနောက်ခံ တို့ကို ပြောင်းလဲထားရကြောင်း တွေ့ရသည်။ တစ်ခါတစ်ရံတွင် ကိုယ့်နိုင်ငံတွင်မရှိသော အရာအတွက် ယုတ္တိတန်စေရန်အတွက်ဟု ပြောင်းလဲဖန်တီးခြင်းမျိုးလည်း ရှိနိုင်ကြောင်း တွေ့ရသည်။ မူရင်းတွင် ရထားမှောက်၍ ရုပ်ပျက်သွားသော်လည်း အမှီးတွင် မီးခွက်ဖြင့်စာဖတ်ရင်း အိပ်ပျော်ရာမှ မီးစွဲလောင်ခဲ့သော ခင်စိန်ကြည်အဖြစ် အသွင်ပြောင်းထားခြင်းမှာ မြန်မာနိုင်ငံတွင် ဗြိတိသျှဘားမား ရထားလိုင်း (၁၈၇၇)က စတင်ခဲ့ခြင်းဖြစ်သော်လည်း ထိုခေတ် ထိုအချိန်က မြန်မာတွင် ရထား အသုံးပြုခြင်း၊ ရထားမှောက်ခြင်း စသည်တို့ ရှားပါးနည်းပါးသည့်ခေတ်ဖြစ်၍ ခင်စိန်ကြည်ကို မီးလောင်၍သာ ရုပ်ပျက်စေရန် ယုတ္တိရှိအောင် ပြောင်းလဲဖန်တီးခဲ့ခြင်းဖြစ်ဟန်တူသည်။

တစ်ဖန် မြန်မာတွင် ထိုစဉ်က မြင်းစီးသည့်ဓလေ့ နည်းပါးသွားပြီး မန္တလေးမြို့ကို နောက်ခံ ထားသဖြင့် မြင်းအစား စက်ဘီးစီးရသည့်အသွင်သို့ ပြောင်းလဲထားခြင်းဖြင့် ပိုမို ယုတ္တိရှိစေကြောင်း တွေ့ရသည်။ ကာလိုင်းအစ်မက အရက်စည်များသွားကြည့်၍ အအေးပတ်ခြင်းကိုထိုခေတ်က မြန်မာ နိုင်ငံတွင်အရက်သောက်ခြင်း ဓလေ့ခေတ်မစားသေး၍ မောင်ထွန်းမြတ်အစ်မ ဒေါ်ဂျမ်းပုံ ကို နှမ်းမနဲစားပြီး နေမကောင်းပုံ ပြောင်းထားခြင်းကအစ မြန်မာမှုဖန်တီးမှုပညာကိုတွေ့နိုင်သည်။

မူရင်းတွင် ခရစ်ယာန်ဘုရားရှိခိုးကျောင်းသို့ သွားသည့်အခန်းကို အမှီးတွင် ဘုန်းကြီးကျောင်း သို့ သီလယူသွားကြောင်း ပြောင်းလဲထားသည်မှာလည်း မြန်မာ့ဘာသာအယူဝါဒနှင့် ဆီလျော် ကြောင်း တွေ့ရသည်။

ဇာတ်ဆောင်တို့၏ ပုံပန်းသဏ္ဌာန်၊ ဓလေ့စရိုက်နှင့် ဝတ်ပုံစားပုံတို့ကို မှီးရာတွင်လည်း မြန်မာ့ ရေမြေသဘာဝနှင့်ကိုက်ညီအောင် မှီးငြိမ်းထားနိုင်သည်ကို တွေ့ရသည်။

မြို့ရွာဒေသအခေါ်အဝေါ်၊ လူအမည်များ၊ ပြောဆိုနေထိုင် စားသောက်ပြုမူပုံ အလုံးစုံကို အင်္ဂလန်ဟု လုံးဝမထင်ရဘဲ မြန်မာပြည် မန္တလေးနှင့် ရန်ကုန်ဟူသော အထင်ရောက်စေအောင် ပြောင်းလဲထားနိုင်ခြင်းမှာ ချီးကျူးစရာပင်ဖြစ်သည်။ ငွေကြေး၊ အဝတ်အစား စသည်တို့ကို ပြောင်းထားခြင်းသည်လည်း ယုတ္တိတန်စေသောနှုန်းထား၊ ထိုခေတ် မြန်မာမိန်းကလေးတို့ ဝတ်ဆင်လေ့ရှိသော ဟန်ပန်အသုံးအဆောင်တို့ကို မြင်ယောင်လာအောင် သရုပ်ဖော်ပြနိုင်ခြင်း စသည်တို့ကြောင့် မငြီးငွေ့နိုင်အောင် ဆွဲဆောင်ထားနိုင်ကြောင်း တွေ့ရသည်။ ထို့ကြောင့်လည်း 'ရတနာပုံ' ဝတ္ထုကို ရုပ်ရှင်ရိုက်ခဲ့ရသည်ထိ အောင်မြင်ခဲ့ရုံမျှမက ရုပ်ရှင်တွင်ပါ နာမည်ကျော်ခဲ့ရသော ဆရာရွှေဥဒေါင်း၏ အမှီးဝတ္ထုဖြစ်ပါသည်။ ဤ ရတနာပုံဝတ္ထုကို မူရင်းအင်္ဂလိပ်ဝတ္ထုနှင့် ယှဉ်တွဲပါမှ ဆရာကြီး၏ ဘာသာပြန် အတတ်ပညာ၊ အမှီးပညာ တို့ကို ယခုကဲ့သို့ ထင်ရှားစွာသိမြင်နိုင်ပြီး အမှီးဝတ္ထုမှန်း မသိသူအတွက်မူ ပင်ကိုရေး မြန်မာအလွမ်းဝတ္ထုနှင့်ပင် တူနေတော့သည်ဖြစ်သည်။

နိဂုံး

ဤစာတမ်းသည် မြန်မာစာပေလောကရှိ ဘာသာပြန်အမှီးလေ့လာချက်စာတမ်းဖြစ်သည့် အားလျော်စွာ တိုက်ရိုက်ဘာသာပြန်ခြင်းနှင့် ဆီလျော်အောင်ဘာသာပြန်ခြင်းတို့၏ မတူကွဲပြားချက်များကို သိရှိစေပြီး ဆီလျော်အောင်ပြန်ခြင်းသည် အမှီးပြုလုပ်ခြင်းပင်ဖြစ်၍ ရသစာပေဖန်တီးမှုတွင်သာ ဆီလျော်အောင်ဘာသာပြန်ခြင်းကို တွေ့ရှိရနိုင်ကြောင်း ဖော်ပြထားသည်။ ဤသို့ဖော်ပြရာတွင် အလေ့လာခံအဖြစ် မူရင်း အိစလင်း (East Lynne) အင်္ဂလိပ်ဝတ္ထုနှင့် 'ရတနာပုံ' အမှီးဝတ္ထုတို့ကို ယှဉ်တွဲကာ အလေ့လာခံအဖြစ်တင်ပြထားရာ အမှီးဝတ္ထုဖန်တီးမှုကိုပါ တစ်စေ့တစ်စောင်း သိရှိနိုင်မည်ဖြစ်သည်။ ဤသို့ ယှဉ်ပြထားရာတွင် စာတမ်းအတိုင်းအတာအရ အနည်းငယ်မျှသော သာဓကများကိုသာ ထုတ်နုတ်တင်ပြထားခြင်းဖြစ်ပါသည်။ မည်သို့ပင်ဆိုစေ ဤစာတမ်းကြောင့် အမှီးဝတ္ထုတစ်ပုဒ်ဘာသာပြန်မှီးရပုံတို့ကို သုတရရှိစေခဲ့သည့်အတွက် ဘာသာပြန်လုပ်ငန်းများ၊ အမှီးဝတ္ထုများ ဖွံ့ဖြိုးလာပါလျှင် စာတမ်းပြုစုရေးရာ နပ်ပြီဟု ယူဆမိပါသည်။

ကျေးဇူးတင်လွှာ

ဤစာတမ်းဖြစ်မြောက်စေရန် ပညာရေးအတွက် အစအဦးမြေတောင်မြောက်ပေးခဲ့ကြသော ကျွန်မ၏ မိဘနှစ်ပါး၊ သင်ဆရာမြင်ဆရာကြားဆရာများနှင့်တကွ (၂၅)နှစ်မြောက် ရန်ကုန်အရှေ့ပိုင်းတက္ကသိုလ် ကျောင်းမွေးနေ့ကျင်းပခြင်း အထိမ်းအမှတ်စာတမ်းဖတ်ပွဲ အတွက်ဖိတ်ခေါ်ရန် စီစဉ်ပေးခဲ့သည့် ရန်ကုန်အရှေ့ပိုင်းတက္ကသိုလ် ပါမောက္ခချုပ်ကြီးအားလည်းကောင်း၊ ကျွန်မအား စာတမ်းသွားရောက်ဖတ်ကြားရန် ခွင့်ပြုပေးခဲ့သည့် မန္တလေး နိုင်ငံခြားဘာသာတက္ကသိုလ် ပါမောက္ခချုပ်ကြီးအားလည်းကောင်း ကျေးဇူးအထူးတင်ရှိပါသည်။

ကျမ်းကိုးစာရင်း

ကြည်ကြည်မိုး၊ (၂၀၀၇)၊ *ရတနာပုံဝတ္ထုနှင့်အမှီးဝတ္ထုများ၏အခန်းကဏ္ဍ*၊ Ph.D Thesis, မြန်မာစာဌာန၊ ရန်ကုန်တက္ကသိုလ်။

ဘာသာပြန်စာပေစာတမ်းများ (၁)တွဲ (၁၉၉၀)၊ ရန်ကုန်၊ စာပေဗိမာန်။

ဘာသာပြန်စာပေစာတမ်းများ (ဒု)တွဲ (၁၉၉၀)၊ ရန်ကုန်၊ စာပေဗိမာန်။

ရွှေဥဒေါင်း၊ (၁၉၅၃)၊ *ရတနာပုံ*၊ ရန်ကုန်၊ လယ်တီမဏ္ဍိုင်စာပေတိုက်။

ရွှေဥဒေါင်း၊ (၂၀၂၂)၊ *ရတနာပုံ*၊ ရန်ကုန်၊ စိတ်ကူးချိုချိုပုံနှိပ်တိုက်။

Wood, Henery (1861), *East Lynne*, T-Nelson & Sons, Ltd.

THE VALUE OF HISTORICAL LINGUISTICS

Yin Myo Tint*

Abstract

This paper analyzes the benefits of studying historical linguistics, a sub-discipline of general linguistics, and provides linguistic examples. It distinguishes between the study of language and the study of linguistics. After introducing various sub-disciplines of linguistics, the Myanmar language is examined through the lens of historical linguistics, incorporating linguistic expressions. Through this study, changes in speech, grammatical expression, and meaning over time are explored. Some usages persist, while others become obscured. This paper aims to highlight how historical linguistics, as a science emphasizing the coexistence of language and culture, sheds light on these phenomena.

Keywords: historical linguistics, speech, grammar, meaning, language and culture

Introduction

This paper deals with Historical Linguistics, exploring different aspects of language change. The most commonly studied areas in historical linguistics include etymology which involves the reconstruction and origin of words as well as analysis and description of multiple speech communities. Another crucial aspect is tracing the history of language as far as possible. Firstly, this paper will introduce the characteristics of Historical Linguistics, as discussed by some scholars. After that, the most appropriate usages in some Myanmar languages will be analyzed based on the historical relations. Finally, the paper will discuss the crucial importance of historical linguistic studies in the Myanmar social community.

Aim

I want to highlight the importance of historical linguistics, a sub-discipline of linguistics that focuses on several languages, including the Myanmar Language. Additionally, this study aims to examine the various usages, considering the assertion that language changes. Specifically, it also aims to illustrate how the Myanmar language changes from period to period through the use of some examples.

Methods

Features of historical linguistics are gathered from various reference books, including 'The World's Major Languages, 2nd Edition (2009) by Campbell, Lyle, Historical Linguistics (2013) by Comrie, Bernard, and 'Historical Linguistics' (1974) by J.M. Anderson and C. Jones. Additionally, insights from Mg Khin Min (Danguphyu) (2010) in the Burmese language are considered. The study then analyzes the social interactions based on some European languages and the Myanmar language.

Research Questions

The research questions for this paper are as follows:

- (a) How are the world's languages related?
- (b) Why did foreign languages come into the mother tongue?
- (c) Why are there any foreign languages in the Burmese language?

Literature Review

General linguistics encompasses a diverse range of interconnected subjects within the broader study of language, featuring subdivisions of the subject are descriptive linguistics, historical linguistics, comparative linguistics, and contrastive linguistics. Ferdinand de

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Saussure's distinction between synchronic and diachronic linguistics remains pivotal, laying the foundation for historical linguistics that emerged in the late 18th century.

P.H. Matthews (1997) defines historical linguistics as the study of language change, focusing on both individual languages and language evolution in general. Widely acknowledged by structural linguistics as a branch dedicated to diachronic relations among language systems, historical linguistics stands apart from synchronic or descriptive linguistics. According to linguist Donald Ringe, historical linguistics assumes continuity in language structures over time unless significant changes in language acquisition and use conditions can be demonstrated.

Historical linguistics seeks to describe language changes at a specific temporal point, whether in the present or a distinct historical period, such as analyzing the grammatical system of contemporary Myanmar or that of Myanmar during the Konbaung period. Descriptive linguistics, which is often considered a cornerstone of general linguistics and synonymous with synchronic linguistics, involves the analysis of languages at a specific point in time, even if they are no longer actively spoken.

Synchronic linguistics is contrasted with diachronic linguistics (or historical linguistics). Historical linguistics, also termed diachronic linguistics, is the scientific study of language change in the sound system, the grammatical system, and semantic changes from period to period, as well as the causes and results of such changes, both from outside the languages and within them.

Comparative historical linguistics, also known as philology, investigates language change and relationships through the comparison of earlier and later forms of a language and different languages. This method helps establish the historical or genetic relationship between languages, using relationships to denote a shared historical origin. For example, the Indo-European languages encompass most European languages and various Asian languages, without multiple branches or sub-families within it. Another significant family is Sino-Tibetan. In the realm of linguistics, three different approaches to language classification, specifically genetic classification, are employed. Genetic classification categorizes languages based on their descent, grouping those that historically evolved from the same ancestor language and are thus considered genetically related. This approach, introduced in the late 18th century, has been widely adopted, serving as the framework for global linguistic surveys. It encompasses the study of the sounds of a language word, word formation, and how languages change from one era to another.

Findings

Linguistics involves the study of the sounds of a language, words, and word structure, encompassing the learning of how to use words. While language is resistant to change, it cannot persist unchanged through time. The three main types of language change are phonological change, semantic change, and grammatical change. Therefore, in this study, I will discuss these aspects based on the Myanmar Language. Additionally, the research explores how languages have evolved from one era to another.

(i) Phonological Change

Phonological change refers to the change in pronunciation. For example, in the Myanmar language,

ပန်ခီ / -pākhī / [in the Bagan period] has become ပန်းချီ / pañ dzī / [in the present day]
 က္လောင် / kalañ / [in the Bagan period] has become ကျောင် / -kañ / [in the present day]
 မ္လေယံ / mṛa-le / [in the Bagan period] has become မြေ / -mje / [in the present day]
 အခိန် / ʔa-kheĩ / [in the Bagan period] has become အချိန် / ʔa-tcheĩ / [in the present day]

ချတ် /tɕhaʔ/ [in the Bagan period] has become ချစ် /thɕiʔ/ [in the present day]

ခရိန်/ka-jeĩ/ [in the Bagan period] has become ခရိုင်/ka-jaĩ/ [in the present day]

ဇီမ /-ɲimá/ [in the Bagan period] has become ညီမ /-ɲimá [in the present day]

Pronunciations in the Bagan period are no longer the same as those in the present day based on orthography.

(ii) Semantic Change

Semantic change refers to changes in the meaning of words over some time. Concerning semantic change, in the Myanmar language, for example, ညံ /-ɲā/ [meant “to be silent/quiet” in the Konbaung period] means “to be noisy” in the present day. သူငယ်တော် /θaŋ dɔ̃/ [meant “a playmate to princes” in the Bagan period] meant “a cleaner in the palace” in the Konbaung period. In the colonial era, young women were called ဇယ်၊ စပုံ၊ မဒ but nowadays it has changed to a common term. Some ancient Burmese words such as ရွာစား၊ နေပုဒ်၊ မိုက်၊ ညံ have been rewritten in modern times, but the meaning is different. These are just examples and there is still a lot of extensive research work to be done. Especially, the meaning of Burmese words used in the Inwa era is different from modern Burmese word meaning although, in the Pagan era, only the speech sounds were different.

(iii) Grammatical Change

Grammatical change refers to the change of grammatical rules in derivation and inflection for the formation of the phrase from the word, the clause from the phrase, the sentence from the clause, etc. As regards grammatical change, in the Myanmar language, for example, the particle သော /ðə/ was used as the particle as well as the adverbializing particle in the grammar of the Bagan period as in:

ယုံသောမူ၍ /-joũ ðə mū jwé/

ဆိုသောမဟုတ်စွာ /shə ðə mə houʔ swā/

In the present day, however, the particle သော is only used as the adjectivizing particle as in ဆိုးသောလူ /shə ðə lū/.

The most common use Burmese grammar in Inwa period was different from today grammar especially particles.

Historical Linguistics observes etymology, the study of history of words and loan words resulting from language contacts. Languages often come into contact due to frequent community interactions, driven by political, economic, and social factors. The language of the community that is politically, economically, militarily, or socially stronger tends to dominate the other. The Myanmar language contains numerous loan words from Pali, English, and Mon. Pali words in particular, are the most commonly used in daily Burmese, reflecting the influence of Buddhism, with words like ဒုက္ခ၊ သုခ၊ မေတ္တာ၊ သစ္စာ၊ ဌာန၊ မုဒိသာ and others. Due to historical and cultural interactions between India and Myanmar, Hindu words such as ပတ်ဆံ၊ ပန်ကာ၊ ပုဆိုး are also present in Burmese. As Burma was once a British colony, English loanwords are politically integrated into the Burmese language. Given the focus on the history of Burmese words, this paper does not delve further into the description of loan words from English. Additionally, neighboring countries like Thailand and Chinese-speaking regions contribute to the linguistic diversity of the Burmese language.

While Myanmar is home to 135 ethnic languages, the Mon people are predominately used in most Burmese peoples. The close historical relationship between Mon and Burmese people, dating back to the Pagan period and influenced by Buddhism, has resulted in numerous

Mon words being integrated into daily Burmese language use, with words like ကျိုက် ၊ ကတော်၊ ဇနီး and more. Many neighborhood and street names in Yangon are also derived from the Mon Language, such as တာမွေ ၊ ကျိုက်ကွဆံ၊ ဗညားဒလ.

Discussion

The Historical Linguistic approach, introduced at the end of the 18th century, has been widely used and provides the framework for all worldwide linguistic surveys conducted to date. Within the field of linguistics, three different approaches to language classification, and genetic classification are employed. Languages that historically developed from the same ancestor language are grouped and are considered genetically related. In geographical contact, languages nearby often borrow words, sounds, morphemes, and even syntactic patterns from each other. Consequently, neighboring languages can come to resemble each other even though they may not be genetically related. As this study has shown, we can observe the multiplicity of languages resulting from natural historical changes and groups of people moving to new places or interacting with speakers of different tongues. When settling in areas with unfamiliar flora and fauna, their language must adapt to new circumstances. As a result, languages exhibit various language varieties and loan words, connecting the world's languages through shared sound and vocabulary similarities. Due to the border between countries, cultures are closely intertwined, and among the mother tongues, foreign languages are present as loan words.

Among the three kinds of language change, phonological change is the most common, semantic change is neither more nor less frequent and grammatical change is relatively rare. Most of the phonological changes occur because people tend to use spoken words more frequently than written words in everyday language. The Burmese language incorporates numerous foreign languages due to the cultural proximity resulting from the closeness of the border.

Conclusion

According to the mentions, it can be seen that Language is constantly changing based on cultural, political, and economic issues. Within the field of linguistics, three different approaches to language classification are employed. Genetic Classification categorizes languages according to their descent, grouping languages that historically developed from the same ancestor language and are considered genetically related.

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သဲကုန်းမြို့နယ်ဒေသသုံး ထူးခြားသည့်ဝေါဟာရများနှင့်စကားသုံးများ လေ့လာချက်

အေးဝင်း*

စာတမ်းအကျဉ်း

ဤစာတမ်းသည် သဲကုန်းဒေသသုံးထူးခြားသည့် ဝေါဟာရများနှင့် စကားသုံးများကို လေ့လာတင်ပြထားသော စာတမ်းဖြစ်ပါသည်။ ဤစာတမ်းတွင် သဲကုန်းဒေသသုံး ထူးခြားသည့်ဝေါဟာရများနှင့် စကားသုံးများကို လေ့လာတင်ပြပါမည်။ ထိုသို့တင်ပြရာတွင် ဘာသာဗေဒပညာရပ်ကို အခြေခံ၍ တင်ပြထားပါသည်။ ဤစာတမ်းကို ပြုစုခြင်းဖြင့် သဲကုန်းမြို့နယ်အတွင်း ပြောဆိုသုံးစွဲနေသော ဒေသိယဝေါဟာရများနှင့် စကားသုံးများသည် မြန်မာစကားပင်ဖြစ်သော်လည်း ဒေသကွာခြားမှုကြောင့် အသွင်ကွဲပြားသော ဒေသိယစကားတစ်ခုပင်ဖြစ်ကြောင်း ခြေခြေမြစ်မြစ်သိရှိနိုင်စေရန်နှင့် ဒေသိယစကားများ မပျောက်ပျက်ဘဲ ထိန်းသိမ်းထားစေရန် မျှော်မှန်းပါသည်။ သုတေသနအမျိုးအစားမှာ ကွင်းဆင်းသုတေသနဖြစ်ပြီး သုတေသနနည်းနာမှာ တွေ့ဆုံမေးမြန်းခြင်းနည်းကို သုံး၍ လေ့လာတင်ပြထားပါသည်။ လေ့လာတင်ပြရာတွင် သဲကုန်းဒေသသုံး ထူးခြားသည့် ဝေါဟာရများနှင့် စကားသုံးများ ဟူ၍ (၂) ပိုင်း ခွဲခြားကာ လေ့လာတင်ပြထားပါသည်။

သော့ချက်ဝေါဟာရများ။ ။ သဲကုန်း၊ ဒေသိယစကား၊ စံစကား၊ အသွင်ကွဲ၊ ဝေါဟာရ၊ စကားသုံး။

နိဒါန်း

ဘာသာစကားအသီးသီးတွင် ပြောဆိုသူတို့၏ နေရာဒေသကိုလိုက်၍ အသံထွက်ပုံ၊ သဒ္ဒါအသုံးအနှုန်း၊ ဝေါဟာရအသုံးအနှုန်း ကွာခြားမှုများ ရှိတတ်ပါသည်။ ထိုသို့ကွဲပြားသော အသွင်ကွဲစကားများကို ဒေသိယစကားဟု သတ်မှတ်ပါသည်။ မြန်မာဘာသာစကားတွင် ဒေသအလိုက်ကွဲပြားနေသောဒေသိယစကားများစွာရှိပါသည်။ ၎င်းဒေသိယစကားများကို မှတ်တမ်းတင်ထားခြင်းမရှိလျှင် တိမ်ကောပျောက်ကွယ် သွားနိုင်ပါသည်။ နေရာဒေသအလျောက် ကွဲပြားသွားသော ဒေသိယစကားများကို ကျယ်ကျယ်ပြန့်ပြန့် လေ့လာခြင်းဖြင့် တိမ်ကောပျောက်ကွယ်သွားမှု မဖြစ်အောင်ထိန်းသိမ်းရန် လိုအပ်လာပါသည်။ ထို့ကြောင့် “သဲကုန်းမြို့နယ်ဒေသသုံး ထူးခြားသည့် ဝေါဟာရများနှင့် စကားသုံးများ လေ့လာချက် ” ခေါင်းစဉ်ဖြင့် စာတမ်းတင်သွင်းခဲ့ခြင်း ဖြစ်ပါသည်။ ဤစာတမ်းတွင် သဲကုန်းမြို့နယ်ဒေသသုံး ထူးခြားသည့်ဝေါဟာရများနှင့် စကားသုံးများကို စံစကားနှင့် နှိုင်းယှဉ်လေ့လာတင်ပြထားပါသည်။

၁။ သုတေသနရည်ရွယ်ချက်

မြန်မာနိုင်ငံအတွင်း ပြောဆိုသုံးစွဲနေသော မြန်မာစကားပင်ဖြစ်သော်လည်း ဒေသကွာခြားမှုကြောင့် အသွင်ကွဲပြားသွားသော သဲကုန်းဒေသိယစကားများကို စနစ်တကျ လေ့လာဖော်ထုတ် နိုင်ရန် ဖြစ်ပါသည်။

* ဒေါ် ဒုတိယကျောင်းအုပ်ကြီး၊ မကွေးပညာရေးဒီဂရီကောလိပ်

၂။ သုတေသနမေးခွန်းနှင့်ပြဿနာ

အောက်ပါ သုတေသန မေးခွန်းနှင့် ပြဿနာအချို့ကို တွေ့ရှိရပါသည်။
 သဲကုန်းဒေသရှိ ဝေါဟာရများနှင့်စကားသုံးများသည် ဒေသအလိုက် ကွဲပြားမှုရှိပါသလား။
 သဲကုန်းဒေသရှိ ဝေါဟာရများနှင့် စကားသုံးများသည် စံစကားနှင့် တူညီမှုရှိပါသလား။
 မတူညီလျှင် မည်သို့ကွဲပြားနေသနည်း။

၃။ သုတေသနအဆိုကြမ်း

သဲကုန်းဒေသသုံး ထူးခြားသည့်ဝေါဟာရများနှင့် စကားသုံးများကို သုတေသနမပြုမီ မေးခွန်းနှင့်ပတ်သက်၍ ကြံဆကြည့်သောအခါ

- (၁) ဒေသိယစကားများသည် ဒေသအလိုက် ကွဲပြားမှုရှိနိုင်သည်။
- (၂) သဲကုန်းဒေသသုံး ထူးခြားသည့်ဝေါဟာရများနှင့် စကားသုံးတို့သည် စံစကားနှင့် ကွဲပြားမှုရှိနိုင်သည်။

၄။ သုတေသနအစီအစဉ်

သဲကုန်းဒေသသုံး ထူးခြားသည့်ဝေါဟာရများနှင့် စကားသုံးများကို လေ့လာသော ဤစာတမ်းတွင်

- (၁) သဲကုန်းဒေသသုံး ထူးခြားသည့် ဝေါဟာရများ
- (၂) သဲကုန်းဒေသ စကားသုံးများ
- (၃) ခြုံငုံသုံးသပ်ချက် ဟူ၍ ခွဲခြားကာ တင်ပြပါမည်။

၅။ သဲကုန်းဒေသ

သဲကုန်းမြို့နယ်သည် ပဲခူးတိုင်းဒေသကြီး (အနောက်) တွင် တည်ရှိပြီး မြောက်လတ္တီတွဒ် (၁၇)ဒီဂရီ (၂၅)မိနစ်နှင့် (၁၈)ဒီဂရီ (၁၅)မိနစ်အကြား အရှေ့လောင်ဂျီတွဒ် (၉၅) ဒီဂရီ (၁၅)မိနစ်နှင့် (၉၅)ဒီဂရီ (၁၇) မိနစ်အကြား တည်ရှိသည်။ ဧရိယာစတုရန်းမိုင် (၂၉၉.၈၇) ကျယ်ဝန်းပြီး ပင်လယ်ရေမျက်နှာပြင်အထက် အမြင့်ပေ (၁၀၃.၀၆) တွင် တည်ရှိပါသည်။ မြေမျက်နှာပြင် အနေအထားမှာ ညီညာပြန့်ပြူးသည်။ မြေဩဇာကောင်းမွန်ပြီး စပါး၊ ပြောင်း၊ နှမ်း၊ မြေပဲ၊ ပဲအမျိုးမျိုးနှင့် ဟင်းသီးဟင်းရွက်များ စိုက်ပျိုးကြသည်။ ဗမာလူမျိုး အများဆုံး နေထိုင်ကြပြီး ကရင်လူမျိုး အနည်းငယ် နေထိုင်ကြသည်။ သဲကုန်းမြို့နယ်သည် ပေါက်ခေါင်း၊ ပေါင်းတည်၊ ရွှေတောင်၊ နတ္ထလင်း ပြည်မြို့နယ်တို့နှင့် နယ်နိမိတ် ထိစပ်လျက်ရှိသည်။

စာပေလေ့လာဆန်းစစ်ချက်များ

စာပေလေ့လာဆန်းစစ်ချက်အနေဖြင့် ဒေသိယနှင့်ပတ်သက်၍ ထုတ်ဝေထားသော စာအုပ်များကို လေ့လာဖတ်ရှုခဲ့ပါသည်။ ဆရာကြီးဦးထွန်းမြင့်၏ ဘာသာဗေဒ၊ သဒ္ဒဗေဒစာအုပ်၊ ဆရာကြီးမောင်ခင်မင်(ဓနုဖြူ)၏ ဘာသာဗေဒနိဒါန်း၊ မြန်မာစကား မြန်မာစာရုပ်ပုံလွှာ၊ စကားသမုဒ္ဒရာ စာသမုဒ္ဒရာ၊ ဒေါက်တာအောင်မြင့်ဦး၏ အင်းလေးဒေသိယစကား ၊လူမှုဘာသာဗေဒသဘောတရား၊ ဘာသာစကားသုတေသန၊ လူမှုဘာသာဗေဒမိတ်ဆက် စာအုပ်များကိုဖတ်ရှုလေ့လာခဲ့ပါသည်။

နည်းနာ

၁။ ပညာရပ်ဆိုင်ရာနည်းနာ

ဒေသိယစကားကို စံစကားနှင့် နှိုင်းယှဉ်တင်ပြရာတွင် ဘာသာဗေဒပညာရပ်ကို အခြေခံ၍ တင်ပြထားပါသည်။ စကားသံများကို သရုပ်ဖော်ရာတွင် အပြည်ပြည်ဆိုင်ရာ သဒ္ဒဗေဒအက္ခရာကို အခြေခံကာ တင်ပြထားပါသည်။ ဆရာကြီးဦးထွန်းမြင့်၏ သဒ္ဒဗေဒစာအုပ်ကို အခြေခံ၍ အသံထွက် အက္ခရာကို ဖလှယ်ကာ တင်ပြထားပါသည်။

၂။ သုတေသနဆိုင်ရာနည်းနာ

၂.၁။ အချက်အလက်များ ကောက်ယူစုဆောင်းခြင်း။

သဲကုန်းဒေသိယ ဝေါဟာရများနှင့် စကားသုံးများကို လေ့လာရာတွင် မိမိသုတေသနအတွက် အချက်အလက်များ ရယူရန် သဲကုန်းဒေသရှိ ကျေးရွာများသို့ ကိုယ်တိုင်ကွင်းဆင်း၍ ဒေသခံတို့နှင့် တွေ့ဆုံမေးမြန်းပြီး လိုအပ်သော အချက်အလက်များကို ရယူခဲ့ပါသည်။ လိုအပ်လျှင်လည်း ဖုန်းဖြင့် ဆက်သွယ်မေးမြန်း၍ အကြောင်းအရာ အချက်အလက်များကို မေးမြန်းမှတ်သား၍ ပြုစုခဲ့ပါသည်။

ပညာရပ်ဆိုင်ရာ သီအိုရီများ

ပညာရပ်ဆိုင်ရာ သီအိုရီများအနေဖြင့် ဘာသာဗေဒပညာရှင်များ၏ ဒေသိယစကားနှင့် စံစကားဆိုင်ရာ သီအိုရီများကို ဖော်ထုတ်တင်ပြပါမည်။

၁။ ဒေသိယစကား

ဒုတိယကျော်အောင်စံထား ဆရာတော်၏ ဝေါဟာရတ္ထပကာသနီကျမ်းတွင်

“ထိုဝေါဟာရသည် ရှင်မဟာသီလဝံသ စီရင်သော လင်္ကာတို့တွင်သာ တွေ့ရများ သည်။ အခြား ရဟန်းပညာရှိ၊ လူပညာရှိတို့ဆိုသော ပျို့၊ မော်ကွန်း၊ ရတု၊ လင်္ကာတို့တွင် မတွေ့ရသဖြင့် ဒေသအလျောက် သုံးစွဲခေါ်ဝေါ်သောအရာကဲ့သို့ရှိ၏” (ကျော်အောင်စံထား၊ ဒုတိယ (ဆရာတော်) ၂၀၁၆၊ စာ-၁၉၉)

ဟူ၍ မိန့်ဆိုထားပါသည်။

ဆရာကြီးမောင်ခင်မင် (ခနုဖြူ)၏ စကားသမုဒ္ဒရာ စာသမုဒ္ဒရာ စာအုပ်တွင်

“နေရာဒေသလိုက်ပြီး အသွင်ကွဲသွားသော စကားမျိုးကို ဒေသိယစကားလေ့လာ သည့် ပညာရှင်များက ဒေသိယစကား (dialect) ဟု ခေါ်ကြသည်။” (ခင်မင်၊ မောင် (ခနုဖြူ)၊ ၁၉၉၇၊ စာ -၃၁)

ဟူ၍ ဖွင့်ဆိုထားပါသည်။

ဒေါက်တာအောင်မြင့်ဦး၏ လူမှုဘာသာဗေဒမိတ်ဆက် စာအုပ်တွင်

“ဘာသာစကားတစ်ခုတွင် အသွင်ကွဲများမည်သို့ ဖြစ်ပေါ်လာသည်။ ဘာသာစကား အသွင်ကွဲများ၏ သွင်ပြင်လက္ခဏာများ မည်သို့ရှိသနည်း။ ဘာသာစကားအသွင်ကွဲများ ဒေသတစ်ခုမှ တစ်ခုသို့မည်သို့ရောက်ရှိသည်။ စသည့်အကြောင်းခြင်းအရာများကို စနစ်တကျ လေ့လာခြင်းသည် ဒေသိယလေ့လာမှုဖြစ်သည်။” (အောင်မြင့်ဦး၊ ဒေါက်တာ၊ ၂၀၀၃၊ စာ-၄၈)

ဟူ၍ ဒေသိယစကားနှင့် ပတ်သက်၍ ဖွင့်ဆိုထားပါသည်။

၂။ စံစကား

ဒေါက်တာအောင်မြင့်ဦး ဘာသာစကားသုတေသနစာအုပ်တွင် စံစကားနှင့်ပတ်သက်၍

“စံစကား၏သွင်ပြင်လက္ခဏာများမှာ တရားဝင်အသိအမှတ်ပြုသော အဘိဓာန်များတွင် စာလုံးပေါင်းသတ်ပုံနှင့်စံဝေါဟာရများဖော်ပြခံရခြင်း၊ တရားဝင်အသိအမှတ်ပြုခံရသည့် သဒ္ဒါ ရှိခြင်း၊ စံအသံထွက်ဖြစ်ခြင်း၊ (စံအသံထွက်ဆိုသည်မှာ စာတတ်ပေတတ်ပုဂ္ဂိုလ်များ၏ မှန်ကန် ပီသစွာပြောဆိုသည့် လေသံမျိုးကို ဆိုလိုသည်။) (အောင်မြင့်ဦး၊ ဒေါက်တာ၊ ၂၀၁၀၊ စာ ၂၃၂)

ဟူ၍ အဓိပ္ပါယ်ဖွင့်ဆိုထားပါသည်။

သဲကုန်းဒေသသုံး ထူးခြားသည့်ဝေါဟာရများနှင့် စကားသုံးများ လေ့လာချက်

သဲကုန်းဒေသတွင်အသုံးပြုသော အချို့ဝေါဟာရများနှင့်စကားသုံးများသည် စံစကားနှင့် မတူဘဲ ထူးခြားမှုရှိနေသည်ကိုတွေ့ရပါသည်။ ထိုဝေါဟာရများသည် သဲကုန်းဒေသဝန်းကျင် တစ်ဝိုက်တွင်သာ အသုံးပြုသော ဒေသသုံး ထူးခြားသည့်ဝေါဟာရများနှင့် စကားသုံးများ ဖြစ်ပါသည်။ ထို့ကြောင့် သဲကုန်းဒေသသုံး ထူးခြားသည့် ဝေါဟာရများနှင့် စကားသုံးများကို လေ့လာတင်ပြပါမည်။

၁။ သဲကုန်းဒေသသုံး ထူးခြားသည့် ဝေါဟာရများ

သဲကုန်းဒေသီယစကားတွင် စံစကား၌ မတွေ့ရဘဲ ဒေသီယတွင်သာ တွေ့ရသည့် စိတ်ဝင်စား ဖွယ် အသုံးထူး ဝေါဟာရများ ရှိပါသည်။ ထို့အပြင် အချို့သော ဝေါဟာရများသည် စံစကားနှင့် မတူဘဲ ထူးခြားမှုရှိနေသည်ကို တွေ့ရပါသည်။ ထိုဝေါဟာရများအနက် ထူးခြား၍ စိတ်ဝင်စားဖွယ် ကောင်းသော ဝေါဟာရအချို့ကို တင်ပြပါမည်။

- အပျိုကြီးပန်း / ə pjō dzì b`ã /

အပျိုကြီးပန်း / ə pjō dzì b`ã / ဆိုသည်မှာ ဒေသသုံး နာမ်ဝေါဟာရတစ်မျိုး ဖြစ်ပြီး စံစကားတွင် ညမွှေးပန်း / ja`hmwè b`ã / ဟူ၍ ပြောဆိုပါသည်။ မြန်မာအဘိဓာန်တွင် “ညမွှေးပန်း / ညှမွှေးပန်း / န - ညအခါတွင် အလွန်မွှေးသော ပန်းပွင့်သည့် အပင်တစ်မျိုး” ဟု ဖွင့်ဆိုထားပါသည်။ ဒေသတွင်း၌သာ တွေ့ရသည့် ထူးခြားသော ဒေသသုံးဝေါဟာရ ဖြစ်ပါသည်။ အပျိုကြီးပန်းနှင့် ညမွှေးပန်းကို တင်စားခေါ်ဝေါ်သည့် သဘောကို တွေ့ရပါသည်။ ဒေသတွင်း နေထိုင်သူများ၏ စိတ်ကူးစိတ်သန်းနှင့် လိုက်လျောညီထွေဖြစ်စေမည့် အဓိပ္ပါယ်ပေါ်မူတည်၍ ခေါ်ဝေါ်သုံးစွဲသည့် ဝေါဟာရ ဖြစ်ပါသည်။

- အရုဏ်ပန်း / ā joũ b`ã /

အရုဏ်ပန်း / ā joũ b`ã / ဆိုသည်မှာ ဒေသသုံး နာမ်ဝေါဟာရတစ်မျိုးဖြစ်ပြီး စံစကားတွင် ဆိပ်ဖလူးပန်း / shei? phə lù b`ã / ဟူ၍ ခေါ်ဝေါ်ကြသည်။ မြန်မာအဘိဓာန်တွင် “ဆိပ်ဖလူး၊ န - လိမ္မော်ရင့်ရောင် ပွင့်တံထိပ်တွင် ပွင့်ဖတ်များရှိသော ရနံ့မွှေးသော ပန်းပွင့်သည့်အပင်” ဟု ဖွင့်ဆိုထားပါသည်။ သဲကုန်းဒေသသုံး ထူးခြားသော ဝေါဟာရ ဖြစ်ပါသည်။ သဲကုန်းဒေသ ကျေးရွာများတွင် ရှေးအခါက ဥပုသ်နေ့ နံနက် အရုဏ်တက်ချိန်တွင် ဘုန်းကြီးကျောင်းများရှိ ဘုရား၊

စေတီများတွင် အရုဏ်ဆွမ်းတင်လှူသည့် အလေ့အထတစ်ရပ် ရှိခဲ့ပါသည်။ ၎င်းအရုဏ်တက်ချိန်တွင် ဆိပ်ဖလူးပန်းများကိုလည်း ကောက်ယူပြီး ဗုဒ္ဓမြတ်စွာအား ကပ်လှူပူဇော်ကြသည်။ အရုဏ်တက်ချိန်တွင် ကပ်လှူပူဇော်သည်ကိုအကြောင်းပြု၍ ဆိပ်ဖလူးပန်းကို "အရုဏ်ပန်း"ဟု ခေါ်ဝေါ်သုံးစွဲသည့် သဘောဖြစ်ပါသည်။ဒေသတွင်း နေထိုင်သူများ၏ စိတ်ကူးစိတ်သန်းနှင့် လိုက်လျောညီထွေဖြစ်စေမည့် အဓိပ္ပါယ်ပေါ်မူတည်၍ ခေါ်ဝေါ်သုံးစွဲသည့် ထူးခြားသောဝေါဟာရ ဖြစ်ပါသည်။

- ရှားယားပန်း / èà jà b`ã /

ရှားယားပန်း / èà jà b`ã / ဆိုသည်မှာ ဒေသသုံးနာမ်ဝေါဟာရတစ်မျိုးဖြစ်ပြီး စံစကားတွင် ခရေပန်း/khə jē b`ã/ ဟူ၍ ခေါ်ဝေါ်ကြသည်။မြန်မာအဘိဓာန်တွင် "ခရေ၊ န-မွေးသောအပွင့်ငယ်များပွင့်သည့်သစ်ပင်ကြီး၊ ချရား" ဟုဖွင့်ဆိုထားပါသည်။ ဒေသသုံးထူးခြားသည့်ဝေါဟာရဖြစ်ပါသည်။ ခရေပန်းကို ရှေးသုံးစကားအနေဖြင့် "ချရား" ဟု သုံးစွဲကြသည်။ ၎င်း ရှေးသုံးစကား "ချရား" မှ "ရှားယား" ဟု သဲကုန်းဒေသီယလေသံဖြင့် ပြောင်းလဲသုံးစွဲသည့် သဘော ဖြစ်သည်။

- တပိုတောင်း / də bō dàũ /

တပိုတောင်း/ də bō dàũ / ဆိုသည်မှာ ဒေသသုံးနာမ်ဝေါဟာရတစ်မျိုးဖြစ်ပြီး စံစကားတွင် တင်းတောင်း/ t`ĩ dàũ / ဟု ခေါ်ဝေါ်ကြသည်။မြန်မာအဘိဓာန်တွင် "တင်းတောင်း / တင်းဒေါင်း/ န-တစ်တင်းဝင်သောတောင်း " ဟု ဖွင့်ဆိုထားပါသည်။ ထမ်းပိုး၍ရသောတောင်း ထမ်းပိုးတောင်း / th`ã pò dàũ / ဟု ခေါ်ဝေါ်ရာမှ သဲကုန်းဒေသီယလေသံဖြင့် တပိုတောင်း / də bō dàũ / ဟူ၍ ခေါ်ဝေါ်သုံးစွဲလာသည့်သဘော ဖြစ်သည်။ဒေသသုံး ထူးခြားသည့်ဝေါဟာရဖြစ်သည်။

- ဂွေအိတ် / gwē ei? /

ဂွေအိတ် /gwē ei? / ဆိုသည်မှာ ဒေသသုံး နာမ်ဝေါဟာရတစ်မျိုးဖြစ်ပြီး စံစကားတွင် ဂုန်နီအိတ် /goũ nī ei? / ခေါ်ဝေါ်ကြသည်။ မြန်မာအဘိဓာန်တွင် " ဂုန်နီ ၊ န - ဂုန်လျှော်ဖြင့် ပြုလုပ်ထားသောပစ္စည်း " ဟု ဖွင့်ဆိုထားသည်။ ဂုန်နီအိတ်ကို "ဂွေအိတ် " ဟူ၍ သဲကုန်းဒေသီယလေသံဖြင့် ခေါ်ဝေါ်သုံးစွဲသည့် သဘောဖြစ်သည်။

- စပါး / zə bə /

သဲကုန်းဒေသသည် လယ်ယာစိုက်ပျိုးရေးကို အဓိကလုပ်ကိုင်သော ဒေသဖြစ်ပြီး အများစုမှာ တောင်သူလယ်သမားများဖြစ်ကြသည်။ ထို့ကြောင့် " စပါး " ဟူသော ဝေါဟာရနှင့် ပတ်သတ်၍ ဒေသသုံး ဝေါဟာရ များစွာရှိသည်။ ဒေသီယ စပါးကြီး / zə bə jì / ဟူသော ဝေါဟာရကို စံတွင် ကောက်ကြီး / kau? tē / ဟူ၍ လည်းကောင်း၊ ဒေသီယ စပါးလတ် / zə bə la? / ဟူသော ဝေါဟာရကို စံတွင် ကောက်လတ် / kau? la? / ဟူ၍ လည်းကောင်း၊ ဒေသီယ စပါးလေး / zə bə lè / ဟူသော ဝေါဟာရကို စံတွင် ကောက်လျင် / kau? jī / ဟူ၍ လည်းကောင်း ခေါ်ဝေါ်ကြသည်။ ထို့ပြင် သဲကုန်းဒေသရှိ တောင်သူလယ်သမားများသည် စပါးဟူသော ဝေါဟာရနှင့် ပတ်သတ်၍ စပါး၏

ပုံသဏ္ဌာန်၊ စပါး၏ သက်တမ်း အနုအရင့်အလိုက် စပါးအမျိုးအမည်များ ချဲ့ထွင်အသုံးပြုပုံကို အောက်ပါအတိုင်း ဇယားဖြင့် ဖော်ပြနိုင်ပါသည်။

စပါး /zə bə /	ဆင့်သွယ်လက် / shi' ʈə la' /
	ကျောက်ရွေး / tɛau' jwè /
	ငွေတိုး / ɲwē tò /
	မှော်ဘီ / hmā bī /
	ရတနာတိုး / jə də nā tò /
	ရာကျော် / jā dzɔ' /
	ရွှေဝါထွန်း / ɛwē wā th'ũ /
	အင်းမရဲဘော် / ʼĩ má jè bə /

၎င်း ဝေါဟာရများသည် လုပ်ငန်းဆောင်တာအရ ချဲ့ထွင် အသုံးပြုရာမှ ဖြစ်ပေါ်လာခြင်း ဖြစ်သည်။

- လယ် / lɛ /

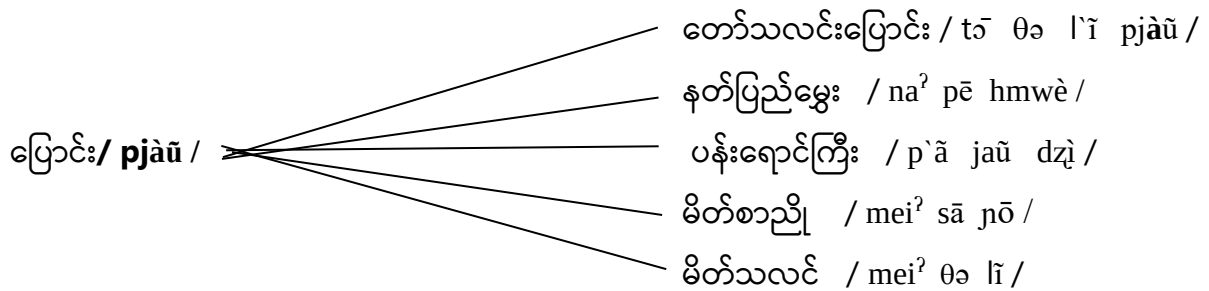
သဲကုန်းဒေသတွင် နေထိုင်ကြသော တောင်သူလယ်သမားများသည် လယ်ယာမြေ များကို အမျိုးအစားအလိုက် ချဲ့ထွင် ခေါ်ဝေါ်သုံးစွဲကြသည်။ လယ် ဟူသော ဝေါဟာရကို ကုန်းခြံ /kòu dzã / (ဟင်းသီးဟင်းရွက်များ စိုက်ပျိုးသောလယ်မြေ)၊ ကုန်းလယ် /kòũ lɛ / (ကောက်လျှင်စပါး စိုက်ပျိုးသောလယ်မြေ)၊ ရိုးလယ် / jò lɛ / (အခြားလယ်များထက် ချိုင့်ခွက်ပြီး ကောက်ကြီးစပါး စိုက်ပျိုးသောလယ်မြေ)၊ ရေလယ်ကွင်း / jɛ lɛ gw'ĩ / (အကောင်းဆုံးမြေ အမျိုးအစားဖြစ်ပြီး ကောက်ကြီးစပါး စိုက်ပျိုးသောလယ်မြေ)၊ ရေနက်ကွင်း / jɛ nɛ' kw'ĩ / (ကောက်ကြီးစပါးစိုက်ပျိုးရသောလယ်မြေ) ဟူ၍ လယ်မြေအမျိုးအမည်များ ချဲ့ထွင်အသုံးပြုပုံကို အောက်ပါအတိုင်း ဇယားဖြင့် ဖော်ပြနိုင်ပါသည်။

လယ် / lɛ /	ကုန်းခြံ / kòũ dzã /
	ကုန်းလယ် / kòũ lɛ /
	ရိုးလယ် / jò lɛ /
	ရေလယ်ကွင်း / jɛ lɛ gw'ĩ /
	ရေနက်ကွင်း / jɛ nɛ' kw'ĩ /

- ပြောင်း / pjəũ /

သဲကုန်းဒေသတွင် ပြောင်းစိုက်ပျိုးရေးကိုလည်း လုပ်ကိုင်ကြသည်။ ထို့ကြောင့် ပြောင်း ဟူသော ဝေါဟာရနှင့် ပတ်သတ်၍ ဒေသသုံး ဝေါဟာရများ ရှိသည်။ ပြောင်း၏ ပုံသဏ္ဌာန်၊

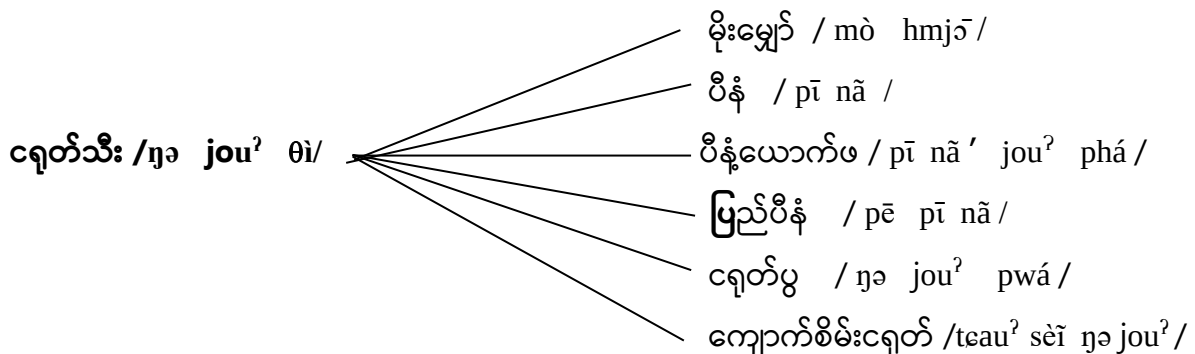
အရောင်အဆင်း၊ သက်တမ်း အနုအရင့်အလိုက် ချဲ့ထွင် အသုံးပြုသည်ကို တွေ့ရသည်။ ပြောင်း ဟူသော ဝေါဟာရကို တော်သလင်းပြောင်း / t̃ ʰ θə l'ĩ pjàũ / (ပြာနှမ်းနှမ်းအစေ့ရှိသော သက်ရင့်ပြောင်း)၊ နတ်ပြည်မွှေး / naʔ pē hmwè / (ရနံ့မွှေးပြီး အဖြူရောင်အစေ့ရှိသော သက်လတ် ပြောင်း)၊ ပန်းရောင်ကြီး / p'ã jaũ dzì / (ပန်းနုရောင်အစေ့ရှိသော သက်လတ်ပြောင်း)၊ မိတ်စာညို / meiʔ sã ɲō / (အညိုရောင်အစေ့ရှိသောသက်နုပြောင်း)၊ မိတ်သလင် / meiʔ θə l'ĩ / (နီကြင်ကြင် အစေ့ရှိသောနူးညံ့သည့်သက်ရင့်ပြောင်းတစ်မျိုး) ဟူ၍ ချဲ့ထွင် အသုံးပြုသည်ကို တွေ့ရပါသည်။ ပြောင်းအမျိုးအမည်များ ချဲ့ထွင် အသုံးပြုပုံကို အောက်ပါအတိုင်း ဇယားဖြင့် ဖော်ပြနိုင်ပါသည်။



၎င်း ဝေါဟာရများသည် ဒေသတွင်း နေထိုင်သူများ၏ စိတ်ကူးစိတ်သန်းနှင့် လိုက်လျောညီထွေ ဖြစ်စေမည့် အဓိပ္ပါယ်ပေါ်မူတည်၍ ခေါ်ဝေါ်သုံးစွဲကြခြင်း ဖြစ်သည်။

- ငရုတ်သီး / ɲə jouʔ θi/

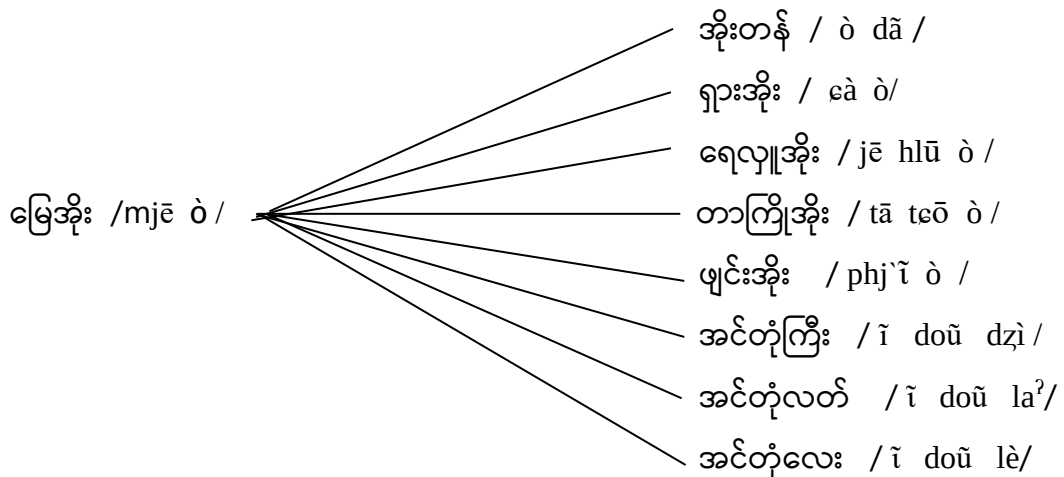
သဲကုန်းဒေသရှိ တောင်သူလယ်သမားများသည် ဆန်စပါးအပြင် ငရုတ်သီးကိုလည်း အဓိက စိုက်ပျိုးကြသည်။ ငရုတ်သီး၏ ပုံသဏ္ဌာန်ကိုလိုက်၍ ငရုတ်သီး ဟူသော ဝေါဟာရကို မိုးမျှော် / mò hmjɔ̃ / (အပေါ်သို့ထောင်၍ သီးသော အလွန်စပ်သည့်ငရုတ်သီးတစ်မျိုး)၊ ဝီနံ / pī nã / (အလွန်စပ်သော အတောင့်သေးငရုတ်သီးတစ်မျိုး)၊ ဝီနံယောက်ဖ / pī nã' jouʔ phá / (ဝီနံသီးထက် အနည်းငယ်ပိုကြီးသောငရုတ်သီးတစ်မျိုး)၊ ပြည်ဝီနံ / pē pī nã / (ဝီနံယောက်ဖထက် အနည်းငယ်ပိုကြီးသော ငရုတ်သီးတစ်မျိုး)၊ ငရုတ်ပွ / ɲə jouʔ pwá / (ငရုတ်သီးအပွကို ခေါ်သောအမည်)၊ ကျောက်စိမ်းငရုတ် / tɛauʔ sɛĩ ɲə jouʔ / (သာမန်ငရုတ်ထက် ပိုရှည်သော အစိမ်းရောင်တောက်တောက်ငရုတ်တစ်မျိုး)ဟူ၍ ချဲ့ထွင်အသုံးပြုသည်ကို လေ့လာတွေ့ရှိရပါ သည်။ ထိုသို့ ငရုတ်သီး၏ဝေါဟာရကိုချဲ့ထွင်အသုံးပြုပုံကိုအောက်ပါအတိုင်းဇယားဖြင့်ဖော်ပြနိုင်ပါသည်။



ဒေသတွင်းနေထိုင်သူများ၏ လုပ်ငန်းဆောင်တာအရ ချဲ့ထွင်အသုံးပြုရာမှ ပေါ်ပေါက်လာသော ဒေသသုံး ထူးခြားသည့် ဝေါဟာရများ ဖြစ်ပြီး ယခုတိုင် သုံးစွဲလျက်ရှိပါသည်။

- မြေအိုး / mjē ò /

သဲကုန်းဒေသတွင် စိုက်ပျိုးရေးလုပ်ငန်းနှင့်အတူ ကျေးရွာအချို့တွင် အိုးလုပ်ငန်းများကို လုပ်ကိုင်ကြသည်။ သဲကုန်းဒေသ ကင်းသန်းရွာမှ ထွက်ရှိသောကင်းသန်းအိုးသည် သဲကုန်းဒေသတွင် နာမည်ကြီးသည်။ ၎င်းဒေသရှိ အိုးလုပ်ငန်းလုပ်ကိုင်သူများကလည်း “အိုး” ဟူသော ဝေါဟာရနှင့် ပတ်သတ်၍ အိုး၏အရွယ်အစား ပုံသဏ္ဌာန်ကိုလိုက်၍ အိုးတန်/ ò dǎ / (မကြီးလွန်း မသေးလွန်း သောအိုး)၊ ရှားအိုး/ èà ò / (အိုးတန်ထက်အနည်းငယ်ကြီးသောအိုးတစ်မျိုး)၊ ရေလှူအိုး/ jē hlū ò / (အမျိုးသမီးလေးများ သင်္ကြန်အခါတွင် ဘုန်းတော်ကြီးကျောင်းသို့ ရေလှူသွားရာတွင် ရွက်သော အိုးတန်ထက် အနည်းငယ်သေးသောအိုးတစ်မျိုး)၊ တာကြိုအိုး / tā tēō ò / သင်္ကြန်အခါတွင် အတာအိုးအဖြစ် အသုံးပြုသော ရေလှူအိုးထက်သေးသောအိုးတစ်မျိုး)၊ ဖျင်းအိုး / phj`ĩ ò / (အဝကျယ်ပြီး ဆန် စသည်ဖြင့် ထည့်သော အိုးတစ်မျိုး)၊ အင်တုံကြီး/ ĩ doũ dzì / (အဝကျယ်ပြီး ဇောက်တိမ်သည့် ရေသုံးပုံးခန့်ဝင်ဆုံသော အိုးတစ်မျိုး)၊ အင်တုံလတ်/ ĩ doũ laʔ / အင်တုံကြီး ထက်သေးပြီး ရေတစ်ပုံးခန့် ဝင်ဆုံသောအိုးတစ်မျိုး)၊ အင်တုံလေး/ ĩ doũ lè / ရေတစ်ဖလားခန့် ဝင်ဆုံသော အသေးဆုံးအင်တုံတစ်မျိုး) ဟူ၍ ချဲ့ထွင်အသုံးပြုသည်ကို လေ့လာတွေ့ရှိရပါသည်။ ထိုသို့ မြေအိုး၏ ဝေါဟာရကို ချဲ့ထွင်အသုံးပြုပုံကို အောက်ပါအတိုင်း ဇယားဖြင့် ဖော်ပြနိုင်ပါသည်။



ဒေသတွင်းနေထိုင်သူများ၏ စိတ်ကူးစိတ်သန်းအပေါ် မူတည်၍ ချဲ့ထွင် အသုံးပြုရာမှ ဖြစ်ပေါ်လာသော ဒေသသုံး ဝေါဟာရများဖြစ်ပြီး ယနေ့တိုင် တွင်ကျယ်စွာ အသုံးပြုလျက်ရှိပါသည်။

၂။ စကားသုံး ထူးခြားမှုများ

သဲကုန်းဒေသိယစကားရှိ စကားသုံးအချို့ကို ကြည့်လျှင် စံစကားနှင့်မတူဘဲ ထူးခြားမှု ရှိသည်ကို တွေ့ရသည်။ ထို့ကြောင့် စံစကားနှင့် သဲကုန်းဒေသိယစကားရှိ စကားသုံး ကွဲပြားမှုများကို သိသာထင်ရှားစေရန် ဝါကျအသုံးနှင့်တကွ လေ့လာတင်ပြ ထားပါသည်။

- အပု / ခ pú /

ဒေသိယစကား

အပု စာမေးပွဲအောင်တယ်

/ခ pú sã mè pwè aũ dē/

အပု သွားတော့မယ်

/ခ pú θwà dɔ' mē /

စံစကား

သမီး စာမေးပွဲအောင်တယ်

/ဓာ mì sã mè pwè aũ dē/

သမီးသွားတော့မယ်

/ဓာ mì θwà dɔ' mē/

စံစကားတွင် မိဘနှင့်သားသမီးအကြား ပြောဆိုဆက်ဆံရာတွင် သမီးဖြစ်သူက မိမိကိုယ်မိမိ ရည်ညွှန်းကာ "သမီး" ဟူသောနာမ်စားကို အသုံးပြုပြောဆိုပါသည်။ မြန်မာအဘိဓာန်တွင် "သမီး၊ န- မိဘနှစ်ပါးမှပေါက်ဖွားသောမိန်းမ၊ သားမိန်းမ။ စည်း၊ တိုက်ရိုက်သွေးမစပ်သောဆွေမျိုးအပြန်အလှန် တော်စပ်မှုကိုပြသောစကားလုံး" ဟူ၍ဖော်ပြထားသည်။ သို့သော် သဲကုန်းဒေသတွင် "သမီး" ဟုမသုံးဘဲ "အပု" ဟု ပြောဆို သုံးနှုန်းကြသည်ကို တွေ့ရသည်။ မိမိထက်ကြီးသူများနှင့်ဖြစ်စေ၊ အဘိုးအဘွား များနှင့်ဖြစ်စေ စကားပြောဆိုရာတွင် "အပု" ဟူသော ပြောသူနာမ်စားကို အသုံးပြုပြောဆိုလေ့ရှိသည်။

- အနန့် / ခ nã' /

ဒေသိယစကား

ပြန်တော့မယ် အနန့်

/pjã dɔ' mē ɔ nã' /

အပြင်သွားမလို့ အနန့်

/ခ pjĩ θwà mə ló ɔ nã' /

ဟုတ်တယ် အနန့်

/hou' tē ɔ nã' /

မှန်တယ် အနန့်

/hmã dē ɔ nã' /

လာလည်ဦးနော် အနန့်

/lã lē òũ nɔ ɔ nã' /

စံစကား

ပြန်တော့မယ်နော်

/pjã dɔ' mē nɔ /

အပြင်သွားမလို့နော်

/ခ pjĩ θwà mə ló nɔ /

ဟုတ်တယ်နော်

/hou' tē nɔ /

မှန်တယ်နော်

/hmã dē nɔ /

လာလည်ဦးနော်

/lã lē òũ nɔ /

ဒေသိယစကား အနန့် /ခ nã' / ဟူသော အသုံးသည် စံစကား နော် / nɔ / နှင့် တူညီသည်ဟု ဆိုရပါမည်။ မြန်မာအဘိဓာန်တွင် "နော်၊ စည်း - (အပြော) စည်းရုံးတိုက်တွန်းသည့်သဘော၊ လေးနက်စေလိုသည့်သဘောဖြင့် ထောက်ပံ့သောစကားလုံး" ဟူ၍ ဖွင့်ဆိုထားသည်။ အနန့်/ ခ nã' / ဟူသော အသုံးသည် နန့်ကြောဆွဲ၊ နန့်နန့်တက် ဟူသော အဓိပ္ပါယ်နှင့် သုံးခြင်း မဟုတ်ပါ။ ဟုတ်မှန်ကြောင်း ပြောဆိုလိုသည့်အခါတွင်လည်းကောင်း၊ သေချာပေါက် ခွင့်ပြုပေးစေချင်သည့်

အခါတွင်လည်းကောင်း၊ခွင့်ပြုချက်တောင်းခံသည့်အခါမျိုးတွင်လည်းကောင်း၊ အနန့်/ə nã' / ကို သုံးလေ့ရှိသည်။သဲကုန်းဒေသ၏ ထူးခြားသောစကားသုံးတစ်ခု ဖြစ်သည်ကို တွေ့ရှိရသည်။

- ဟိုမိုး / hō mò / ၊ ဒီမိုး / dī mò /

ဒေသိယစကား

ဟိုမိုး / hō mò /

ဒီမိုး / dī mò /

စံစကား

ဟိုမှာ / hō hmā /

ဒီမှာ / dī hmā /

ဟိုမိုး / hō mò / ၊ ဒီမိုး / dī mò / ဟူသော အသုံးသည် ဒေသိယစကားတွင် အရာဝတ္ထုတစ်ခုခု၊ ပစ္စည်းတစ်ခုခုတို့၏ တည်နေရာကို ညွှန်ပြရာတွင် အသုံးပြုသည်။ စံစကားတွင် ဟိုမှာ / hō hmā / ၊ ဒီမှာ / dī hmā / ဟူသော အသုံးနှင့် တူညီသည်ဟု ဆိုရပါသည်။ သဲကုန်းဒေသိယစကား၏ ထူးခြားသော အသုံးတစ်ခု ဖြစ်သည်ကို တွေ့ရသည်။

- ဟိုမှာကျန်း / hō hmā te'ā / ၊ ဒီမှာကျန်း / dī hmā te'ā /

ဒေသိယစကား

ဟိုမှာကျန်း / hō hmā te'ā /

ဒီမှာကျန်း / dī hmā te'ā /

စံစကား

ဟိုမှာကြည့်စမ်း / hō hmā tei' z'ā /

ဒီမှာကြည့်စမ်း / dī hmā tei' z'ā /

ဟိုမှာကျန်း / hō hmā te'ā / ၊ ဒီမှာကျန်း / dī hmā te'ā / ဟူသော အသုံးသည် ဒေသိယစကားတွင် အရာဝတ္ထုတစ်ခုခု၊ ပစ္စည်းတစ်ခုခုတို့ကို ညွှန်ပြရာတွင် အသုံးပြုသည်။ စံစကားတွင် ဟိုမှာကြည့်စမ်း / hō hmā tei' z'ā / ၊ ဒီမှာကြည့်စမ်း / dī hmā tei' z'ā / ဟူသော အသုံးနှင့် တူညီသည်ဟု ဆိုရပါမည်။ စံစကားရှိ ကြည့်စမ်း / tei' z'ā / ဟူသော ဝေါဟာရတွင် အသံနှစ်သံထွက်သည်ကို သဲကုန်းဒေသိယက ကျန်း / te'ā / ဟူသော ဒေသိယလေသံဖြင့် ပြောဆို သည့် သဘောဖြစ်သည်။ သဲကုန်းဒေသ၏ ထူးခြားသော ဝေါဟာရတစ်ခု ဖြစ်သည်ကို တွေ့ရသည်။

- ဟုတ်လောက်သား / hou' lau' θà / ၊ ပြောလောက်သား / pjā lau' θà /

ဒေသိယစကား

ဒီအကြောင်းကို ငါပြောတာ ဟုတ်လောက်သား

/dī ə teàũ kō ŋā pjā tã hou' lau' θà /

နင့်အကြောင်းကို ငါ ပြောလောက်သား

/nī' ə teàũ kō ŋā pjā lau' θà /

စံစကား

ဒီအကြောင်းကို ငါပြောတာ မဟုတ်ဘူး

/dī ə teàũ kō ŋā pjā tã mə hou' bə /

နင့်အကြောင်းကို ငါ မပြောဘူး။

/nī' ə teàũ kō ŋā mə pjā bə /

ဒေသိယ ဟုတ်လောက်သား / hou' lau' θà / ၊ ပြောလောက်သား / pjā lau' θà / ဟူသောစကားကို စံတွင် မဟုတ်ဘူး / mə hou' bə / ၊ မပြောဘူး / mə pjā bə / ဟူ၍ ပြောဆိုပါသည်။ အကြောင်းအရာတစ်ခုခု၊ သတင်းတစ်ခုခုကို မိမိသည် လုံးဝစိတ်မဝင်စားကြောင်း၊

မပြောဆိုကြောင်းကို အသိပေးလိုသည့်အခါ တိကျစေချင်သည့်သဘောဖြင့် “ပြောလောက်သား၊ ဟုတ်လောက်သား” ဟူ၍ ပြောဆိုသုံးနှုန်းကြသည်။ သဲကုန်းဒေသ၏ ထူးခြားသော စကားသုံးတစ်ခု ဖြစ်ပါသည်။

သုံးသပ်ချက်

သဲကုန်းဒေသတွင်း နေထိုင်သူများသည် စပါး / zə bə /၊ လယ် / lɛ /၊ ပြောင်း / pjəu /၊ ငရုတ်သီး / ɲə jou' θi /၊ မြေအိုး / mjɛ̀ ò / ဟူသော ဝေါဟာရများကို လုပ်ငန်းဆောင်တာ အလိုက် ချဲ့ထွင် အသုံးပြုသည်ကို တွေ့ရှိရသည်။ ချဲ့ထွင် အသုံးပြုထားသော ဝေါဟာရအများစုမှာ စံစကားတွင်မရှိသော ဝေါဟာရများဖြစ်ပြီး ဒေသတွင်း နေထိုင်သူများက တွင်တွင်ကျယ်ကျယ် အသုံးပြုနေသော ဒေသသုံး ဝေါဟာရများ ဖြစ်သည်ကို တွေ့ရှိရသည်။

အပျိုကြီးပန်း / ə pjō dzì b'ǎ /၊ အရုဏ်ပန်း / ǎ jōu b'ǎ /၊ ရှားယားပန်း/ ɛə jà b'ǎ /၊ တပို့တောင်း / də bō dàu /၊ ဂွေအိတ် / gwɛ̀ ei' / ဟူသော ဝေါဟာရများသည် ဒေသတွင်း နေထိုင်သူများ၏ စိတ်ကူးစိတ်သန်းနှင့် လိုက်လျောညီထွေ ဖြစ်စေမည့် အဓိပ္ပါယ်ပေါ်မူတည်၍ ခေါ်ဝေါ်သုံးစွဲသည့် ဝေါဟာရများဖြစ်သည်။ အပျိုကြီးပန်း၊ အရုဏ်ပန်း၊ ဂွေအိတ် ဟူသော ဝေါဟာရ များသည် စံစကားနှင့်အဓိပ္ပါယ်အားဖြင့် ဆက်စပ်၍မရနိုင်သော ကွဲပြားသည့်ဝေါဟာရများ ဖြစ်သည်။ တပို့တောင်း၊ ရှားယားပန်း ဟူသော ဝေါဟာရများသည် စံစကားနှင့် အဓိပ္ပါယ်ဆက်စပ် သော်လည်း အသုံးနှုန်း ကွဲပြားသော ဝေါဟာရများ ဖြစ်သည်ကို တွေ့ရှိရသည်။

အပု / ə pú /၊ အနန့် / ə nǎ' /၊ ဟိုမိုး / hō mò /၊ ဒီမိုး / dī mò /၊ ဟိုမှာကျန်း / hō hmā tɛə /၊ ဒီမှာကျန်း / dī dmā tɛə /၊ ဟုတ်လောက်သား / hou' lau' θà /၊ ပြောလောက်သား/ pjə' lau' θà / ဟူသော ဒေသသုံးစကားများသည် သဲကုန်းဒေသီယလေသံကို ဖော်ညွှန်းနေသော စကားသုံးများ ဖြစ်ကြောင်း လေ့လာတွေ့ရှိရသည်။

အထက်ဖော်ပြချက်များအရ သဲကုန်းဒေသသုံး ထူးခြားသည့်ဝေါဟာရများနှင့် စကားသုံးများ သည် ဒေသတွင်းနေထိုင်သူများ၏ နေ့စဉ်ဖြစ်ပျက်ကြုံတွေ့နေရသော လူမှုကိစ္စအမျိုးမျိုးကိုအခြေခံ၍ ပေါ်ထွက်လာခြင်းဖြစ်ပြီး ဒေသကွာခြားမှုကြောင့်ကွဲပြားသွားသော မြန်မာဘာသာစကား၏အသွင်ကွဲ ဒေသီယစကားတစ်ခုပင် ဖြစ်ကြောင်း လေ့လာတွေ့ရှိရပါသည်။

နိဂုံး

ဤစာတမ်းတွင် သဲကုန်းဒေသသုံး ထူးခြားသည့်ဝေါဟာရများနှင့် စကားသုံးများသည် စံစကားရှိ ဝေါဟာရများနှင့်ကွဲပြားမှုရှိကြောင်း လေ့လာဖော်ထုတ်တင်ပြထားပါသည်။ လေ့လာတွေ့ရှိ ချက်များအရ ၎င်းဒေသသုံး ဝေါဟာရများနှင့် စကားသုံးတို့သည် နေထိုင်ရာ အရပ်ဒေသအလျောက် ကွဲပြားသွားသော ဒေသီယစကားများဖြစ်ပါသည်။ မြန်မာဘာသာစကား၏ အသွင်ကွဲစကားဖြစ်သော သဲကုန်းဒေသီယစကားများကိုလေ့လာခြင်းဖြင့် အသွင်ကွဲဘာသာစကားတစ်ခု၏ သဘောသဘာဝကို သိရှိနိုင်သည့်အပြင် ဒေသီယလေ့လာမှုအတွက် အထောက်အကူပြုနိုင်မည်ဟု ယုံကြည်မိပါသည်။

ကျေးဇူးတင်လွှာ

ဤစာတမ်းကို ကြီးကြပ်လမ်းညွှန်ပေးပါသော ဒေါက်တာထွန်းအောင်ကျော်(ပါမောက္ခ၊ ဌာနမှူး၊ မြန်မာစာဌာန) ရန်ကုန်တက္ကသိုလ်အားလည်းကောင်း၊ အနီးကပ်ကြီးကြပ် လမ်းညွှန်မှုပေးပါသော ဒေါက်တာမင်းမင်းမိုး (ပါမောက္ခ၊ မြန်မာစာဌာန) မကွေးတက္ကသိုလ်အားလည်းကောင်း၊ စာတမ်းပြုစုနိုင်သည်အထိ ပညာအမွေပေးခဲ့ပါသော ကျေးဇူးရှင် မိဘနှစ်ပါးအားလည်းကောင်း၊ စာတမ်းတင်သွင်းရန် ခွင့်ပြုပေးပါသော၊ ဒေါ်ခင်မြင့်လှိုင် (ကျောင်းအုပ်ကြီး၊ မကွေး ပညာရေးဒီဂရီကောလိပ်) အားလည်းကောင်း၊ စာတမ်းအတွက် အချက်အလက်များ စုဆောင်းရှာဖွေရာတွင် ကူညီ ဖြေကြားပေးသော သဲကုန်းသူ၊ သဲကုန်းသားများအားလည်းကောင်း၊ သင်ဆရာ၊ မြင်ဆရာ၊ ကြားဆရာများနှင့် ကျေးဇူးတင်ထိုက်သူအားလုံးကို ကျေးဇူးတင်ရှိကြောင်း မှတ်တမ်းတင်အပ်ပါသည်။

ကျမ်းကိုးစာရင်း

ကျော်အောင်စံထား၊ ဒုတိယ(ဆရာတော်)။ (၂၀၁၆)။ ဝေါဟာရတ္ထပကာသနီကျမ်း။ရန်ကုန်။ စိတ်ကူးချိုချိုပုံနှိပ်တိုက်။
ခင်မင်၊ မောင် (ခနုဖြူ)။ (၁၉၉၀)။ မြန်မာစကား မြန်မာစာရုပ်ပုံလွှာ။ ရန်ကုန်။ စာပေဗိမာန်။
ခင်မင်၊ မောင်(ခနုဖြူ)။(၂၀၁၂)။စကားသမုဒ္ဒရာ စာသမုဒ္ဒရာ(တ-ကြိမ်)။ရန်ကုန်။ ရာပြည့်စာပေ။
ခင်အေး၊ မောင် (ခနုဖြူ)။ (၂၀၂၂)။ ဘာသာဗေဒနိဒါန်း။ ရန်ကုန်။ အေးကမ္ဘာ။
ထွန်းမြင့်၊ ဦး။ (၂၀၀၇)။ ဘာသာဗေဒ၊ ရန်ကုန်။ ရာပြည့်စာကြည့်တိုက်။
ထွန်းမြင့်၊ ဦး။ (၂၀၀၇) သဒ္ဒဗေဒ။ ရန်ကုန်။ ရာပြည့်စာကြည့်တိုက်။
မြန်မာစာအဖွဲ့။ (၂၀၀၈)။ မြန်မာအဘိဓာန်၊ ရန်ကုန်။
အောင်မြင့်ဦး၊ ဒေါက်တာ။(၂၀၀၅)။ လူမှုဘာသာဗေဒသဘောတရား။ ရန်ကုန်။ ပညာတန်ဆောင်ပုံနှိပ်တိုက်။
အောင်မြင့်ဦး၊ ဒေါက်တာ။ (၂၀၀၆)။ အင်းလေးဒေသီယစကား။ ရန်ကုန်။ ပညာတန်ဆောင်ပုံနှိပ်တိုက်။
အောင်မြင့်ဦး၊ ဒေါက်တာ။ (၂၀၁၀)။ ဘာသာစကားသုတေသန။ ရန်ကုန်။ ပညာတန်ဆောင်ပုံနှိပ်တိုက်။
အောင်မြင့်ဦး၊ ဒေါက်တာ။ (၂၀၂၃)။ ဘာသာစကားဝေဟင်ခရီးနှင့်ပျံသန်းခြင်း။ ရန်ကုန်။ ပညာရပ်ဝန်းစာပေ

ဆလုံရိုးရာယဉ်ကျေးမှုနှင့်နေထိုင်မှုဘဝ

ဇင်မိုးဝံ့

စာတမ်းအကျဉ်း

ဤစာတမ်းတွင် တနင်္သာရီတိုင်းဒေသကြီးအတွင်းရှိ ဆလုံ(ခေါ်)မော်ကင်းလူမျိုး တို့၏ယဉ်ကျေးမှုနှင့် နေထိုင်မှုဘဝပုံစံများကို စိတ်ဝင်စားဖွယ် လေ့လာတင်ပြထားပါသည်။ ထိုသို့လေ့လာတင်ပြရာတွင် ဆလုံလူမျိုးတို့၏ တစ်မူထူးခြားသော ရိုးရာယဉ်ကျေးမှုဓလေ့ထုံးတမ်းနှင့် ကိုးကွယ်ယုံကြည်မှုများ၊ ဆလုံလူမျိုး တို့၏ သမိုင်းကြောင်းနှင့် ထူးခြားသော လူနေမှုပုံစံများကို လေ့လာတင်ပြထားပါသည်။ထို့အပြင် ဆလုံစကားများကို အနည်းအကျဉ်းတင်ပြထားပါသည်။ ဆလုံ လူမျိုးတို့၏ ယဉ်ကျေးမှုရိုးရှင်းစွာ နေထိုင်တတ်ကြသည့် လူနေမှုစနစ်သည် တဖြည်းဖြည်း တိုးတက်လာနေပြီဖြစ်ကြောင်းကို သိရှိစေလိုသော ရည်ရွယ်ချက် ဖြင့် ရေးသားပြုစုထားခြင်း ဖြစ်သည်။

သော့ချက်စကားလုံး။ ။ယဉ်ကျေးမှု၊ကိုးကွယ်ယုံကြည်မှု၊ လူနေမှုပုံစံ၊ ဆလုံစကား။

နိဒါန်း

ဤစာတမ်းသည် တနင်္သာရီတိုင်းဒေသကြီးအတွင်းရှိ ကျွန်း၊ ပင်လယ်များတွင် အခြေချနေထိုင်လျက် ရှိသည့် ဆလုံ(ခေါ်) မော်ကင်းလူမျိုးတို့၏ ရိုးရာယဉ်ကျေးမှုနှင့် နေထိုင်မှုဘဝပုံစံများကို လေ့လာ တင်ပြထားပါသည်။ ထိုသို့ လေ့လာတင်ပြရာတွင် ဆလုံလူမျိုးတို့၏ နေ့စဉ်သုံးဝေါဟာရများမှ လူမှုဆိုင်ရာဝေါဟာရအသုံးများကိုလည်း စိတ်ဝင်စားဖွယ်ဖြစ်အောင် လေ့လာတင်ပြထားပါသည်။ မြိတ်ကျွန်းစုရှိ အဖိုးမဖြတ်နိုင်သော ဆလုံလူမျိုးတို့၏ ရိုးသားဖြောင့်မတ်မှုကို လေ့လာတင်ပြထား ပါသည်။ ဆလုံလူမျိုးတို့သည် မြန်မာနိုင်ငံ တောင်ဘက်စွန်း တနင်္သာရီတိုင်းဒေသကြီးရှိ မြိတ်ခရိုင်နှင့် ကော့သောင်းခရိုင်အတွင်းရှိ ကျွန်းများတွင် လူနည်းစုအဖြစ် သီးခြားနေထိုင်ကြသည်။ မြိတ်ခရိုင်နှင့် ကော့သောင်းခရိုင်အတွင်း ဆလုံတိုင်းရင်းသားများနေထိုင်ကြသော မြို့နယ်နှင့်ကျွန်းများမှာ မြိတ်မြို့နယ်၊ ကျွန်းစုမြို့နယ်၊ ပုလောမြို့နယ်၊ တနင်္သာရီမြို့နယ်၊ ကော့သောင်း မြို့နယ်၊ ဘုတ်ပြင်းမြို့နယ်၊ ဒုန်းကျွန်း(Done Island)၊ ဇာဒက်ကြီးကျွန်း၊ လန်းပိကျွန်း(Lumpi Island)၊ မကြုံကလက်ကျေးရွာ နှင့် ညောင်ဝိကျေးရွာတို့ ဖြစ်သည်။

၁။ သုတေသနရည်ရွယ်ချက်

မြန်မာလူမျိုးတို့နှင့်မတူသည့် တိုင်းရင်းသားမျိုးနွယ်စုတစ်စုတွင် ပါဝင်သည်။ ဆလုံ လူမျိုးတို့၏ ယဉ်ကျေးမှုရိုးရှင်းစွာ နေထိုင်တတ်သည့် လူမှုစနစ်နှင့်ထူးခြားသည့် ရိုးရာ ပွဲတော်များအကြောင်းကို သိရှိစေလိုရန်အလိုငှာ တဖြည်းဖြည်းတိုးတက်လာနေပြီဖြစ်သည်။ လူနေမှုစနစ်ကို ဖော်ထုတ်မျှဝေ လိုသည့်ဆန္ဒဖြင့်ပြုစုထားခြင်းဖြစ်သည်။

¹ ဒေါက်တာ၊ ကထိက၊ မြန်မာစာပေ၊ ရန်ကုန်အရှေ့ပိုင်းတက္ကသိုလ်

၂။ သုတေသနအစီအစဉ်

ဆလုံရိုးရာယဉ်ကျေးမှုနှင့်နေထိုင်မှုဘဝကို လေ့လာသော ဤစာတမ်းတွင်

- (၁) ဆလုံလူမျိုးတို့၏ လူမျိုးအမည်၊ ရုပ်လက္ခဏာနှင့်ဝတ်စားဆင်ယင်မှု
- (၂) ဆလုံလူမျိုးတို့၏ အစားအသောက်အလုပ်အကိုင်နှင့်ကိုးကွယ်ယုံကြည်မှု
- (၃) ဆလုံဘာသာစကားနှင့်စာပေ
- (၄) လူမှုဆိုင်ရာဝေါဟာရအသုံးများ
- (၅) ခြုံငုံသုံးသပ်ချက်ဟူ၍ ခွဲခြားကာတင်ပြပါမည်။

စာပေလေ့လာဆန်းစစ်ချက်

စာပေလေ့လာဆန်းစစ်ချက်အနေဖြင့် ဆလုံတိုင်းရင်းသားများနှင့်ပတ်သက်၍ ထုတ်ဝေထားသည့် စာအုပ်များကို လေ့လာဖတ်ရှုခဲ့ပါသည်။ ဆရာကြီးဦးဖေမောင်တင်၏ ဘာသာလောကကျမ်း၊ ပါမောက္ခ ဒေါ်တင်ရီ၏ ဆလုံတိုင်းရင်းသားများ၏ လူမှုစီးပွားရေးဘဝ(ဒု-ကြိမ်)၊ စာပေဗိမာန်က ထုတ်ဝေသည့် မြန်မာ့စွယ်စုံကျမ်းအတွဲ(၄)၊ အတွဲ(၁၀)၊ တက္ကသိုလ်ကိုလတ်၏ပင်လယ်ပျော်မော်ကင်း၊ ကျော်စိုး(စိတ်ပညာ)၏ ဆလုံရိုးရာ၊ ဆလုံစရိုက်စသည့်စာအုပ်များကို ဖတ်ရှုလေ့လာခဲ့ပါသည်။

အချက်အလက်များကောက်ယူစုဆောင်းချက်

ဆလုံရိုးရာယဉ်ကျေးမှုနှင့် နေထိုင်မှုဘဝကို လေ့လာရာတွင် မိမိသုတေသနအတွက် အချက်အလက်များကို ကောက်ယူရာတွင် မြိတ်မြို့ပေါ်ရှိ ဆလုံလူမျိုးတို့၏ နေအိမ်သို့ ကိုယ်တိုင် သွားရောက်မေးမြန်းခဲ့ပါသည်။ ထို့အပြင် ဆလုံလူမျိုးတို့နေထိုင်ရာ ကျွန်းများကိုလည်း ကိုယ်တိုင် ကွင်းဆင်း၍ အချက်အလက်များ ကောက်ယူခဲ့ပါသည်။ ရာသီဥတုအခြေအနေ၊ လုံခြုံရေးအခြေအနေများကြောင့် နေရာအားလုံးကို သွားရောက်လေ့လာရန် မလွယ်ကူသော်လည်း အနီးစပ်ဆုံးနေထိုင်ရာဒေသများနှင့်လုပ်ငန်းခွင်များကိုသာ သွားရောက်သုတေသနပြုပြီး လိုအပ်သည့် အချက်အလက်များကို တွေ့ဆုံမေးမြန်းခဲ့ပါသည်။

၁။ လူမျိုးအမည်

‘ဆလုံ’ ဟူသောအမည်သည် မြန်မာတို့ကခေါ်သောအမည်ဖြစ်သည်။ ဆလုံတို့က ၎င်းတို့ကိုယ်ကို မော်ခင် (မော်ကင်း) (Mowken) ဟုခေါ်သည်။ ‘မောင်ခင်’၏ အဓိပ္ပာယ်မှာ ပင်လယ်တွင် နေသူဖြစ်သည်။ ‘မော်ကင်း’ Mawken ‘မိုကန်း’ Moken (ထိုင်းအခေါ်)ဟုလည်းခေါ်ကြသည်။ မောရစ်ကောလစ်ရေး “ယိုးဒယားဂျိုက်” စာအုပ်တွင် ခရစ်နှစ် ၁၆၇၅ ခုနှစ်ရက်စွဲဖြင့် ဗောင်းရေးဆိုသူ ရေးသားသော ခရီးစဉ် မှတ်တမ်းတစ်ခုကိုကိုးကား၍ ဆလုံတို့ကို ဆီလီတာ (siliter) ဟုခေါ်ကြောင်း ဖော်ပြထားသည်။(မြန်မာ့စွယ်စုံကျမ်းအတွဲ(၄)၊ ၁၉၇၅ခုနှစ်၊စာ၂၉) ၁၈၉၁ခုနှစ် သန်းခေါင်စာရင်း အစီရင်ခံစာတွင် ဆလုံ ကို ဆီလုံ(selung) ဟုဖော်ပြထားသည်။ သမိုင်းသုတေသီ မစ္စတာဂျွန်အင်ဒါဆင်က ဆလုံတို့ကို အခြားလူမျိုးများက ဆီလန်၊ ဆလုံဟူသော အခေါ်အဝေါ် နှစ်မျိုး ဖြင့်သာခေါ်ဝေါ်သည်ဟုဆိုသည်။ (ကျော်စိုး၊ ၁၉၆၈၊ စာ-၄၁) ဆလုံတို့ကို မလေးလူမျိုးတို့က ဩရန်ဘောဆင် ဟုခေါ်၍ ထိုင်းလူမျိုး တို့ကချော်နန်၊ ချောင်နန် (ရေတွင်ပျော်မွေ့သူ)ဟု ခေါ်သည်။(ကျော်စိုး၊ ၁၉၆၈၊ စာ-၄၃)

ယခုအခါ ဆလုံတို့ကို ထိုင်းတို့က ထိုင်းပိုင်း(ထိုင်းသစ်) ဟုခေါ်သည်။ ကမ္ဘာ့သမိုင်း ပညာရှင်အချို့ကမူ ပင်လယ်ဂျစ်ပစီ (sea gypsies) (ရေတွင်ကျက်စားသူများ) ဟုလည်းကောင်း၊ လှေအိမ်လူသား ဟုလည်းကောင်း ခေါ်ကြသည်။ ဆလုံလူမျိုးတို့သည် ပင်လယ်ပြင်တစ်ခွင်တွင် ဝမ်းစာအတွက် လှည့်လည် ကျက်စားကြသည်။ ထို့ကြောင့် Sea Gypsy or Men of the sea အဖြစ် အမည်တွင်ခြင်း ဖြစ်သည်။ ဤသို့ခေါ်ရခြင်းမှာ ဆလုံတို့သည် မွေးဖွားသည်မှသေဆုံးသည်အထိ ၁၀ တစ်လျှောက် လုံး ကဗန်းလှေကိုအမှီပြု၍ ပင်လယ်ပြင်ကြီးအတွင်း ပေါ့ပေါ့ပါးပါးတည်ဆောက်ထားသည့် ရိုးရာ လှေကို အိမ်လိုသဘောထားပြီး မိသားစုကြီးတစ်ခုလုံး နေထိုင်ကျက်စားသောကြောင့် ဖြစ်သည်။ (နိုင်တာရာ၊ ၂၀၀၄၊ စာ ၄-၅)

၂။ ဆလုံလူမျိုးတို့၏ ရုပ်လက္ခဏာနှင့်ဝတ်စားဆင်ယင်မှု

ဆလုံလူမျိုးတို့၏ရုပ်သွင်သည် မလေးလူမျိုးတို့နှင့်ဆင်တူသည်။ ဆလုံလူမျိုးစစ်စစ်များ၏ ရုပ်သွင် သည် (၃)မျိုးကွဲနေသည်ကို လေ့လာတွေ့ရှိရသည်။ မလေးလူမျိုးနှင့် တူသူများရှိသကဲ့သို့ ထိုင်းလူမျိုး နှင့်တူသူများလည်းရှိသည်။ မြန်မာလူမျိုးနှင့် တူသူများလည်းရှိသည်။ နဖူးမကျယ် မကျဉ်း၊ မျက်ခုံးကောင်းပြီး မျက်ရစ်ပေါ်ကာ မျက်ဆန်ညိုသည်။ နှာခေါင်းအနည်းငယ်ပြားသည်။ အချို့မှာ နှုတ်ခမ်းအနည်းငယ်ထူပြီး၊ အချို့မှာအနည်းငယ်လန်သည်။ မေးရိုးကားသည်။ နားရွက်အနေတော် ပုံမှန်အနေအထားရှိသည်။ ဆံပင်မှာအနက်ရောင်ရှိသော်လည်း ပင်လယ်ဆားငန်ရေကြောင့် နီကြောင် ကြောင်အနေထားဖြစ်နေသည်။ အသားအရေမှာ မွေးဖွားစဉ်အခါက အသားလတ် သော်လည်း ကြီးလာသောအခါ နေဒဏ်၊ လေဒဏ်၊ ပင်လယ်ဆားငန်ရေဒဏ်ကြောင့် မည်းခြောက် လျက်ရှိသည်။ ဆလုံအမျိုးသားများသည် ရေကူး၊ ရေငုပ်ပြီး အသက်မွေးရသဖြင့် လက်ပြင်ကုန်း သည်။ ဆလုံတို့သည် ယခင်ကအရပ်ပုသော်လည်း ယခုအခါ အမျိုးသားများမှာ ၅ပေ ၂လက်မ မှ ၅ပေ ၆လက်မအထိ ရှိတတ်ပြီး အမျိုးသမီးများမှာ ၅ပေ ၂လက်မ မှ ၅ ပေ ၄ လက်မအထိရှိသည်။ ဆလုံလူမျိုးတို့သည် ဘိန်း၊အရက်စသည်တို့ကို စွဲမြဲစွာ သုံးစွဲခြင်းကြောင့် အသက်အရွယ်နှင့်မမျှ အောင် အိုမင်းရင့်ရော် ကြသည်။

ဆလုံတိုင်းရင်းသားတို့သည် မွေးကင်းစကလေးအရွယ်မှ ငါးနှစ်ခြောက်နှစ်အရွယ်အထိ ယခင်က အဝတ်အစား ဝတ်လေ့ဝတ်ထမရှိသော်လည်း ယခုအခါအဝတ်အစားဆင်ယင်လာ ကြသည်။ အမျိုးသမီးများမှာ သူတို့ခလေ့အရ အပေါ်ပိုင်းအောက်ပိုင်း လုံလုံခြုံခြုံဝတ်ဆင်သည် ဆိုသော်လည်း အချို့မှာ အိမ်ထောင်ကျသည်နှင့် အပေါ်ပိုင်းဗလာကျင်နေတတ်ကြသည်။ ယခုအခါတွင် အိုမင်းသော အရွယ်မှလွဲ၍ အမျိုးသမီးအများစုမှာ လုံလုံခြုံခြုံဝတ်ဆင်လာကြသည်။

ဆလုံအမျိုးသားတို့မှာ များသောအားဖြင့် ယခင်ကအောက်ပိုင်းတွင် လုံချည် (သို့မဟုတ်) ဘောင်းဘီတိုနှင့်နေပြီး အပေါ်ပိုင်းဗလာနှင့် နေတတ်သည့်သဘာဝရှိသည်။ သူတို့ခလေ့အရ တော်ရုံ ဖျားနာခြင်းမရှိကြပါ။ ခံနိုင်ရည်ရှိသော လူမျိုးများပင်ဖြစ်သည်။ သို့သော်လည်း ယခုအခါ သူတို့လည်း အပေါ်ပိုင်းအင်္ကျီများကို များသောအားဖြင့် ဝတ်ဆင်လာကြသည်။ ဆလုံတိုင်းရင်းသားတို့သည် ခေတ်မီလာသည့်အလျောက် ယိုးဒယားနိုင်ငံမှထွက်သည့် အထည်များဖြစ်သည့် ပါတိတ်၊ တီရှပ်၊ စသည်တို့ကို ဝတ်ဆင်လာကြသည့်အတွက် သစ်လွင်တောက်ပလာနေပြီဖြစ်သည်။ ယခင်က

ဖြစ်သလိုနေခဲ့သော်လည်း ယခုအခါ ဆလုံတို့သည် အသိအမြင်တိုးတက်လာပြီ ဖြစ်သဖြင့် အဝတ်အစားပြည့်ပြည့်စုံစုံ ဝတ်လာကြပေသည်။

ရှေးယခင်က ဆလုံတို့သည် ဆံပင်နှင့်မျက်နှာကို ခြယ်သပြင်ဆင်ဖိးလိမ်းခြင်း မပြုကြပေ။ ယခုခေတ် ဆလုံအမျိုးသမီးများသည် သနပ်ခါး(အခဲဘူး)များကို လိမ်းကြသည်။ မိတ်ကပ်၊ ပေါင်ဒါ၊ အလှဆီ၊ နှုတ်ခမ်းနီတို့ကို သုံတတ်နေကြပြီဖြစ်သည်။ ဆံပင်ဖြတ်လိုပါက ပုလင်းကိုရိုက်ခွဲပြီး ပုလင်းကွဲဖြင့် တစ်ယောက်နှင့်တစ်ယောက် ဆံပင်ဖြတ်ပေးလေ့ရှိသည်။ ယခုအခါ ဆလုံတို့ နေထိုင်ရာ ဒေသအချို့တွင် ဆံပင်ညှပ်ဆိုင်များ ရှိလာပြီဖြစ်ရာ အမျိုးသားများ ဆံပင်အတိုညှပ်ကြသည်။ အမျိုးသမီးများက ဆံပင်အတိုညှပ်သူညှပ်၊ ဆံပင်ကောက် သူကောက်ဖြင့် ခေတ်မီနေကြ ပြီဖြစ်သည်။ အချို့ဆလုံကလေးငယ်များသည် ဆံပင်ကိုအရောင်ဆိုးထားကြသည် အထိ ခေတ်မီလာ ကြပြီဖြစ်သည်။ ရှေးကဆလုံအမျိုးသမီးများသည် ခရုစေတီ၊ ခရုအခေါင်းပိတ် များကို လက်ဖွဲ့သဖွယ် ဝတ်ဆင်လေ့ရှိကြသည်။ ယနေ့ခေတ်တွင် ဆလုံလူမျိုးများသည် ရွှေထည် ပစ္စည်းများကို ဝတ်ဆင် လာကြသည်။

၃။ ဆလုံလူမျိုးတို့၏အစားအသောက်အလုပ်အကိုင်

ဆလုံလူမျိုးတို့သည် ပင်လယ်ထဲတွင် အတည်တကျမနေဘဲ ရေကြည်ရာမြက်နုရာသို့ သွားလာလုပ်ကိုင်နေထိုင်ကြသည့် ပင်လယ်ပျော်များဖြစ်သည်။ နွေနှင့်ဆောင်းရာသီတို့တွင် ‘ကဗန်းလှေ’ပေါ်တွင် သောက်ရေ၊ ဆန်၊ ဆီ၊ ဆား၊ ပန်းကန်ခွက်ယောက်များ၊ မိသားစုပိုင်ပစ္စည်းများနှင့် အိမ်မွေးမွေးပါမကျန် တင်ဆောင်ကာ ပင်လယ်ပြင်၌ သွားလာနေထိုင် ရှာဖွေစာသောက်ကြသည်။ များသောအားဖြင့် ပင်လယ်အစားအစာများ စားသောက်ကြသည်။ ပင်လယ်ကျွန်းစု၊ ကျောက်ဆောင်များတွင် တွယ်ကပ်လျက်ရှိသော ဂုံး(ခရုတစ်မျိုးအထဲတွင်ရှိသည်) ဟုခေါ်သည့် တငိုကို ခွာ၍ အထဲမှ ခရုသဖွယ်အရာချက်ပြုတ်စားသောက်ကြသည်။ ပင်လယ်ကျောက်ဆောင် ဂူထဲတွင်ရှိသော လင်းနို့၊ လင်းဆွဲများကို တုတ်ရှည်ဖြင့်ရိုက်ချကာ ခုတ်ထစ်ဖြတ်တောက်၍လည်း ချက်ပြုတ်သုံးဆောင်ကြသည်။ ဆလုံတို့၏သဘာဝမှာ စားသောက်ရာတွင်လည်း သူတို့ရိုးရာလှေပေါ်တွင် မိသားစုအားလုံး သိုက်သိုက်ဝန်းဝန်း ပျော်ပျော်ရွှင်ရွှင် ချက်ပြုတ်စားသောက်ကြသည်။

မျက်မှောက်ခေတ် ဆလုံလူမျိုးများသည် အခြားတိုင်းရင်းသားလူမျိုးများနှင့် ထိတွေ့ရောနှော ဆက်ဆံလာရသည့်အတွက်ကြောင့်လည်းကောင်း၊ ကုန်းပေါ်တွင် အခြေချနေထိုင်မှုများရှိလာသည့် အတွက်ကြောင့်လည်းကောင်း စားသောက်မှုပုံစံများ ပြောင်းလဲလာသည်။ ဆလုံရွာအချို့တွင် လက်ဖက်ရည်ဆိုင်၊ ထမင်းဆိုင်များရှိသည့်အတွက် မနက်စာကို လက်ဖက်ရည် သို့မဟုတ် ကော်ဖီ၊ ပလာတာ၊ အီကြာကွေး စသည်တို့ကို ဝယ်ယူစားသောက်နေကြပြီဖြစ်သည်။ ဆလုံလူမျိုးတို့တွင် မပြောင်းလဲသည့်အချက်တစ်ခုမှာ အမျိုးသားရော အမျိုးသမီးပါ အရက်ကိုစွဲစွဲလမ်းလမ်း သောက်သုံးခြင်းဖြစ်သည်။ ဗမာ-ဆလုံ အချို့နှင့် ဘုန်းတော်ကြီးများ၏ ဆုံးမမှုအောက်တွင်ရှိသော ဆလုံအချို့တွင်မူ အရက်သုံးစွဲမှုလျော့နည်းလာသည်။

ဆလုံတိုင်းရင်းသားတို့သည် အသက်မွေးဝမ်းကျောင်းအဖြစ် ငါးဖမ်းခြင်း၊ ပုလဲငုပ်ခြင်း၊ ပင်လယ်မျှောငုပ်ခြင်း၊ ကနုကမာရှာဖွေခြင်း၊ ပျားဖွတ်ခြင်း၊ ငှက်သိုက်ရှာခြင်း စသည့် ရေနံပတ်သက်သော လုပ်ငန်းအဝဝကို ကျွမ်းကျင်စွာလုပ်ကိုင်နိုင်သော တိုင်းရင်းသားများဖြစ်သည်။

သူတို့သည် မျှော့မျိုးစုံဖမ်း၍ အခြောက်လှန်းကာနိုင်ငံခြားသို့ တင်ပို့ရောင်းချကြသည်။ မျှော့ရှာခြင်း မှာဆလုံလူမျိုးတစ်မျိုးတည်း၏ အတတ်ပညာဖြစ်သည်။ တေးဆိုရင်း တံတွေးထွေးရင်း တုတ်တစ်ချောင်းနှင့် ဒီရေအတက်ပါလာသော မျှော့မျှော့လေ့ရှိသည်။ ပဋိဖမ်းခြင်းကို ကျား၊မ မရွေး လုပ်ကိုင်ကြသည်။ တန်ဖိုးကြီးမားသော ပုလဲရတနာများကိုလည်း ဌာနဆိုင်ရာများနှင့် ပူးပေါင်းကာ ရှာဖွေငုပ်ယူ ကြသည်။ ဇီဝဇီဝသိုက်များရှာဖွေ၍ ငှက်ကြီးအန်ဖတ်များကို ထိုင်းနိုင်ငံဘက်သို့ သွားရောက် ရောင်းချကြသည်။ နိုင်ငံခြားဈေးကွက်ရှိသည့် လုပ်ငန်းများကို အစိုးရထံတွင် တရားဝင်လိုင်စင်တင်ပြီး လုပ်ကိုင်ကြသည်။ ထိုမျှမက ဆလုံလူမျိုးတို့အတွက် မုတ်ကောင်ရှာသည့် လုပ်ငန်းမှာ ဝင်ငွေကောင်းသော လုပ်ငန်းတစ်ခုဖြစ်သည်။ မုတ်ကောင် ဖမ်းသူများသည် ပင်လယ် ရေအောက်တွင် ၁၅ မိနစ်၊ နာရီဝက်ခန့် ရေငုပ်နိုင်သူဖြစ်ရမည်။ ရေအောက် ပေ ၁၀၀ မှ ၁၈၀ ခန့် အထိ ငုပ်ရသည်။ ယနေ့ခေတ် တွင်ခေတ်မီလာသော ဆလုံလူမျိုးတို့သည် ရေငုပ်မျက်မှန် အကောင်းစားနှင့် အောက်စီဂျင် အသက်ရှူဘူးတို့ဖြင့် ရေငုပ်ကာ ပုလဲရှာနေကြပြီဖြစ်သည်။

၄။ ကိုးကွယ်ယုံကြည်မှု

ဆလုံလူမျိုးတို့သည် ဘာသာတရားနှင့်ပတ်သက်၍ ကိုယ်ပိုင်ယုံကြည်မှုများရှိကြသည်။ နတ်ကောင်း နှင့် နတ်ဆိုးဟူ၍ နတ်ဘုရားကိုးကွယ်မှု နှစ်ခုရှိသည်။ နတ်တိုင်များမှာ ဆလုံလူမျိုးတို့၏ အဓိက နတ်ဆရာသည် ၎င်းတို့၏အကွာဖြစ်သည်။ ထိမ်းမြားလက်ထပ်ခြင်းကအစ သေဆုံးသည်အထိ နတ်ဆရာသည်မပါမဖြစ်ပေ။ လက်ထပ်ပွဲများတွင် နတ်ဆရာနှင့် ရိုးရာနတ်ကို ပူဇော်ပသမှုပြုပြီးမှ လင်မယားအရာမြောက်သည်ဟု ဆလုံတို့က ယူဆထားကြပါသည်။ ပျော်ပွဲရွှင်ပွဲများကိုသာမက ဖျားနာသည့်အခါ၊ တစ်ဦးတစ်ယောက်သေဆုံးသည့်အခါများတွင် နတ်ဆရာတို့၏ပြောဆိုမှုအတိုင်း စပါး၊ ပြောင်း၊ အရက်၊ ပျားရည်၊ ကွမ်း၊ ဘဲသွေးစိမ်း၊ ကြက်၊ လင်းပိုင်၊ ပင်လယ်လိပ်တို့ဖြင့် ယဇ်ပူဇော် လေ့ရှိကြသည်။ နှစ်စဉ် မြန်မာသင်္ကြန်အပြီး ဧပြီလနှောင်းပိုင်းတွင် ပြုလုပ်လေ့ရှိသည်။ နတ်တိုင် ထူပြီးလျှင် ထိုနတ်တိုင်၌ တံခွန်အလံများ တပ်ဆင်ချိတ်ဆွဲရသည်။ နတ်ပူဇော်မှုအောင်ပွဲအဖြစ် ရိုးရာဗုံကို တီးခတ်၍ နတ်တင်ထားသော အစားအစာ အရက်များသောက်စားကာ ပျော်ရွှင်စွာ ကခုန်သီဆိုလေ့ရှိကြသည်။

နတ်တေးဆို၍ကခုန်ခြင်း၊ နတ်ပူဇော်ပွဲနှင့် ဆေးကုခြင်း၊ ဝိညာဉ်ဆိုး ဝိညာဉ်ကောင်း စသော မလေးယဉ်ကျေးမှုများ ဆက်လက်တည်ရှိပြီး ဗုဒ္ဓဘာသာနတ်များနှင့် အတူတူကိုးကွယ်လာကြသည်။ မိုးဝင်လာသည်နှင့်တစ်ပြိုင်နက် မျောလှေတို့ စုပေါင်းကာ ‘ဘိုလိုဘု(င်)း’ခေါ် ရိုးရာနတ်ပူဇော်ပွဲများ ကျင်းပကြသည်။ ‘စီးတီး’ ခေါ် နတ်တေးသီဆိုကခုန်သူများ၊ ‘ဘေလမ်း’ခေါ် ရှားမင်း နတ်ဆရာအကူ များ၊ ‘လေးဖယ်င်း’ ခေါ် ပူဇော်ပွဲဆရာ၊ အလေ့အထ နည်းပါးသော်လည်း တခါတရံ ‘ဂျင်ညောင်း’ ခေါ် ရှားမင်းနတ်ဆရာတို့သည် နတ်တို့အား ပူဇော်ပင့်မြှောက်ပြီးလျှင် လောကအမျိုးမျိုးနှင့် ဆက်သွယ် ပူးကပ်ကြသည်။ ထိုသို့ဆက်သွယ်ရာတွင် စီးတီးတို့သည် စားသောက်ဖွယ်ရာ အမျိုးမျိုးဖြင့် နတ်တင် နတ်စီးလေ့ရှိသည်။ နတ်ဆရာကနတ်တိုင်များကို ပွဲဆက်ကပ်ခြင်းဖြင့် ပူဇော်ပွဲစဉ်သည်။ နတ်ဝင်သူ အမျိုးသားနှင့်အမျိုးသမီးများက နတ်ဆရာကို ဦးခိုက်ရသည်။ အကာအကွယ်လက်ဖွဲ့များအဖြစ်

တောဝက်စွယ်ဆွဲကြိုးနှင့် လိပ်ခွံသားငါးရုပ်ပုံဖြစ်သည်။ ၎င်းတို့သည့် မြေကြီးနှင့် ပင်လယ်ပြင်၏ အင်အားများဟု သတ်မှတ်ထားသောကြောင့် ဖြစ်သည်။

၅။ ဆလုံဘာသာစကားနှင့်စာပေ

ဆလုံလူမျိုးတို့၏ဘာသာစကားများသည် ဆင်တူဟန်ရှိသော်လည်း နေထိုင်ရာဒေသကိုလိုက်၍ စကားအသုံးအနှုန်း၊ လေယူလေသိမ်းအနည်းငယ်ကွဲပြားသည်။ အပြောအဆိုအသုံးအနှုန်းကိုလိုက်၍ ယေဘုယျအားဖြင့် ဘာသာစကား (၄)မျိုးရှိသည်ဟု ဝေါ်တာဂရိန်းဂိုက်က ဆိုသည်။ ထိုဘာသာ စကား ၄ မျိုးမှာ လော်တ(Lawta)၊ ဂျအိ(Jait)၊ လဘီ(Lbi)၊ ဒန်း(Dung) ဘာသာစကားတို့ဖြစ်သည်။ (ကျော်စိုး၊ ၁၉၈၆၊ စာ ၅၇) ထိုဘာသာစကား (၄)မျိုးတွင် ဒန်း (Dung) ဘာသာစကားသည် စံဘာသာ စကား(သို့မဟုတ်) မူရင်းဘာသာစကားဖြစ်ကြောင်းကို Walter Grainge White ဆိုသူက The Sea Gypsies of Malaya စာအုပ်တွင် ဖော်ပြထားသည်။

လော်တစကားသည် မလေးဘာသာစကားနှင့် အများဆုံးတူညီ၍ မလေးလူမျိုးများနှင့် အလုပ်အကိုင်အဆက်အသွယ်အများဆုံးရှိကြသော လောတနှင့်တွန်တာ(Tungka)ဆလုံအုပ်စုဝင် များပြောဆိုကြသည်။ နာမည်များ၊ နေ့စဉ်သုံးဝေါဟာရများကို မလေးဘာသာစကားမှ အများဆုံးကူး ယူပြောဆိုကြကြောင်း တွေ့ရသည်။ ဂျအိစကားကို လမ်ပိကျွန်းနှင့် ဘုတ်ပြင်းမြို့နယ်ဧရိယာ တစ်ဝိုက်မှ ဆလုံတို့အသုံးများကြသည်။ လဘီဘာသာစကားကို ဝိတိုရိယအင်္ဂတစ်ဝိုက်မှ ဆလုံတို့ အသုံးများကြသည်။ လဘီဘာသာစကားကို ဝိတိုရိယအင်္ဂတစ်ဝိုက်နှင့် မက်သယူးကျွန်း(ဇာဒက်ကြီး ကျွန်း)အနီးအနားတစ်ဝိုက်တွင် နေထိုင်သော ဆလုံတို့ အများဆုံးပြောကြသည်။ ဒန်းဘာသာစကား ကို မြိတ်မြို့အနီးဝန်းကျင်မှဆလုံများ (ယခုမြိတ်မြို့အနီးတွင် ဆလုံများမနေကြချေ) အများဆုံးပြော ကြသည်။ ယေဘုယျအားဖြင့် ဘာသာစကား ၄ မျိုးအနက် ဒန်းဘာသာစကားသည် ဆလုံလူမျိုးတို့ ၏ မူရင်းဘာသာစကားဖြစ်သည်။ (ကျော်စိုး၊ ၁၉၆၈၊ စာ ၅၈) စကားအသုံးအနှုန်းကွဲပြားမှုကို သာဓက ပြရလျှင် ခုံးပုလဲအော်၊ ပုလဲကျွန်းဘက်မှ ဆလုံများသည် ရေကို'နော်အဲ၊နော်အင်း' ဟုခေါ်၍ လမ်ပိ၊ မကြုံကလက်မှ ဆလုံများက 'ဝေ၊ဝေ' ဟုခေါ်သည်။

ဆလုံတို့၏စကားပြော လေယူလေသိမ်းသည် နေရာဒေသအလိုက် နီးစပ်ရာလူမျိုးများ၏ အသံနှင့်ဆက်နွယ်လျက်ရှိသည်။ ပုလဲကျွန်းဘက်မှဆလုံတို့က အသံပြတ်ဖြင့်ပြော၍ မကြုံကလက်မှ ဆလုံတို့က အသံဆွဲ၍ပြောသည်။ အထူးသဖြင့် ဆလုံတို့၏သီချင်းသံများသည် နီးစပ်ရာလူမျိုးများ၏ အသံနှင့် များစွာဆက်နွယ်လျက်ရှိသည်။ အများအားဖြင့် ဘုတ်ပြင်းမြို့နယ်ရှိ ဆလုံတို့၏သီချင်းသံ သည် ပသျှူးသံနွယ်၍ ကော့သောင်းမြို့နယ်ရှိ ဆလုံတို့၏သီချင်းသံသည် ယိုးဒယားသီချင်းသံနွယ် သည်။ မြိတ်မြို့အနီးဝန်းကျင်ရှိ ဆလုံတို့၏သီချင်းသံသည် မွန်သီချင်းသံနွယ်သည်။ (ကျော်စိုး၊ ၁၉၆၈၊ စာ ၅၈၊၅၉)

ဆလုံတို့၏ဘာသာစကားများမှာ သာမန်အားဖြင့်ကြည့်လျှင် မလေးဘာသာစကားနှင့် များစွာ ဆက်နွယ်လျက်ရှိသည်ဟု ထင်မှတ်ရသည်။ ဆလုံဘာသာစကားနှင့်ပတ်သက်၍ ပညာရှိများ၏ အယူအဆ (၂)မျိုးကွဲလျက်ရှိသည်။ တစ်မျိုးမှာ ဆလုံတို့သည် မလေးလူမျိုးအဆက်အနွယ် ဖြစ်သည် ဟူသောအဆိုဖြစ်သည်။ အဘယ်ကြောင့်ဆိုသော် ဆလုံတိုင်းရင်းသားများပြောဆိုသောစကားများ

တွင် မလေးအခေါ်အဝေါ်များပါဝင်နေသောကြောင့်ဖြစ်သည်။ နောက်တစ်မျိုးမှာ မွန်-ခမာအနွယ် ဖြစ်သည်ဟူသော ယူဆချက်ဖြစ်သည်။ မြန်မာနိုင်ငံတောင်ပိုင်း၊ အင်ဒိုချိုင်းနားကျွန်းဆွယ်၊ ထိုင်းနိုင်ငံ တို့ဘက်မှ မြန်မာပြည်အတွင်းသို့ဝင်ရောက်လာသော မွန်-ခမာများထဲတွင် ဆလုံတိုင်းရင်းသားများ သည် မွန်နှင့်အတူဝင်ရောက်လာသည်ဟူ၍လည်းကောင်း၊ မွန်-ခမာတို့၏အပြောအဆိုအသုံးအနှုန်း တို့သည် ဆလုံတိုင်းရင်းသားတို့ပြောဆိုကြသော အသုံးအနှုန်းနှင့်ဆင်သောကြောင့် မွန်-ခမာအနွယ် မှ ဆင်းလာသည်ဟု ယူဆကြခြင်းဖြစ်သည်။ သို့သော် နောက်ပိုင်းအမြင်များကမူ ကမ္ဘောဒီးယား မှ ‘ခမ်’ (cham)တို့၏ ဘာသာစကားနှင့် နီးနီးကပ်ကပ်ဆက်သွယ်မှုရှိသည်ဟု ယူဆကြကြောင်း ‘ဂျီပီအင်ဒရူး’ က တင်ပြခဲ့သည်။ (ကျော်စိုး၊ ၁၉၆၈၊ စာ ၅၇)

ဆလုံဘာသာစကားမျိုးရိုးနှင့်သမိုင်းကြောင်းကိုကြည့်လျှင် မြန်မာပြည်တွင် တိဗက်တရုတ် မျိုးရိုးနှင့် ဩစထရိုနီးရှင်းမျိုးရိုးဟူ၍ ဘာသာစကားမျိုးရိုးကြီးနှစ်ခုရှိရာ ဆလုံဘာသာစကားသည် ဩစထရိုနီးရှင်းတွင် ပါဝင်ပေသည်။ ဩစထရိုနီးရှင်းသည် တိဗက်တရုတ်မျိုးရိုးထက်ရှေးကျသော ဘာသာစကားတစ်ခုဖြစ်ပေသည်။ ဩစထရိုနီးရှင်းဘာသာစကားကို ပြောဆိုကြသောလူမျိုးများထဲမှ တရုတ် တိဗက်ဘာသာစကားပြောဆိုသော လူမျိုးများက အတတ်ပညာများကို သင်ကြားခဲ့ရသည်။ သို့ဖြစ်၍ မွန်တို့ထံမှ ဗမာတို့က သင်ကြားခဲ့ရသည်။ ခမာတို့ထံမှ ရှမ်းတို့က သင်ကြားခဲ့ရသည်ဟု ဆရာကြီးဦးဖေမောင်တင် ရေးသားသော ဘာသာလောကကျမ်းတွင် တွေ့ရှိရသည်။

ဩစထရိုနီးရှင်းဘာသာစကားမျိုးရိုးကြီးတွင် ဩစထရိုနီးရှင်း ခေါ် ပင်လယ်ပိုင်းတွင် ပြောသော စကားနှင့် ဩစထရိုအေရှတစ်ဟုခေါ်သော ကုန်းပိုင်းတွင် ပြောသောစကားဟူ၍ နှစ်မျိုးရှိပေရာ ဆလုံတိုင်းရင်းသားဘာသာစကားများသည် ဩစထရိုနီးရှင်းအုပ်စုတွင် ပါဝင်ပေသည်။ ဩစထရို နီးရှင်း ဘာသာစကားကိုပြောဆိုသောလူမျိုးမှာ တောင်ဘက်စွန်းရှိကျွန်းများတွင် နေထိုင်သော မော်ကင်းခေါ်ဆလုံတိုင်းရင်းသားများနှင့် ပဿူးတိုင်းရင်းသားတို့ဖြစ်ကြသည်။

ဆလုံတို့သည် မြန်မာစာပေအရေးသား တတ်မြောက်ခဲ့ကြောင်းကို ခိုင်လုံသောအထောက် အထားမတွေ့ရသေးချေ။ ဆလုံတိုင်းရင်းသားများတွင် ကိုယ်ပိုင်စာပေမရှိချေ။ ၁၈၄၆ ခုနှစ်တွင် ဒေါက်တာ ဘရေတန်ကလည်းကောင်း၊ ၁၉၀၀ပြည့်နှစ်တွင် ခရစ်ယာန်သာသနာပြုဆရာမကြီး ဒေါက်တာဒေစီအဖွဲ့က လည်းကောင်း၊ ၁၉၈၈ ခုနှစ်တွင် ခရစ်ယာန်သာသနာပြု ဆရာမကြီး နော်ဆေဘောနှင့် နော်ဖိုးလေတို့ကလည်းကောင်း၊ အင်္ဂလိပ်အက္ခရာ၊ ပိုးကရင်အက္ခရာ တို့ဖြင့် ဆလုံ စာပေကိုတီထွင်ပေးခဲ့ကြသည်။ (၁၉)ရာစုနှစ်ဦးပိုင်းတွင်လည်း အမေရိကန်နှစ်ချင်း ခရစ်ယာန် သာသနာပြု မစ္စတာစတီဗင် (Mr Stevens) ဆိုသူက ရောမအက္ခရာများကို အသုံးပြုကာ စာပေ တီထွင်ပေးခဲ့ပြီး ခေါင်းစဉ်မှာ A Primer of the Salone Language ဖြစ်ပေသည်။ ၎င်းစာအုပ်မှာ ဖတ်စာအုပ်ငယ်ဖြစ်ပြီး အတော်အတန်ပင်ပြည့်စုံမှုရှိကြောင်း၊ ယခုအခါရှာဖွေ၍မရတော့ကြောင့် သိရသည်။ ခရစ်ယာန်သာသနာပြုများတီထွင်သော ဆလုံစာပေနှင့်အရေးအသား ကျွမ်းကျင် တတ်မြောက်ခဲ့ကြောင်းကို ‘ဂျီပီအင်ဒရူး’ နှင့် ‘ဒေါက်တာဂရိန်းဂိုက်’ တို့၏တင်ပြချက်များကို ထောက်ရှု၍ သိရသည်။ ဆလုံစာပေသည် ၁၉ရာစုရှေးဦးပိုင်းက ပေါ်ပေါက်ခဲ့သည်။ အမေရိကန် ခရစ်ယာန်နှစ်ခြင်းသာသနာပြု မစ္စတာစတီဗင်က ရောမအက္ခရာများကို အသုံးပြု၍ မူကြမ်းအဖြစ်

တီထွင်ပြုစုသည်။ ‘ဒေါက်တာဒီအယ်လ်ဘာရေတွန်’ က ထိုမူကြမ်းကို ကူးယူသည်။ ၁၈၄၆ ခုနှစ် ‘အခြေခံဆလုံဖတ်စာအုပ်’ (A Primex of the Selong Language) အမည်ဖြင့် အမေရိကန်နှစ်ခြင်း ခရစ်ယာန် သာသနာပြုပုံနှိပ်တိုက်မှတစ်ဆင့် မော်လမြိုင်မြို့တွင် အုပ်ရေ (၁၀၀) ပုံနှိပ်ထုတ်ဝေ ခဲ့သည်။

ထိုစာအုပ်၌ ဆလုံဘာသာစကားအသံထွက်ကို ရောမအက္ခရာဖြင့်ဖလှယ်၍ ဆလုံအက္ခရာ အဖြစ် ဖန်တီးထားသည်။ အက္ခရာ ၂၂ လုံးပါသည်။ ဆလုံစာအရေးအသားမှာ နာမ်စားမြှုပ်၍ ရေးသည်။ သဒ္ဒါသတ်မှတ်ချက် အတိအကျမရှိ။ စာကြောင်းတစ်ကြောင်း၏အဓိပ္ပာယ်သည် ပါဝင်သော စကားလုံးများ၏အစီအစဉ်ကိုလိုက်၍ အဓိပ္ပာယ်ထွက်သည်။ ယေဘုယျအားဖြင့် ရေးသား ရာတွင် သာယာနာပျော်ဖွယ် အသံထွက်ကို အလေးအနက်ထားသည်ဟု ဝေါ်တာဂရိန်းဝိုက် က လေ့လာတင်ပြခဲ့သည်။ ဒေါက်တာဘာရေတွန်က ထိုစာအုပ်ကို လက်စွဲစာအုပ်အဖြစ်သတ်မှတ်၍ ကျောင်းတစ်ကျောင်း တည်ထောင်ပြီး သင်ကြားပေးသည်။ နောက်ပိုင်းကာလများတွင် ဆက်လက် ထိန်းသိမ်းခြင်း၊ ပြန်လည် ဖြန့်ဖြူးသင်ကြားပေးခြင်း မပြုသောကြောင့် ပြန်လည်တိမ်မြုပ်သွားသည်။ (ကျော်စိုး၊ ၁၉၈၆၊ စာ ၆၁)

ဆလုံစာပေခါးဆက်ပြတ်သွားချိန်တွင် ၁၉၇၄ ခုနှစ်၌ ရန်ကုန်တက္ကသိုလ်၊ သမိုင်းဌာနမှ ကထိက နော်စေးဘေသည် မြိတ်ခရိုင် ကျွန်းစုမြို့နယ်ရှိ ဒုံးပုလဲကျေးရွာသို့ ရောက်ရှိလာသည်။ ထိုရွာ တွင် ၂ နှစ်ခန့်နေထိုင်၍ ဆလုံတို့၏ဘဝလေ့ကို စိတ်ဝင်စားစွာလေ့လာပြီး ဆလုံစာပေကို တီထွင် ကာ ပြန်လည်သင်ကြားပေးခဲ့သည်။ သို့သော် ထိုဆလုံစာပေသည် ဆလုံအုပ်စုအားလုံးအပေါ် မလွှမ်းမိုးနိုင်သေးချေ။ ဒုံးကျွန်းတစ်ဝိုက်ရှိ ဆလုံ၊ ကရင်-ဆလုံများအတွင်း၌သာ ပျံ့နှံ့သည်။

ဆလုံတိုင်းရင်းသားတို့သည် စာပေသင်ကြားခြင်းထက် ပင်လယ်လုပ်ငန်းခွင်ကိုသာ ဝင်ရောက်လုပ်ကိုင်လိုစိတ်ပြင်းပြသောကြောင့် ယခုအချိန်အထိ စာပေဟူ၍ တိကျခိုင်မာစွာပေါ်ထွက် လာခြင်းမရှိပေ။ ဆလုံတိုင်းရင်းသားတို့ပြောသော ဘာသာစကားလေးမျိုးအနက် မလေးနှင့် အဆက်အသွယ်ရှိသော လူမျိုးများက လောတ၊ လန်းပိကျွန်းနှင့် ဘုတ်ပြင်းမြို့နယ်တွင် နေထိုင်ကြ သောဆလုံတိုင်းရင်းသားများက ဂျအိစကားကိုပြောဆိုကြသည်။ မြိတ်ခရိုင်အတွင်းမှာ နေထိုင်ကြ သော ဆလုံတိုင်းရင်းသားများသည် ဒန်းဘာသာစကားကိုပြောဆိုကြပြီး ကော့သောင်းခရိုင်ကျွန်းစု မြို့နယ်အတွင်းတွင် နေထိုင်ကြသူများသည် လဘီဘာသာစကားကို ပြောဆိုနေထိုင်လျက်ရှိကြသည်။

နောက်ပိုင်းခေတ်ကာလတွင် ဆလုံရွာများတွင် ကလေးများအတွက် မူလတန်းကျောင်းများ ဖွင့်လှစ်ပေးခဲ့ပြီး အခမဲ့ပညာသင်ကြားစေသည်။ အစိုးရမဟုတ်သော အဖွဲ့အစည်းအချို့ကလည်း ထောက်ပံ့ကူညီမှုများပြုကြသည်။ သို့သော်လည်း ဆလုံကလေးငယ်တို့၏ ပညာရေးသည် နှေးကွေး နေဆဲဖြစ်သည်။ အကြောင်းအရင်းမှာ ဆလုံတို့၏ ဘဝရပ်တည်မှုနှင့် သက်ဆိုင်နေသည်။ နောက်ပိုင်းတွင် ဂျပန်ကျွန်း၊ မကြုံဂလက်၊ ညောင်ဝို၊ ဇာဒက်ကြီးကျွန်းတို့တွင် ဆလုံတို့အတွက် အသုံးလုံးသင်တန်းများကို ဖွင့်လှစ်ပေးခဲ့သည်။ အသိဉာဏ်မြှင့်သော အချို့သောဆလုံတို့မှာ မိမိတို့ ကလေးကို မြို့ပေါ်တွင်ပညာသင်ကြားစေသည့်အတွက် ဘွဲ့ရပညာတတ်ဆလုံတိုင်းရင်းသားများ တဖြည်းဖြည်းများပြားလာခဲ့သည်။

လူမှုဆိုင်ရာဝေါဟာရအသုံးများ

ဆလုံလူမျိုးတို့၏ လူမှုဆိုင်ရာဝေါဟာရအသုံးများတွင် ဆွေမျိုးစပ်ဝေါဟာရအသုံးများ၊ ခံစားမှုဆိုင်ရာ အသုံးများကို စိတ်ဝင်စားဖွယ်တင်ပြထားပါသည်။

ဆလုံစကား

ကာနည်
ဘီနည်
အဲပေါင်
အဲနောင်
အဲဘောက်/အဲဘတ်
အဖူန်
အဲကွ ကာနည်
အဲကွ ဘီနည်
ဘော၊ ဘူဇာ
မဲ
လာကွ အဒ
အနတ် ကလ လဘိုန်
ံဘူန်
လဲန်
ဘီနည်ကာနည်
ညောညာမ်
ဖယဲာ
အပေါင်နဲက်

ဆလုံစကား

နောလို
အူအဲန် ခလော
ဇာလတ်
အတက်
မဲဆ မဖေတ် ပေါထာဝ်
တု မကောင် မလိုဝ်
တာ ပါတောညီ
အဟူဟ် ယဲာ
တု နဲငါ

မြန်မာစကား

ယောကျ်ားလေး
မိန်းကလေး
အဖေ
အမေ
အဖိုး
အဖွား
ကိုကို
မမ
သား၊ ကောင်လေး
သမီး၊ ကောင်မလေး
ကိုယ်ဝန်ဆောင်
မွေးကင်းစ
မွေး
အဒေါ်
လင်၊ မယား
ရည်းစား
ရှင်ဘုရင်
ပထွေး၊ မိထွေး

မြန်မာစကား

နာမည်
မျက်ရည်
သွေး
ခေါင်းဆောင်
အုပ်ချုပ်
ကုန်းချော
သူပုန်
ဟုန်းခဲ
ယုံကြည်

အင်္ဂလိပ်စကား

boy
girl
father
mother
grandfather
grandmother
brother
sister
son
daughter
pregnancy
baby
born
aunt
man and wife
sweet heart
king
step-father,
step-mother

အင်္ဂလိပ်စကား

name
tear
blood
leader
govern
make mischief
rebel
incandescence
believe

ဆလုံစကား	မြန်မာစကား	အင်္ဂလိပ်စကား
ဘူဘိုက်	မနေ့က	yesterday
စီဆာဝ်	မနက်ဖြန်	tomorrow
တာမညမ် တာမာကန် ကမန်	ညစာ	dinner
ကလဲက်	မုန်း	hate
လာည်	ချစ်	love
ပေါလူစ် ဘာဇီ	ဆွေးမြည့်	mouldering
ကတာည် ညာဝါ	စိတ်	agony
ကောလက်၊ အူအုန်	နွေး	warms
ညာဝါ	အသက်	age

အထက်ဖော်ပြပါ လူမှုဆိုင်ရာဝေါဟာရအသုံးများကဲ့သို့ မြန်မာစကားတွင်ရှိသည့် အချို့အသီးအရွက်ဆိုင်ရာ ဝေါဟာရအသုံးများသည် ဆလုံစကားတွင်မရှိပေ။ဆလုံတို့သည် ရေကြည်ရာမြက်နုသွားလာလုပ်ကိုင် စားသောက်နေထိုင်ကြသည့် ပင်လယ်ပျော်များဖြစ်သည်။ ထို့ကြောင့် များသောအားဖြင့် အသီးအရွက်ထက် ပင်လယ် အစားအစာများကို စားသုံးလေ့ရှိသည်။ မြန်မာစကား တွင် ‘အသီး’ ဟူသောစကားလုံးကို ‘အ’ဖြုတ်၍ ‘သရက်သီး’ စသည်ဖြင့် ပြောဆိုလေ့ရှိသော်လည်း ဆလုံစကားတွင် ‘အသီး’ကို ‘ဘူဝါက်’ဟုခေါ်ပြီး သက်ဆိုင်ရာအသီးအမည်၏ရှေ့တွင် ထည့်လေ့ရှိ သည်။

ဆလုံစကားတွင် ‘ငှက်’အမည်ကို အမျိုးမျိုးခေါ်လေ့မရှိဘဲ မည်သည့်ငှက်မဆို ‘စီစိမ်’ ဟူသော စကားလုံးတစ်လုံးကိုသာ ခေါ်ဆိုလေ့ရှိသည်။ တိရစ္ဆာန်အမည်များတွင် ပုံပန်းသဏ္ဌာန်ကို အစွဲပြု၍ ပြောဆိုသုံးနှုန်းထားသည့် စကားလုံးများကိုလည်း စိတ်ဝင်စားဖွယ်တွေ့ရသည်။ ဥပမာ ကျားဟူ သော ဝေါဟာရကို ‘ပနံ’ ခြင်္သေ့ နှင့် ‘တာမဲဝ်’ ကြောင် ဟူသော ဝေါဟာရနှစ်ခုကို ပေါင်းပြီး ကျား၏ မျက်နှာကြောင်နှင့်တူပြီး ကိုယ်ထည်မှာခြင်္သေ့နှင့်တူသောကြောင့် ‘ပနံ တာမဲဝ်’ ဟု ပုံသဏ္ဌာန်ကို အစွဲပြု၍ ခေါ်ဆိုထားခြင်းဖြစ်သည်ကို စိတ်ဝင်စားဖွယ်လေ့လာတွေ့ရှိရသည်။

ခြုံငုံသုံးသပ်ချက်

ဆလုံလူမျိုးများသည် ပင်လယ်ပြင်အတွင်း လှည့်လည်နေထိုင်ကြရာမှ ကျွန်းများ၊ ရွာများတွင် အခြေတကျနေထိုင်လာကြသောအခါ ၎င်းတို့၏ဘေးဘိုးအစဉ်အဆက်ကတည်းကရှိခဲ့သော လူနေမှုဘဝပုံစံသည် အပြောင်းအလဲများ ဖြစ်ပေါ်လာရသည်။ ထိုပြောင်းလဲမှုမှာ စာတတ်သူဆလုံများ ပေါ်ပေါက်လာခြင်း၊ ပညာသင်ယူရန် အခွင့်အရေးများရလာခြင်း တို့ကြောင့် ဖြစ်သည်။ ဆလုံအချင်းအချင်း အိမ်ထောင်ပြုသူနည်းသွားသဖြင့် ဆလုံလူမျိုးစစ်စစ်ဦးရေ လျော့နည်းလာခြင်းတို့ကြောင့်ဖြစ်သည်။ ဒုတိယ ပြောင်းလဲမှုမှာ နတ်ကိုးကွယ်ခြင်း၊ နတ်ပူဇော်ခြင်း၊ နတ်ကခြင်း၊ နတ်သီချင်းသီဆိုခြင်းများ အပေါ် ဆလုံလူငယ်လူရွယ်များ စိတ်ဝင်စားမှုလျော့နည်းလာခြင်းတို့ကြောင့် ဖြစ်သည်။ တတိယ ပြောင်းလဲမှုမှာ ဝတ်စားဆင်ယင်၊ ပြင်ဆင်လိမ်းခြယ်မှုပုံစံပြောင်းလဲ လာသည်။ စတုတ္ထ ပြောင်းလဲမှုမှာ ဆလုံကလေးနှင့် လူငယ်များသည် တစ်ဦးနှင့်တစ်ဦးအပြန်အလှန် လက်တန်းစပ် သီဆိုရသော ဆလုံသီချင်းများထက် ခေတ်ပေါ်သီချင်း၊ ခေတ်ပေါ်အကများနှင့် ပို၍ စိတ်ဝင်စား လာခြင်းကြောင့်

ဖြစ်သည်။ ပဉ္စမပြောင်းလဲမှုမှာ စာတတ်သူဆလုံများပေါ်ပေါက်လာခြင်းနှင့် ပညာ သင်ယူရန် အခွင့်အလမ်းများရလာခြင်း၊ ဆဌမပြောင်းလဲမှုမှာ ပင်လယ်ပြင်တွင် သဘာဝ သယံဇာတများ လျော့နည်းလာခြင်း၊ ဆလုံတို့၏တစ်ပိုင်တစ်နိုင် ဝမ်းစာရှာသည့် လုပ်ကွက် အတွင်းသို့ ခေတ်မီငါးဖမ်းကိရိယာများ တပ်ဆင်ထားသော ငါးဖမ်းလှေ၊ ကင်းမွန်ဖမ်းလှေကြီးများ ဝင်ရောက်လုပ်ကိုင်လာခြင်းတို့ကြောင့် ဆလုံတို့၏စီးပွားရေး ပိုမိုကျပ်တည်းလာခြင်း၊ လုပ်ငန်းရှင်များမှ အလုပ်သမားဘဝသို့ ရောက်ရှိသွားခြင်းတို့ကြောင့် ဖြစ်သည်။

နိဂုံး

ဆလုံလူမျိုးတို့၏ ရိုးရာယဉ်ကျေးမှု၊ နေထိုင်မှု၊ ဘာသာစကားကို လေ့လာရာတွင် ဆလုံလူမျိုးများ နေထိုင်ရာဒေသ၊ လုပ်ငန်းခွင်၊ ပင်လယ်ပြင်စသည့်နေရာအားလုံးသို့သွားရောက် လေ့လာသင့်ပေသည်။ သို့သော် ရာသီဥတုအခြေအနေ၊ လမ်းပန်းဆက်သွယ်ရေးအခြေအနေ၊ လုံခြုံရေးအခြေအနေ စသည့်အခက်အခဲများကြောင့် နေရာအားလုံးသို့ သွားရောက်လေ့လာရန်မလွယ်ကူချေ။ ထို့ကြောင့် ဤစာတမ်းတွင် ဆလုံလူမျိုးတို့၏ယဉ်ကျေးမှုလေ့ထုံးတမ်း၊ ဆလုံလူမျိုးတို့၏ လူမှုဆိုင်ရာ ဝေါဟာရအသုံးများနှင့်ပတ်သက်၍ မပြည့်စုံမှုများ၊ ချွတ်ချော်တိမ်းစောင်းမှုများ ရှိနိုင်ပါသည်။ ဆလုံစကားများကို စိတ်ဝင်စားသူများ၊ ဆလုံသုတေသီတို့ကထပ်မံဖြည့်စွက်မွမ်းမံ ပြင်ဆင်နိုင်လိမ့်မည်ဟု ယုံကြည်မိပါသည်။ ဤစာတမ်းမှတစ်ဆင့် ဆလုံလူမျိုးတို့၏တိုးတက်ပြောင်းလဲလာသည့် ယဉ်ကျေးမှု၊ လူနေမှုစနစ်များကို သိရှိစေသည်သာမက ဆလုံလူမျိုးများတွင် အပြောစကားသာမက စာအရေးအသားရှိသည်ကိုလည်း ဖော်ထုတ်တင်ပြလိုသော ရည်ရွယ်ချက်ဖြင့် ရေးသားပြုစုတင်ပြထားခြင်း ဖြစ်သည်။

ကျေးဇူးတင်လွှာ

အနန္တော အနန္တငါးပါးကို ဦးထိပ်ထား၍ စာပေဖြင့်ဘဝခွန်အားပေးခဲ့သည့် ကျေးဇူးရှင်သင်ဆရာ၊ မြင်ဆရာ၊ ကြားဆရာအပေါင်းတို့အား ဤစာတမ်းဖြင့် ပူဇော်ကန်တော့ပါသည်။ ဤစာတမ်းကို တင်သွင်းဖတ်ကြားရန် ခွင့်ပြုပေးပါသော ကြီးကြပ်လမ်းညွှန်ပေးပါသော ဒေါက်တာသင်းသင်းစိုး (ပါမောက္ခ၊ ဌာနမှူး၊ မြန်မာစာဌာန)နှင့် ဒေါက်တာအေးအေးမွန် (ပါမောက္ခ၊ မြန်မာစာဌာန) တို့အားလည်းကောင်း၊ ပညာအမွေပေးခဲ့သည့် ကျေးဇူးရှင် မိဘနှစ်ပါးတို့အားလည်းကောင်း၊ စာတမ်း အတွက်လိုအပ်သည့်အချက်အလက်များကို ကူညီဖြေကြားပေးခဲ့သည့် မြိတ်မြို့နေ ဆလုံလူမျိုး မိသားစုဝင်များ၊ ဒုံးညောင်မှိုင်းကျေးရွာရှိ ဆလုံလူမျိုးများ၊ ကျွန်းခရီးစဉ်ကို လိုက်ပို့ပေးပါသော မိတ်ဆွေအပေါင်းအသင်းများအားလုံးကို လှိုက်လှဲစွာ ကျေးဇူးတင်ရှိကြောင်း မှတ်တမ်းတင် အပ်ပါသည်။

ကျမ်းကိုးစာရင်း

မြန်မာဘာသာ

လတ်၊ ကို(တက္ကသိုလ်)။ (၂၀၀၃)။ *ပင်လယ်ပျော်မော်ကင်း*။ ရန်ကုန်၊ စာပေဗိမာန်။
ကျော်စိုး(စိတ်ပညာ)။ (၁၉၆၈)။ *ဆလုံရိုးရာ၊ ဆလုံစရိုက်*။ ရန်ကုန်၊ မင်းလှစာပေ။
တင်ရီ၊ ဒေါ်(ပါမောက္ခ)။ (၂၀၀၄)။ *ဆလုံတိုင်းရင်းသားများ၏လူမှုစီးပွားရေးဘဝ* (ဒု-ကြိမ်)။ ရန်ကုန်၊ ပညာရေးဝန်ကြီးဌာန၊
အမျိုးသားလူ့စွမ်းအားအရင်းအမြစ်ဖွံ့ဖြိုးမှုဌာန။
နိုင်တာရာ။ (၁၉၉၆)။ *ဆလုံ (ခ)မော်ကင်း*။ ကော့သောင်း၊ သုတေသနစာတမ်း။
ဖေမောင်တင်၊ ဦး။ (၁၉၈၀)။ *ဘာသာလောကကျမ်း*။ ရန်ကုန်၊ စာပေဗိမာန်။
မြန်မာ့စွယ်စုံကျမ်း၊ အတွဲ ၁၀။ (၁၉၆၂)။ ရန်ကုန်၊ စာပေဗိမာန်။

မြန်မာ့စွယ်စုံကျမ်း၊ အတွဲ ၄ (စ-ကြိမ်)။ (၁၉၇၅)။ ရန်ကုန်၊ စာပေဗိမာန်။
သန်းထွန်း၊ ဒေါက်တာ။ (၂၀၁၁)။ ဆလုံ ခေါ် မော်ကင်း။ *မြန်မာ့လောကွတ် ၂၀၀၄ စာစု*။ ရန်ကုန်၊ စိတ်ကူးချိုချို။ ၂၄၈-၂၅၂။

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THE EFFECTIVENESS OF URBAN RESEARCH AND DEVELOPMENT INSTITUTE (URDI) IN ADVANCING URBAN DEVELOPMENT: STRENGTHS AND CHALLENGES

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Abstract

This paper is a study of the strengths and weaknesses of the functions of the Urban Research and Development Institute (URDI), Department of Urban and Housing Development, Ministry of Construction, a training institution that teaches several subjects on urban development. Globally, systematic and sustainable urban development is a very important sector. Urban planners, governments, policymakers, and citizens are all concerned with urban planning. Urban planners are urban professionals, although they have expertise in planning. If the officials re-implementing the project do not know about urban planning, the original urban plan image may be lost. Therefore, a training center that disseminates the knowledge of urban planning and the knowledge of housing development involved in urban planning is essential. The main aim of this paper is to explore the current situation of URDI. The institution is a very active urban training center in Myanmar. The paper is based on a quantitative: Likert scale, qualitative fieldwork, and expert interviews with instructors, trainees, and policymakers. First, a literature review took place and secondary data was collected from the Ministry of Construction. Then key actors were asked in qualitative open interviews with expertise. Finally, triangulation and SWOT analysis come to a comprehensive assessment. The findings have implications for urban planning, and policy-making and guide the development of courses to adapt to the needs and preferences of the country. Ultimately, this research not only shares knowledge needed for urban development but also contributes to factors to be considered for increased collaboration and cooperation with other universities and institutions.

Keywords: urban development, institution, urban planning, housing, sustainable, collaboration

Introduction

In every country, urban planning is a necessity and important for several reasons, as it plays a basic role in the growth, development, and sustainability of urban development sectors. Urban development is a very important sector for the country. Only with systematic urban development will the country's development speed be high. To have systematic urban development, there is a special need for urban managers and policymakers who must draw up and re-apply the plan by the key urban planners of the urban development sector. In addition, urban residents should have basic knowledge of urban development. Therefore, there is a need for places to disseminate knowledge about systematic urban development, such as urban training institutes.

As a developing country, urban development training institutions are essential because of the following factors.

- To address the challenges of growing urbanization.
- To improve development governance and decision-making.
- To achieve sustainable development.
- To address social inequalities.
- To improve the orderly development of infrastructure.
- To foster innovations and resilience.
- To promote inter-departmental or public-government collaboration and cooperation.

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This paper explores the strengths and challenges of the Urban Research and Development Institute (URDI) for urban development and identifies its effectiveness.

Research Background

Urban Research and Development Institute (URDI) is the very first and only Urban Institute in Myanmar. In 2011, a memorandum of understanding (MoU) was signed between the Department of Urban and Housing Development (DUHD) under the Ministry of Construction (MOC) and UN-Habitat for implementing a project “Myanmar Programmed for Safer Settlements and Urban Research (MPSSUR)”. To these memoranda, the Urban Research and Development Institute (URDI) was founded and supported by UN-Habitat on 20th January 2012. According to the memorandum, URDI was established to support the development of urban infrastructure regulations in addition to the promotion of urban research sectors, and capacity building of technical experts in urban development sectors.

Achievements are:

- Training
- Research
- Resource center

URDI is on the 2nd floor of the DUHD office at No. 228/234, Bo Gyoke Road, Botahtaung Township, Yangon. Since 2012, URDI has made 74 training programs for 2217 trainees (Figure 1).

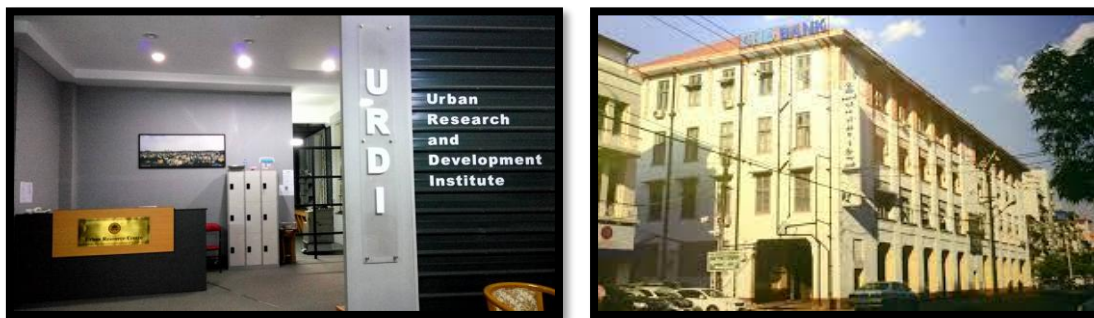


Figure 1. Location of Urban Research and Development Institute,
Source: Department of Urban and Housing Development, DUHD (2024)

Urban Research and Development Institute's Visions

- To establish the Myanmar Urban Development Centre and internationally recognizable Urban and Housing Development Institute.
- To research urban and housing by international research standards.
- To become a Hub of urban and housing experts and a Centre for nurturing new generations of urban and housing specialists.

Urban Research and Development Institute's Missions

- To do analyses, reviews, and consultations on the urban planning process, housing development measures, urban research, and legislations performed by DUHD.
- To become a national-level urban research institute, to give capacity building and training programs for government staff including other CSOs that are performing urban development.
- To interlink with international organizations and expect to learn international urban and housing practices and knowledge.

Collaboration and Corporation

Urban Research and Development Institute Collaboration and Corporation with both international and local organizations. The international organizations that URDI Collaboration and Corporation were as follows;

- UN-Habitat
- Asian Development Bank (ADB)
- Japan International Cooperation Agency (JICA)
- Singapore Cooperation Enterprise (SCE)
- University of Cologne, Germany
- Institute for Housing and Urban Development Studies (IHS), Netherlands
- SKL International, Swedish International Development Cooperation Agency (SIDA)
- Cities and Infrastructure for Growth (CIG) program Myanmar, (DFID, UK) (Hlanchi Program)

URDI Collaboration and Corporation with local organizations are; the General Administration Department (GAD), Yangon City Municipal Development Committee (YCDC), Mandalay City Municipal Development Committee (MCDC), City Development Committees, Environmental Conservation Department, Township Development Committees, Yangon University (Geography Department), Yangon University of Technology (Architecture Department), Universities of Technology and Public.

Training Sectors

Training programmers are intended to implement for government staff and citizens for urban development in their respective regions aimed to understand the importance of urban planning concerning human settlement and economic development, know the functions of cities, know urban challenges, understand potential problems in urban development, as well as to realize future probable cases together with adaptation measures. From 2012-2020, all trainings were 74, and about 800 midlevel government officials participated (Table 1). The training programs were accomplished not only in Yangon but also in other cities of Myanmar and training durations are one day to five days (Figure 2).

Table (1): Number of Training Programs (2012-2020)

No	Year	Number of Trainings	Number of Participants
1	2012	2	105
2	2013	3	212
3	2014	2	70
4	2015	35	895
5	2016	18	450
6	2017	6	216
7	2018	4	147
8	2019	3	105
9	2020	1	17
Total		74	2217

Source: Department of Urban and Housing Development, DUHD (2024)

URDI partners with different institutions, resulting in varying course subjects taught from 2012 to 2020.

1. Sustainable Urban Management
2. Sustainable Land Management in Urban Contexts
3. Urban Land management
4. Concepts of Urban Planning
5. City Development Strategies (CDS)
6. Urban Infrastructure Finance
7. Urban Services Business Operation Plans
8. Infrastructure and Basic Services
9. Preparation of Urban Infrastructure Investments

10. Management of Public-Private Partnerships
11. Management of Procurement & Project Implementation
12. Operations and Maintenance
13. Environmental Safeguards
14. Social Safeguards
15. Township Planning and Public Housing Program
16. Urban Planning and Pro-motion of Housing Delivery System for Low-income Population in Myanmar
17. Affordable Housing
18. Geographic Information System (GIS)



Figure 2. Giving urban development and urban planning training to various stakeholders **Source:** Department of Urban and Housing Development, DUHD (2012,2020)

Most of the trainers were international experts, while some were local. The training was attended by government officers and members of local organizations. The organizations that participated in the training are listed below:

- General Administrative Department
- Road Department
- Planning Department
- Township Development Committees
- Department of Archaeology and National Museum
- Environmental Conservation Department
- Department of Basic Education,
- Department of Public Health
- Department of Agricultural Land Management and Statistics
- Technological Universities
- Women Association
- Irrigation and Water Utilization Management Department,
- Department of Meteorology and Hydrology (DMH)
- Directorate of Water Resources and Improvement of River Systems
- Electricity Department,
- Kalaw Tourism Organization
- Yangon City Development Committee
- Mandalay City Development Committee
- Township Development Committees
- Planning Department
- Township Committees

By the leading of the Institute of Urban and Housing Studies (I HS) Netherlands, international participants also came to study courses at URDI in the 2015 course “Affordable Housing Concepts and Approaches”—twenty Participants from ASEAN Countries and

Trainers from IHS, Netherlands. In 2016, the Refresher course was held at URDI by Almina students from IHS International. With the support of SKL International, the Swedish International Development Cooperation Agency (SIDA), Public Lecture Sessions were also held once a month from 2016 to 2019 (Figure 3).



Figure 3. Urban Research and Development Institute Lecture Room and Relaxing Area

Source: Department of Urban and Housing Development, DUHD (2023)

Research Sector

In the research sector, in cooperation with Un-Habitat, they are studying urban development with their funding and writing a series of discussion papers on National Urban Policy and National Housing Policy. Similarly, the Mapping of Yangon's informal settlements was carried out by URDI together with YCDC and UN-Habitat. Also, URDI published research publications and educational materials in urban management and disaster risk reduction and conducted seminars and workshops.

In collaboration with SKL International Swedish International Development Cooperation Agency (SIDA), URDI carried out research projects in the cities of Kalay Kalaw and Dawei. Among these projects, Sustainability Review and Strategies for Kalay City (2040), Sustainability Review and Strategies for Kalaw (2030), Dawei Sustainability Review Strategies (2030) and Kalaw City Profile Book were also published. URDI has also published an educational book "Symbio City Approach Program" for urban sustainability. URDI has published (36) books with both English versions and Myanmar versions. The publication and distribution costs of all the books have been supported by international organizations cooperating with URDI on their respective projects.

Resource Center

Urban Research Centre is a modern library that keeps urban and housing publications. URDI Library is located at No. 228/234 Botgyi Road, Botahtaung Township, where the URDI office and training hall are located. In addition, URDI E-Library already has on www.duhd.org.mm. The E-Library is in the process of being launched and more books will be added. All books in the library are related to urban development sectors. The stakeholders from various fields can learn the library (Figure 4). The types and number of books in the library are as follows (Table 2).



Figure 4. Learning the different fields of stakeholders at the URDI Library**Source:** Department of Urban and Housing Development, DUHD**Table (2): The different types of books at the URDI Library**

No	Category	Number of Books
1	Climate Change	35
2	Computer	4
3	Disaster Risk Reduction	138
4	Electricity	6
5	Economics	75
6	Housing	80
7	Infrastructure	28
8	Land & Land Used	45
9	Laws & Regulations	65
10	Poverty	44
11	Rural	18
12	Transportation	26
13	Urban	403
14	Water	49
15	Report	26
16	Population	13
17	Catalog	112
18	Social	4
19	Management	5
20	Environment	16
21	Specification	1
22	Planning	21
23	Research Paper	85
24	General	80
25	Total	1379
	Soft Books	16488
	All totals	17867

Source: Department of Urban and Housing Development, DUHD (2024)

Research Questions

A research paper has been conducted to study the current activities and functions of the Urban Research and Development Institute (URDI) and the factors that will lead to further development through the strengths and challenges of URDI. The guiding research questions are:

- 1) Whether we should continue this Institute?
- 2) Should it be linked with other organizations?
- 3) Should only urban planning staff be involved?
- 4) Discuss the current strengths and weaknesses to move forward with this Institute.

Materials and Methods

This paper explores the “**mixed-methods approach**” with quantitative and qualitative data collection methods.

Quantitative: Likert scale questions; first a literature review took place and secondary data was collected from the Department of Urban and Housing Development, Ministry of Construction; Number of trainings, Number of participants, Training Subjects, Department list of participants, List of corporation's organizations, and Library Data.

Qualitative: Primary data: Interviews and talks: with expertise: in-depth qualitative interviews, semi-structured interviews with instructors, trainees, policymakers, and fieldwork.

Analyze perceptions of trainees: Comprehensive, integrated analysis, triangulation method, and SWOT analysis.

Results and Finding

The Urban Research and Development Institute Library was founded in 2013 as an Urban Resource Center in Yangon. It functions as both a physical library and an online E-library, providing books on urban and housing development. The library can be accessed through the www.duhd.org.mm website, where readers can find a collection of E-books. According to a project 'Myanmar Programmed for Safer Settlements and Urban Research (MPSSUR)' of a memorandum of understanding (MoU) signed in 2012 by the Department of Urban and Housing Development (DUHD), Ministry of Construction (MOC) and UN-Habitat, Urban Research and Development Institute (URDI) started.

Among the points included in the project of the MoU, is the implementation of the Urban Research and Development Institute (URDI) to pay special attention to the development of building regulations and technical laws, capacity building of relevant technical experts, etc.

In 2013, the Urban Research and Development Institute Library was established as an Urban Resource Center in Yangon. It serves as both a physical library and an online E-library, featuring books on urban and housing development sectors. The library can be accessed through the www.duhd.org.mm website, where readers can also find a collection of E-books. In 2013, the Urban Research and Development Institute Library was established as an Urban Resource Center in Yangon. It serves as both a physical library and an online E-library, featuring books on urban and housing development sectors.

The library can be accessed through the www.duhd.org.mm website, where readers can also find a collection of E-books. In 2013, the Urban Research and Development Institute Library was opened as an Urban Resource Center. It is also a library with books on urban and housing development sectors. The URDI library is both an E-library and library room which is located at the URDI office, in Yangon the E-library can be also read online E-Books through the www.duhd.org.mm website. Doctoral and master's students from Yangon Technology University, as well as professionals in urban development, visit the library.

From (2012-2020), URDI has delivered (74) training courses. The trainers are organized by international organizations that have signed a project agreement with URDI; most are international experts. There was a total of (10) projects, a total of (18) subjects were taught and a total of (2217) trainees attended. The training participants were government employees working in the urban development sectors, local people, and representatives of local organizations.

The training was conducted in the pilot areas where the project will be implemented, just as there are lectures at the URDI training hall in Yangon. The duration of the training varied from 3 to 5 days, depending on the specific project. Once the courses were completed, the training was held either once a month or once every two months throughout the year. The project also included research publications and educational materials in the relevant fields. The financial sector was supported by international organizations that were involved in the project. Furthermore, SKL International conducted a public lecture series once a month for three hours, featuring subject-related experts from 2016 to 2019.

URDI, in partnership with UN-Habitat and YCDC, conducted a research project on the "Mapping of Yangon's informal settlements". In addition, URDI in cooperation with SKL

International also published four research books in both English and Myanmar languages. After completing training courses with international organizations, educational materials on urban management are compiled and published based on field research. UN-Habitat has collaborated with international experts to develop the housing sector and urban sector regulations and laws necessary for the Department of Urban and Housing Development.

Based on the analysis of ten key questions among twenty questions and the responses provided, it has been confirmed that all participants thoroughly enjoyed the activities offered by URDI. This overwhelmingly positive feedback is a testament to the quality of the experiences provided by URDI and underscores its commitment to delivering excellent services to all its patrons. They also expressed their appreciation for URDI's current location in Yangon and the expansion of URDI to Naypyidaw. The respondents also expressed a strong interest in online lectures, with a particular desire for regular lectures from experts in our department.

A significant number of people who are presently participating in URDI's training programs are working in governmental roles. There is a growing interest in making these courses available to everyone interested in urban development. Although the current courses are short-term, there is a preference for URDI to provide long-term programs that lead to certification. It seems that URDI's current focus is on the urban sector, and it plans to expand to housing courses and more research sectors. They think that research activities should be carried out exclusively. They agreed that URDI is an essential institute for the department. The table and chart below show the interviewees' views on the Likert scale questions.

Table (3): Stakeholders' Perceptions on URDI

No	Questions	Extremely Disagree(%)	Disagree (%)	Neutral (%)	Agreed (%)	Extremely Agree(%)
1	Are you satisfied with the course taught by URDI?	0	0	2	22	76
2	I like that URDI is located in Nay Pyi Taw.	0	0	4	10	86
3	I like that URDI is located in Yangon.	0	0	6	14	80
4	URDI courses should continue to be delivered online.	0	0	2	2	96
5	Courses from URDI should be long-term courses leading to certification.	0	0	8	12	60
6	Courses at URDI should be regularly taught by departmental experts from the Urban and Housing Department.	0	0	0	18	82
7	There is a need for more research in URDU.	0	0	0	8	92
8	URDU should expand training and research activities in the housing sector	0	0	0	2	98
9	Courses at URDI should be offered to anyone interested in urban development subjects.	0	0	20	14	66
10	For the Urban and Housing Department, URDI is essential.	0	0	4	10	86

Source: Based on Survey (2023-2024)

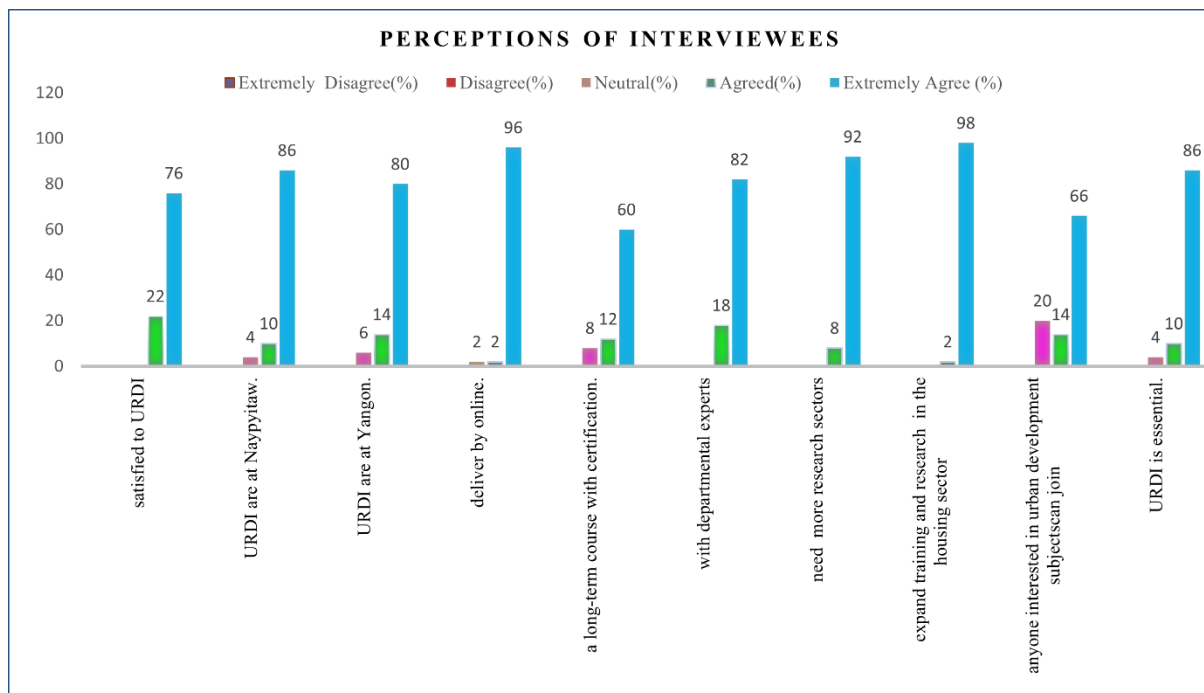


Figure 5. Perceptions of interviewees

Source: Based on Table (3)

During the interviews, I discovered that URDI's training courses are based on international experience, providing an opportunity for trainees to learn methods that are appropriate to the cities of Myanmar. The training is not only conducted in the classroom but also practical fields, allowing trainees to apply their knowledge effectively in their workplace. Lectures by international experts enable trainees to gain international experience and compare and analyze Myanmar's current nature, type, and situation.

The lectures delivered by the local experts are incredibly valuable as they highlight points of weakness and areas for improvement in practical operations. The teaching style is not typical, as it focuses on knowledge-sharing rather than traditional lecturing. The participants come from various urban development sectors, enabling them to discuss and exchange views during the course and fostering greater cooperation between departments. Some courses were not only local but also international, providing them with the opportunity to learn about practical experiences from around the world.

They want international experts to teach the courses and experts from local departments. In response to trainees from other departments, want to study GIS courses due to their importance in urban development. GIS diploma holders recommended that GIS courses should be conducted continuously in collaboration with Yangon University's Department of Geography.

They also want to get the courses regularly online. The courses offered were mostly short-term ones, although some people were interested in long-term courses that provided training leading to certification or expertise. Some individuals desired more training and research opportunities in the housing sector. They are aware that attending courses at URDI is very convenient when translators are available but can be challenging when there are no translators. Attending URDI courses is not just about acquiring knowledge, but also about enjoying comfortable training rooms, site visits, and quality food.

When it comes to the URDI library, it is known that most of the participants do not use the URDI library. To address this issue, it is suggested that the library should be made more popular and more updated books should be kept. Additionally, report books and research books written by staff in the ministry should also be kept and copies of existing original books should

also be kept. As for URDI, it is seen that there is a weakness in the writing of research papers required for the department and there are only a lot of training course-based activities. URDI has been responsible for writing and updating various important policies such as the National Urban Policy, National Housing Policy, and National Building Codes.

This has been achieved with the help of UN-Habitat and local and international experts. URDI conducts research programs that include City Profiles, Urban Governance, Urban Demographic information, Socio-Economic Profiles, and more. These research programs have been carried out in collaboration with other organizations. URDI's Source Materials have been used to publish Research Publications with the support of international organizations. Those with international experience suggested that URDI should continuously write and compile research papers, which would be necessary for the department and ministry.

When analyzing the responses to the interview questions related to URDI using “SWOT” analysis, the following were found:

Strengths

- URDI is the only urban development institute, which gives it a unique advantage.
- URDI provides an opportunity for trainees to learn various urban planning methods.
- The training offered by URDI enables trainees to systematically reuse urban projects that have already been designed.
- URDI's training program fosters cooperation among different departments and trainees.
- Trainees gain international skills and knowledge through the program.
- URDI teaches trainees to conduct research through fieldwork.
- URDI's training program is cost-effective, as there are no additional costs for food or training.

Weaknesses

- Insufficient regular training.
- Short training programs.
- Difficulty for everyone to attend classes.
- A limited number of participants. –
- Inadequate research activities in the housing sector.
- Over-reliance on other organizations.
- Insufficient staff.
- Weak funding.

Opportunity

- Collaborating with others to design and plan urban plans.
- Properly reusing previously systematic urban projects that have already been designed.
- Sharing the knowledge gained with their community.
- Understanding urban planning and management methods to develop their town/village and reuse them effectively.
- It's great to have the opportunity to closely discuss with experts.
- Acquiring international knowledge is valuable for personal and professional growth.
- Learning how to conduct research activities.
- Enhancing the welfare of departments and communities through the results of research.

Threat

- The difficulty in changing the majority's perspective that urban planning is solely for urban planners and not for the people.
- There is a poor knowledge of GIS, which is the core of urban planning, among people.
- Research on both urban and housing sectors is weak.

- A lack of effort to work independently without depending on international organizations.
- Staffing difficulties, meaning the lack of structure, is another challenge.
- Poor financial/budgetary allocation is also a significant issue.
- Inability to fully implement URDI's vision and mission statements.

Recommendations and suggestions

URDI's missions and visions are highly valuable and beneficial for our developing country. Based on the analysis, it is evident that URDI is an excellent institute for professional urban and housing development. The research indicates that the participants have received positive feedback from the trainees and partnership organizations. However, it has been observed that the courses have been conducted intermittently, and after 2020, they have become almost non-existent. To develop continuously, it is recommended that URDI focuses on its original (3) achievements: *“training, research, and resource center”* while considering the researcher's perspective and the following points. According to the international experience studied by the researcher, URDI recommends financial measures based on international research to reduce budget consumption when other organizations do not cooperate. To ensure URDI's continued growth, it is recommended that the following points be implemented.

Training Sector

People in most developing countries have accepted the misconception that urban development and urban planning are the government's and urban planners' responsibility. To rectify this misunderstanding, it is important to make training and knowledge-sharing programs mandatory. As a national responsibility, URDI should undertake the dissemination of this knowledge. Training courses should be conducted continuously both in the URDI training hall and online. As URDI is the training and research center of the Department of Urban and Housing Development (DUHD), URDI should offer training related to urban development and housing sectors and issue recognized training certificates. Those who want to attend the training should give priority to those who are working in the urban development sector and housing development sector. The training fee should be determined based on the support received from cooperating organizations. It is important to conduct an online "Public Lecture Series" once a month as a Knowledge Sharing Program for the public. This will help individuals learn about urban development and develop a willingness to work together toward the country's progress.

It would be helpful to implement a monthly rotation system for the staff of the Department of Urban and Housing Development at the state and regional. This would allow them to gain a realistic understanding of the challenges faced by department employees in various regions and provide necessary support to the union. Trainers could visit these areas or conduct online training sessions as needed. URDI should work with universities and ensure that urban and housing subjects are taught by departmental experts who specialize in the respective subjects.

In this way, the number of people with knowledge and expertise in urban development will increase. From 2012 to 2020, URDI only taught subjects that were requested by its partner institutions. As a result, it was observed that more emphasis was given to the urban sector than the housing sector. Moving forward, URDI should consider teaching courses that cater to both the urban and housing sectors, instead of just focusing on one. URDI should teach the following subjects;

1. Geographic Information System (GIS)
2. Sustainable Urban Management
3. Sustainable Land Management in Urban Contexts
4. Concepts of Urban Planning

5. Basic Urban Planning
6. Advance Urban Planning
7. City Development Strategies
8. Urban Management Strategies
9. Management of Public-Private Partnerships
10. Management of Procurement & Project Implementation
11. Public Housing Management
12. Project Management
13. Estate Management
14. Environmental Management and Environmental Safeguards
15. Social Safeguards and Strategies
16. Disaster Risk Management
17. Socio-economic
18. Time Management
19. Zoning Management
20. Housing Delivery System and Strategies
21. Affordable Housing Strategies and Finance
22. Housing and Bank Lending Sector
23. Urban Infrastructure Finance
24. Urban Services Business Operation Plans
25. Strategies of Operations and Maintenance
26. Sustainable Local Economic Development
27. Departmental laws and regulations
28. laws and regulations of Land, Urban, and Housing sectors

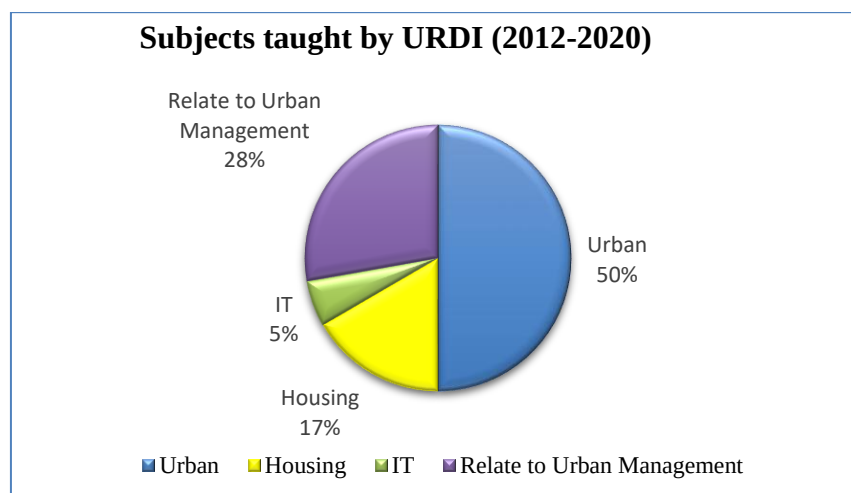


Figure 6: Subjects taught by URDI (2012-2020)

Source: Data from DUHD

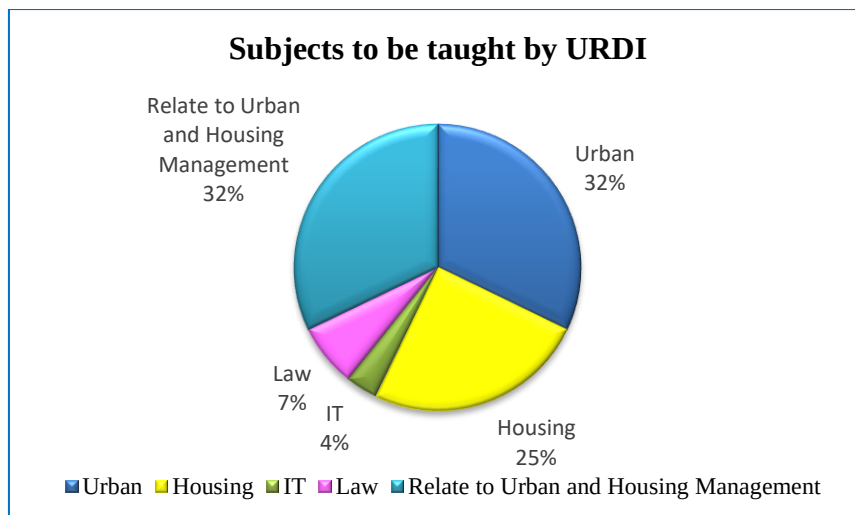


Figure 7. Subjects to be taught by URDI

Source: Based on Interview (2023-2024)

Research Sector

Some of the URDI's goals are for the field of urban research, to become a hub for international urban and housing development projects as an independent academic urban research center, and to provide national-level urban and housing development consulting services. However, it has been observed that these objectives have not been effectively implemented in practice. URDI should conduct necessary research activities and recommend departmental requirements. However, only training course-based research activities were carried out based on the support of international organizations that cooperated.

According to the international experiences studied by researchers, the Korea Research Institute for Human Settlements (KRIHS) in Korea, the Urban Design and Development Center (UDDC) in Thailand, the National Research and Innovation Agency Badan Riset dan Inovasi Nasional (BRIN) in Indonesia, the Public Works and Transport Training Institute (PTTI) in Laos have researched various fields of the department and compiled research papers that will be useful for their department and their Nation. The government carries out national development activities based on its research papers. Like these, URDI should conduct continuous research and innovation in areas related to the department's work, such as slum upgrading, encroachment, public housing, urban planning, land compensation, land use, etc. URDI should organize research paper contests similar to universities and the Myanmar Academy of Arts and Sciences. This will enable me to choose and utilize research papers that can be used by DUHD.

Resource Centre

Since the URDI Library was established as a Resource Center in 2013, it has been observed that the library is mainly used by master students in the urban sector. However, there has been little increase in the number of books since its inception. As there are other libraries within the department, the collection of books in the URDI library seems weak. To improve the library's resources, books from the National Library, as well as master's these and research papers of DUHD staff, should be added to the collection. It is also important to raise awareness of the E-Library and URDI library in Yangon and encourage more people to use them.

Conclusion

The government-based URDI was established with the support of UN-Habitat. money employees It found that resources such as facilities and equipment were limited and URDI relied heavily on partnerships to survive. Due to the limited use of state funds, URDI needs to generate its income to develop its fund. This can be done by following the example of training institutes/research centers operating in other countries. By disbursing its income; URDI's

activities will be further developed, which will reduce the state's need for financing and avoid dependence on other institutions. Here are some of the ways URDI can raise funds;

- Professional courses are offered for a fee based on the subject of the professional training certificate.
- Pay a fee to borrow books from the library.
- To use the training hall for rent.
- Open coffee shops and bookstores around the training hall and sell books.
- Photocopying shops and computer typing shops will be opened in the URDI compound.

This research paper's findings have significant implications for urban and housing development sectors. It can guide the creation of policies and courses that meet the needs and preferences of the country, as well as promote the emergence of individuals who will systematically understand urban development to help the country become modern and developed. Additionally, collaborations with other universities and institutions, increasing corporate partnerships, and reducing the use of state funds are helpful factors to consider. As URDI's reputation for successful urban development grows, international organizations and other institutions are showing interest in cooperating with URDI. This will further enhance URDI's development through collaboration. The improved image of URDI will also strengthen the Department of Urban and Housing Development, and the Ministry of Construction, and greatly benefit the urban development sector of our Nation.

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THE SPATIO-TEMPORAL TRENDS OF URBAN GREEN SPACE AND ITS INTERACTIONS WITH URBAN GROWTH IN THANLYIN, YANGON REGION

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Abstract

The role of urban green space (UGS) in urban sustainability is attracting and increasing attention for researchers. In this study, we investigate the spatio-temporal variation of urban green space and its relationship based on an empirical analysis in Thanlyin in the Yangon Region. The remote sensing data will reveal a changing urban green space pattern with the green areas mainly clustered in urban centers. We will use piecewise linear regression to investigate the impacts of urban growth on the urban green space in the economy, population, and land-in socio-economic development phases (2003-2023) based on Land Use and Land Cover. The results that the growth of the economy and population reduced urban green space in the initial stage of development. urban green space decreased slightly during 2003-2023, and it is necessary to maintain urban green space in the Thanlyin environment in the future. Finally, we will discuss the potential of urban growth to improve urban environment and propose nature-based solution to mitigate the conflicts between urban compactness and urban green space layout.

Keywords: urban green space (UGS), socio-economic development, environmental issues, Land Use and Land Cover (LULC), and urban environment

Introduction

Urban Green Space is defined as urban land, partly or completely covered with grass, trees, shrubs, or other vegetation. Urban green space is also referred to as blue-green zone, because urban water such as ditches, rivers and riverbanks, is considered as urban green space. Urban green space reduces the risks of flooding in cities, cools the city in the summer and provides biodiversity (Haase et al., 2014). Urban green space contributes to the wellbeing of cities and its residents, for better health, and social cohesion (Hartig et al., 2014; Hunter et al., 2019). The positive impacts of urban green space on health, local economy and wellbeing are often reflected in higher land. Such a city is also likely to have healthier citizens, reducing demands on health services and contributing to a stronger economy.

Study Area

Thanlyin is located on the southern part of Yangon Region. Thanlyin is a major port city of Myanmar, located across Bago River from the city of Yangon. It's located from the river mouth in which Yangon River, Bago River and Pazundaung creek converge.

Aim

To identify the spatial changes of Urban Green Space in Thanlyin and its surroundings using.

Objectives

-To understand changes in urban green space occurring in Thanlyin base on analysis of land cover data.

-To identify and compare of land cover change in the study area.

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- To investigate between 2003 and 2023, the spatial distribution pattern of urban green space change in the study area.

Sources of data and Methodology

Land Cover data, which classifies land cover by using Google Earth Pro satellite imagery in time series. ArcGIS software version 10.4 was used for analysis of data.

Geographical and Social Background of Thanlyin

Thanlyin is located on the southern part of Yangon Region, in Myanmar. May 1st, 2022, Thanlyin is to become one of the Thanlyin District presently. Thanlyin is situated between 16° 44' to 16° 47' North Latitudes and between 95° 14' to 96° 16' East Longitudes. It is composed of 17 wards of urban settlement. According to Township Administrative Department, the areal extent of Thanlyin is 15.36 square kilometres. However, MIMU (Myanma Information Management Unit) shape file, extracted by areal extent of the township is about 14.38 square kilometers (1438.4 hectares). Thus, it is used by the areal extent of Thanlyin in our research paper. Thanlyin has slightly an elongated shape.

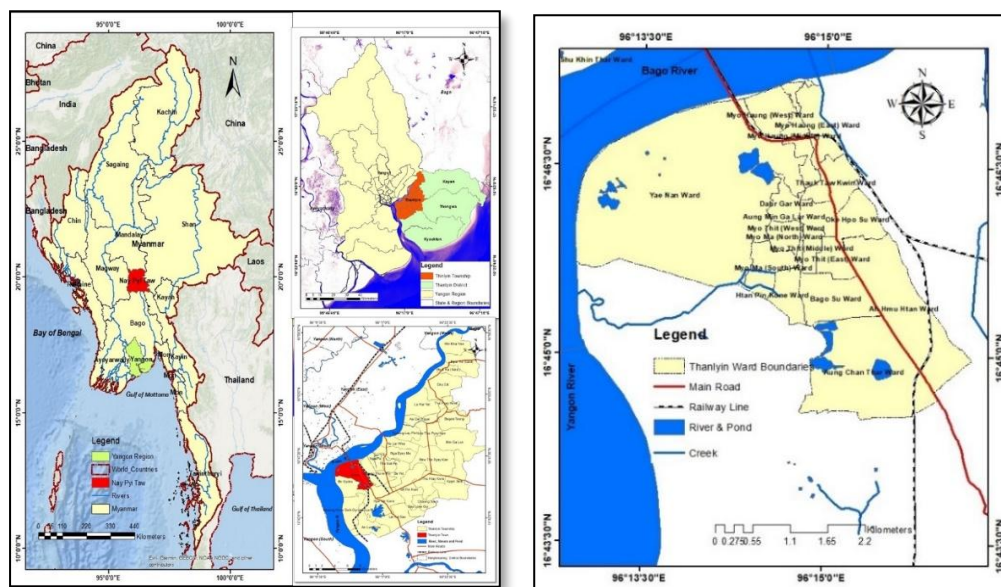


Figure 1 Location map of Thanlyin in Thanlyin District, and Yangon Region, in Myanmar

Source: Myanma Information Management Unit & Open Street Map Shp.2018

According to NASA, Monthly and Annual data, the study area has monthly average temperature of 28.69 °C and the total rainfall has 1415.74 mm during the period from 1981 to 2022.

Thanlyin urban area formed with seventeen wards. In 2021, the highest population distribution with over 12,000 was Myo Haung (East) Ward. Myo Thit wards were the lowest population distribution with less than 2000 in 2021.

Image Analysis of Urban (Thanlyin) Green Space

Owing to Google Earth Pro, the analysis of the present study was only from 2003, 2006, 2009, 2012, 2015, 2018, 2021 and 2023 data firstly. Land cover maps were prepared using Google Earth Pro images and ground checked during the field survey. Moreover, during 2003-2023 with urban green space the majority of the changes occurred from building, bare ground and road. Transport as main road is one of the important factors influencing the arrangement of spatial relations and creating spatial interactions in society. This study, however, focused on how land is being used at present compared to the use of the same land in the past.

Based on table 1 and figure 2, from Google Earth Pro satellite image to analysis of Classification in 2003 image revealed that vegetation including park, community gardens, rooftop gardens and vertical gardens constituted the largest area and proportion of land cover in Thanlyin with a value of 517.06 hectares of the total area, followed by grass cover which accounts for 314.42 hectares. Road and water body like river, stream and pond, constituted 227.57 hectares and 174.43 hectares respectively, while bare ground, and building cover area showed coverage values of 158.91 hectares, and 45.92 hectares respectively. So, urban green space showed a vital role in reconnecting human and urbanized landscape with its unique characteristics that had 831.48 hectares (vegetation and grass) in 2003.

Table 1 The Area Extent of Land Cover (Hectares) in Thanlyin

LULC	(2003) Hectares	(2006) Hectares	(2009) Hectares	(2012) Hectares	(2015) Hectares	(2018) Hectares	(2021) Hectares	(2023) Hectares
Water	174.43	172.64	133.61	210.96	91.64	238.27	239.72	113.46
Grass	314.42	227.83	313.99	331.77	218.12	301.49	109.77	259.16
Vegetation	517.06	395.75	480.43	509.60	397.67	513.40	552.32	508.13
Building	45.92	63.72	57.95	62.69	80.43	80.02	93.87	67.25
Road	227.57	259.13	257.52	141.80	308.47	231.01	351.11	420.50
Bare ground	158.91	319.26	194.86	181.53	342.01	74.14	91.52	69.82
Total (Hectares)	1438.31	1438.34	1438.35	1438.34	1438.32	1438.33	1438.30	1438.31

Source: Google Earth Pro images results

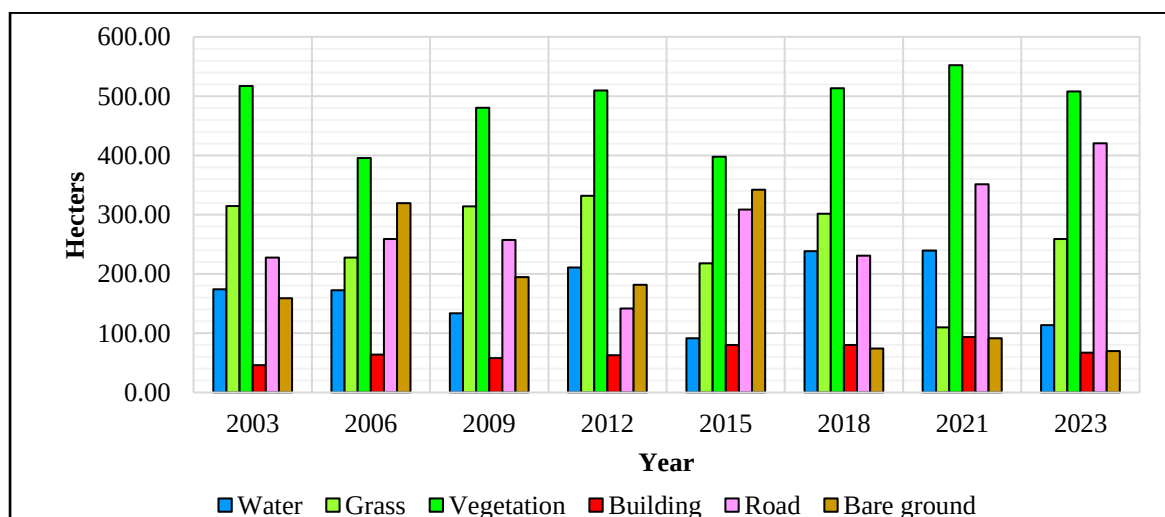


Figure 2 The Area Extent of Land Cover in Thanlyin

Source: Table 1

In 2023 image revealed that vegetation also constituted the leading area and proportion of land cover in Thanlyin with a value of 508.13 hectares of the total area followed by road cover which accounts for 420.50 hectares. Grass and water body area constituted 259.16 hectares and 109.77 hectares. Bare ground and building cover area showed 69.82 hectares and 91.52 hectares. So, urban green space showed that had 767.29 hectares vegetation and grass.

The Spatio-Temporal Trends of Urban Green Space

The spatial distribution of urban green space shown in figure 3, analysis of these images revealed that vegetation or trees coverage constituted the leading and proportion of land cover in Thanlyin totally.

Change Detection Analysis Results (2003 and 2023)

According to Google Earth Pro, the images change detection analysis between 2003 to 2023 indicated that the largest change of land coverage ranks following from the vegetation to vegetation with 223.46 hectare, vegetation to road with 136.40 hectares, grass to vegetation

with 98.22 hectares, grass to road with 85.16 hectares, vegetation to grass with 80.76 hectares, grass to grass with 80.04 hectares, road to road with 77.08 hectares, road to vegetation with 70.73 hectares, water to vegetation with 62.01 hectare and bare ground to road with 55.16 hectares and so on shown in table 2 and figure 4.

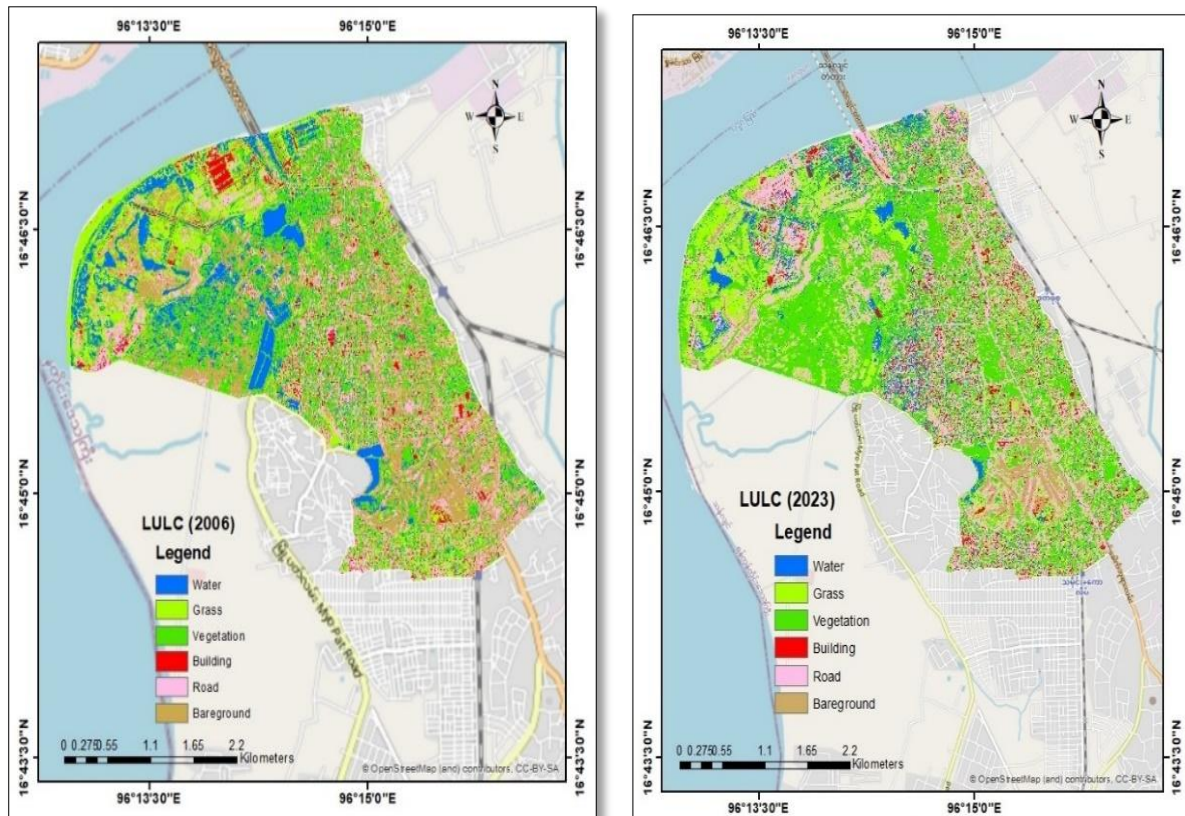


Figure 3 Satellite Imagery and Land Cover of Thanlyin in 2003 and 2023

Source: Google Earth Pro images results Maximum Likelihood Classification

Owing to images results, from 2003 to 2023, the road cover is extremely changed to increase from vegetation to road 136.40 hectares, grass to road with 85.16 hectares, bare ground to road with 55.16 decreased to change from road to vegetation with 70.73 hectares, road to grass with 39.18 hectares, road to water 15.96 hectares, road to building 12.43 hectares and road to bare ground 12.09 hectares.

Likewise, the Building cover is somewhat increased to coverage from vegetation to building with 23.43 hectares, road to building with 12.43 hectares, water to building with 9.34 hectares and bare ground to building with 6.27 hectares. However, the buildings cover is a little decreased to change from Building to Road with 17.08 hectares, building to Vegetation with 15.19 hectares, Building to Grass with 4.38 hectares, building to water with 3.52 hectares and Building to Bare ground with 1.77 hectares.

Discussion

The field data and Google Earth Pro time series are used for the accuracy assessment process for the year 2003 and 2023, the classification system classifies in six. A total of 250 random points was used for the validation and accuracy of the classification results. Random points are selected based on field data and analyzed into statistical information on land cover types. The users of land use and land cover maps need to know the level of accuracy of the map so that it can be used more efficiently and correctly. According to images, the interpretation accuracy of land use and land cover change is not allowed below 80%. The most

widely promoted classification accuracy is in the form of error matrix which can be used to derive a series of descriptive and analytical statistics.

Table 2 Change Detection Analysis (2003 and 2023)

Class (2003)	Area (2003)	Class (2023)	Area (2023)	Class Change (2003-2023)	Change Area (Hectares)	Change %
Water	174.43	Water	113.46	Water - Water	18.24	1.27
Water	174.43	Grass	259.16	Water - Grass	29.99	2.09
Water	174.43	Vegetation	508.13	Water - Vegetation	62.01	4.31
Water	174.43	Building	67.25	Water - Building	9.34	0.65
Water	174.43	Road	420.50	Water - Road	49.48	3.44
Water	174.43	Bare ground	69.82	Water - Bare ground	5.30	0.37
Grass	314.42	Water	113.46	Grass - Water	29.04	2.02
Grass	314.42	Grass	259.16	Grass - Grass	80.04	5.57
Grass	314.42	Vegetation	508.13	Grass - Vegetation	98.22	6.83
Grass	314.42	Building	67.25	Grass - Building	11.79	0.82
Grass	314.42	Road	420.50	Grass - Road	85.16	5.92
Grass	314.42	Bare ground	69.82	Grass - Bare ground	10.11	0.70
Vegetation	517.06	Water	113.46	Vegetation - Water	37.39	2.60
Vegetation	517.06	Grass	259.16	Vegetation - Grass	80.76	5.62
Vegetation	517.06	Vegetation	508.13	Vegetation - Vegetation	223.46	15.54
Vegetation	517.06	Building	67.25	Vegetation - Building	23.43	1.63
Vegetation	517.06	Road	420.50	Vegetation - Road	136.40	9.49
Vegetation	517.06	Bare ground	69.82	Vegetation - Bare ground	15.50	1.08
Building	45.92	Water	113.46	Building - Water	3.52	0.24
Building	45.92	Grass	259.16	Building - Grass	4.38	0.30
Building	45.92	Vegetation	508.13	Building - Vegetation	15.19	1.06
Building	45.92	Building	67.25	Building - Building	3.97	0.28
Building	45.92	Road	420.50	Building - Road	17.08	1.19
Building	45.92	Bare ground	69.82	Building - Bare ground	1.77	0.12
Road	227.57	Water	113.46	Road - Water	15.96	1.11
Road	227.57	Grass	259.16	Road - Grass	39.18	2.72
Road	227.57	Vegetation	508.13	Road - Vegetation	70.73	4.92
Road	227.57	Building	67.25	Road - Building	12.43	0.86
Road	227.57	Road	420.50	Road - Road	77.08	5.36
Road	227.57	Bare ground	69.82	Road - Bare ground	12.09	0.84
Bare ground	158.91	Water	113.46	Bare ground - Water	9.27	0.64
Bare ground	158.91	Grass	259.16	Bare ground - Grass	24.70	1.72
Bare ground	158.91	Vegetation	508.13	Bare ground - Vegetation	38.41	2.67
Bare ground	158.91	Building	67.25	Bare ground - Building	6.27	0.44
Bare ground	158.91	Road	420.50	Bare ground - Road	55.16	3.84
Bare ground	158.91	Bare ground	69.82	Bare ground - Bareground	25.05	1.74
Total					1437.91	100.00

Source: Image detection Analysis

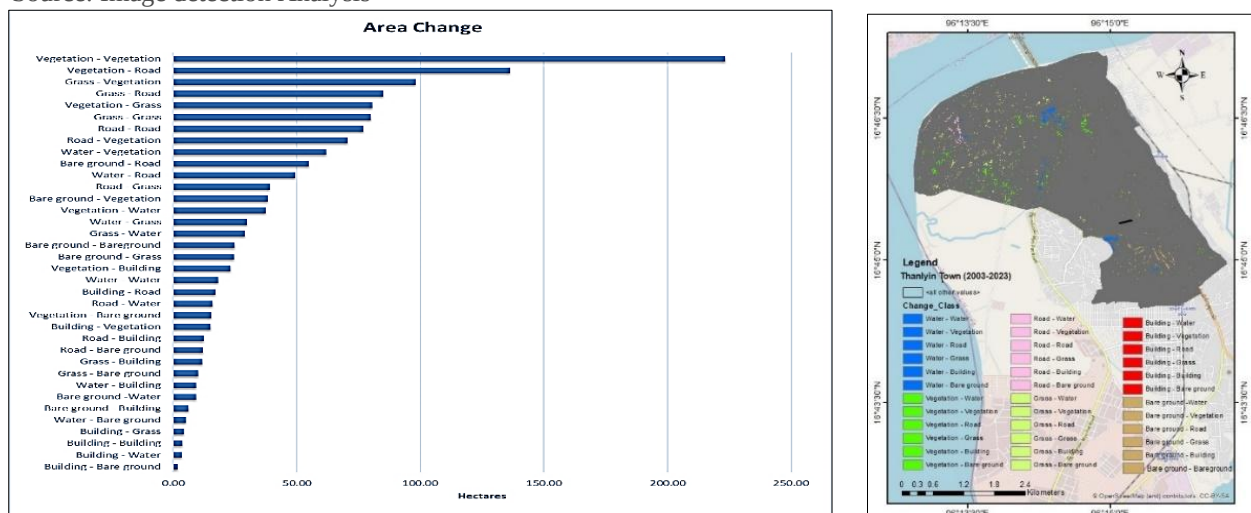


Figure 4 Area Change of Land Cover and Change Detection Analysis in Thanlyin (2003-2023)

Source: Based on Table

Accurate land use and land cover information is important for the various spatial planning decision making. Remote sensing is an effective mapping technique of the Earth's

surface that is spatially highly consistent. This study compared the classification accuracies of land cover/land use maps created from image classification of Google Earth Pro to Thanlyin as a research area. One hundred and fifty data references were generated from Google Earth Pro imagery as the sample data set is compared with the classification maps that are being assessed. With the Kappa analysis approach, error matrices are made based on the same data references for two images to assess the classification quality and to find out the best imagery that yields the most accurate land use and land cover data.

According to urban green space definition, vegetation and grass cover have slightly decreased from 831.48 hectares to 767.29 hectares in the study area from 2003 to 2023 respectively. Moreover, road and building are related to develop for urban growth in the study area. In particular, urban green space was about 58 % in 2003, 44% in 2006, 55 % in 2009, 58 % in 2012, 43 % in 2015, 57 % in 2018, 46 % in 2021, and 53 % in 2023 respectively.

Change of urban green space cover is common phenomena depend on modification of physical factors such as climate, soils conditions and socio-economic factors. Of these, urban growth evidence of access to road network and urban building structure such as houses are increased in the town.

The urban green space of Thanlyin is got to fluctuation rate in study periods. Concluded up, the linear trend line indicates the town total urban green space coverage have been slightly decreasing between 2003 to 2023 and its trends may be to decrease in the future shown in figure 5. The change of land cover between 2003–2023 periods are presented in table 4 and figure 6.

Table 3 Change of Urban Green Space in Thanlyin

Year	Vegetation		Grass		Total (UGS)	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
2003	517.06	36	314.42	22	831.48	58
2006	395.75	28	227.83	16	623.58	44
2009	480.43	33	313.99	22	794.42	55
2012	509.60	35	331.77	23	841.37	58
2015	397.67	28	218.12	15	615.79	43
2018	513.40	36	301.49	21	814.89	57
2021	552.32	38	109.77	8	662.09	46
2023	508.13	35	259.16	18	767.29	53

Source: Based on Table 5 and 6

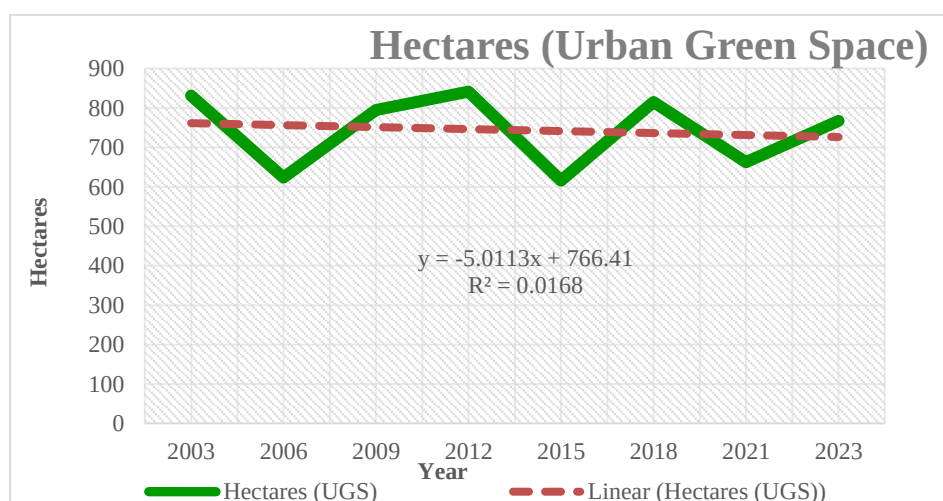


Figure 5 Change of Urban Green Space Between 2003 to 2023

Source: Based on Table 8

Due to google image results, in 2003, the leading type is vegetation with 517.06 hectares, but the smallest amount of type is building with 45.92 hectares in the study area. Likewise, in 2023, the leading type is vegetation with 508.13 hectares, but the smallest amount of type is building with 67.25 hectares

in the study area. And then, the largest covering change of types are road (+13.4%) and bare ground (-6.2%) between 2003 to 2023. In contrast, the lowest covering change of types are vegetation (-0.6%) and grass (-3.8%) between 2003 to 2023. Moreover, urban green space is covered by over half of area in Thanlyin shown in Plate 1 to 3. Thus, it is seen that urban green space in Thanlyin is the positive impacts of urban green space on health, local economy and wellbeing, are often reflected in higher land and housing prices, which can contribute to a gentrification process.

Table 4 Change of Land Cover in Thanlyin

LULC	Area (2003)	Area (2023)	Change Area	Change %
Water	174.43	113.46	-60.97	-4.2
Grass	314.42	259.16	-55.26	-3.8
Vegetation	517.06	508.13	-8.93	-0.6
Building	45.92	67.25	+21.33	+1.5
Road	227.57	420.5	+192.93	+13.4
Bare ground	158.91	69.82	-89.09	-6.2
Total (Hectares)	1438.31	1438.31	0.00	0.0

Source: Based on Table 5

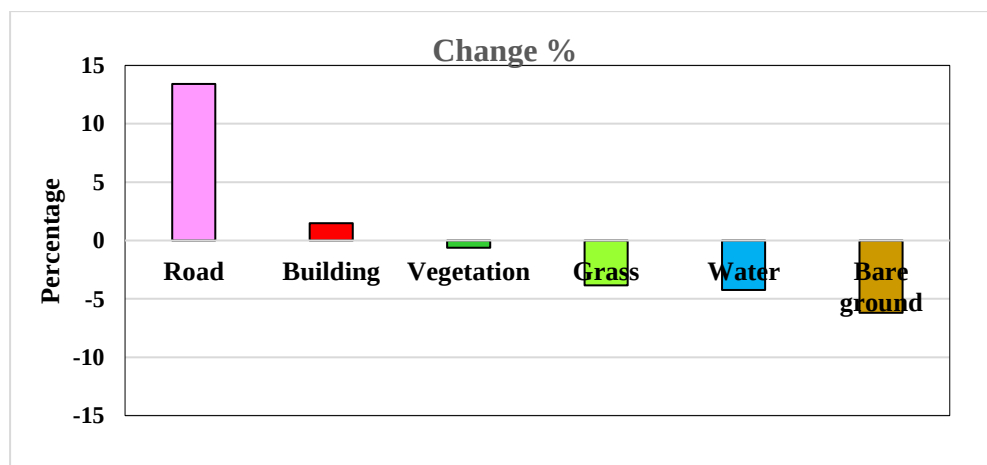


Figure 6 Change Percentage of Land Cover Between 2003 to 2023

Source: Based on Table 4



Plate 1 Thanlyin Town and Plate 2 Bo Gyoke Park in Ah Hmu Htan Ward, Thanlyin

Source: Field Survey

Findings and Suggestions

The main finding of this study is that the Land Use and Land Cover process is generally impacted by a variety of interconnected elements, ranging from transportation development to

legislation, as well as contextual demographic, socio-economic, and environmental aspects. According to Myanmar Information Management Unit and image analysis, the area of Thanlyin defined about 14.38 square kilometers (1438.4 hectares) digitally. Owing to DEM results, the highest elevation of the township locates about 37.05 meters above sea level.



Plate 3 Star City Urban Green Space near Bago River

Source: Field Survey

Google Earth Pro using Land Use and Land Cover classification legends, six major land use and land cover types. Land Use and Land Cover change analysis of Thanlyin for the last 20 years (2003–2023) shows a dynamic landscape change that elimination of bare ground, water body vegetation, and grass but road and building areas like settlement are expansion. Moreover, large area of bare ground is decreased in the study periods. The most dominant type of vegetation constituted the main land cover types in the study area. Of the total area of the study area, vegetation and grass as well as urban green space shared about 58 % in 2003 and 53 % in 2023. It indicates that the land conversion was caused by expansion of transport infrastructure like road area and building area as settlement infrastructures. Nevertheless, urban green space is covered by over 50 % of area in Thanlyin at present. The images detection analysis results, the township is extremely changing following to cover from vegetation to vegetation 15.45%, vegetation to road 9.49 %, grass to vegetation 6.83 %, grass to road 5.92 %, vegetation to grass 5.62 %, grass to grass 5.57 % in overall and so on.

Generally, the results imply that bare ground to road with 55.16 hectares or 3.84 % expansion increased access from place to other place within the study area by transportation network. And then, it is also changed bare ground to vegetation with 38.41 hectares or 2.67 %, and bare ground to grass with 24.70 hectares or 1.72% At present, Thanlyin has more than 50 % urban green space, so there may be urban green space than other urban downtown areas in Yangon. However, according to this research, it decreased slightly between 2003 and 2023 and should be maintained in the future. It is also one of the environmental issues.

Urban green space decreased slightly during 2003-2023, and it is necessary to maintain urban green space in the Thanlyin environment in the future. In maintaining of urban green space in the environment, especially in areas with bare ground should be grown to suitable trees and flowers. There should be also lawns and places to relax and practice sports and children's playgrounds. In addition, urban green space should be done with trees and flowers in residential houses with large yards in Thanlyin. Although the population is increasing in Thanlyin, the building housing is also increasing, but on the other hand, the environmental

conditions should not be neglected continuously. Having urban green space helps health, lowers health costs, and also contributes to socioeconomic development. Therefore, projects that do not reduce urban green space, the plan needs to be adapted to the circumstances faced.

Recently, there is more awareness of the importance of environmental issues in socioeconomic development in Thanlyin. Further, the growth of the economy and population could promote urban green space in recent years. However, the growth of urban land is contrary to the sustainable and compact development of the Thanlyin.

Finally, Thanlyin needs the potential of urban growth to improve urban environment and propose nature-based solution to mitigate the conflicts between urban compactness and urban green space conditions into sustainable urban environment. This study supplements the theory of urban growth and the environment with evidence from Myanmar town and other insights into sustainable urban environment in Myanmar. Moreover, there is a need for more research to assess the spatial and temporal variations of urban green space, driving forces, and their implications on climate, soils as physical, cultural, and socio-economic variabilities.

Conclusion

Thanlyin is located on the southern part of Yangon Region, Myanmar. Thanlyin is one of the town in Thanlyin District. Thanlyin is composed of 17 wards of urban settlement. It has an area of about 14.38 square kilometers (1438.4 hectares). The average elevation is about 14.03 meters (46.02 feet) above sea level. The study area has monthly average temperature of 28.69 °C and the total rainfall is 1415.74 mm during the period from 1981 to 2022. In 2021, the highest population distribution with over 12,000 in study area are Myo Haung (East) Ward and the highest population density with over 20,000 person per sq.-km in Thanlyin was Dahr Gar Ward with 30518 people.

According to Supervised Land Cover image the classification system classifies in (1) water, (2) Grass, (3) Vegetation, (4) Building, (5) Road and (4) Bare ground. urban green space defines Vegetation (dark green), and Grass (light green) in Thanlyin. Thus, urban green space showed a vital role in reconnecting human and urbanized landscape with its unique characteristics that had about 831.48 hectares or 58 % in 2003, and 767.29 hectares or 53 % in 2023 respectively.

Based on Google Earth Pro, the images change detection analysis between 2003 to 2023 indicated that the largest change of different land coverage ranks following from the Vegetation to Road with 136.40 hectares or 9.49%, Grass to Vegetation with 98.22 hectares or 6.83 %, Grass to Road with 85.16 hectares or 5.92% , Vegetation to Grass with 80.76 hectares or 5.62%, Road to Vegetation with 70.73 hectares or 4.92 %, Water to Vegetation with 62.01 hectare or 4.31% and Bare ground to Road with 55.16 hectares or 3.84 %. And then, the largest covering change of road is increased to 192.93 hectares or 13.4% and bare ground is decreased to 89.09 hectares or 6.2% between 2003 to 2023. In contrast, the lowest covering change of vegetation is decreased to 8.93 hectares or 0.6% and grass is also decreased to 55.26 hectares or 3.8% between 2003 to 2023. Moreover, urban green space is covered by over half of area in Thanlyin at present. However, the linear trend line indicates Thanlyin total urban green space coverage have been slightly decreasing between 2003 to 2023 and its trends may be to decrease in the future.

The present study focused on the spatio-temporal trends of urban green space, as well as creation of sustainable spaces and habitats by establishing a relationship between Thanlyin and landscape or land cover. To integrate urban and urban green space, the analysis of the advantages and disadvantages of urban features and the density of the built environment based on urban green space and the combination of the landscape and ecological processes need. Thus, urban green space in Thanlyin should be sustained the positive impacts of urban green space on health, local economy and wellbeing, are often reflected in higher land and housing prices, which can contribute to a redevelopment process and socio-economic development.

Today is information and technology age, due to the widespread use of computers and phones on a daily basis, people's eyesight problems and reduced activity have led to the need to maintain green views and places that can provide physical relaxation.

Acknowledgements

We would like to express my thanks Dr. Nay Win Oo (Rector), Pro-rectors and all departmental Professor (Head), East Yangon University for permission to do this project paper. We would like to Professor (Head) Dr. Aung Swe and professor Dr. Thida Win, Department of Geography, East Yangon University for their help and encouragement.

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ASSESSMENT OF GROUNDWATER QUALITY STANDARD BY USING WATER QUALITY INDEX (WQI) AND GEOGRAPHIC INFORMATION SYSTEM (GIS) APPROACHES: A CASE STUDY OF BOGYOKE VILLAGE TRACT, THANLYIN TOWNSHIP, YANGON REGION

Thein Zaw Win**

Abstract

Earth's water is vital for known forms of life, even though it provides neither food and energy nor organic micronutrients. Groundwater quality refers to the state of water that is located beneath earth surface. The main aim of this research is to investigate the distribution pattern of groundwater quality of the Bogyoke Village Tract in Thanlyin Township. The physiochemical test is mainly used to analyze some water quality parameters. Water samples are collected from randomly selected points of village tract divisions in field survey. The water temperatures are measured in the field using portable electronic instruments instruction manual waterproof. Latitude, Longitude and Elevation of sites have been measured by Global positioning system (GPS). Spatial Analysis Tools are used to describe the potable water areas with suitable water quality.

Key Words: Bogyoke Village Tract, ground water quality, pollution area, portable electronic instruments, spatial analysis tools.

Introduction

Nowadays, several people worldwide the groundwater are used as portable drinking water sources. During the last decades, groundwater levels in some regions are lower than other regions because of over extraction. The concentration of urban population will depend on the water sources, required to satisfy human needs for present and future generation.

Bogyoke Village Tract is located in Thanlyin Township in the Thanlyin District. There are fifteen divisions in Bogyoke Village Tract. Its area is 14.6 square kilometers (5699.41 acres) and has a fairly compact shape.

The physical, chemical and bacterial characteristics of groundwater determine its usefulness for various purposes. In this study, the physiochemical test is mainly used to analyze the contents of Temperature, pH (Hydrogen ions), Electric conductivity (EC), Total Dissolved Solids (T.D.S), Salinity, Iron (Fe), Calcium (Ca), Magnesium (Mg), Cadmium (Cd), Copper (Cu), and Lead (Pb). The groundwater quality values are compared with assessment of WHO standard.

Aim and Objectives

The main aim of this research is to study of the variability of groundwater quality in the Bogyoke village tract. Objectives are to identify the present groundwater quality system in Bogyoke village tract, to analyze the contamination of chemical concentration of groundwater in the study area, to define the occurrence of groundwater pollution area, to identify the important Parameters of groundwater quality in study area.

Sources of Data and Methodology

Primary data based on field observation is performed to identify variation of sources of water and quality for all residential areas. Analyses are carried out by statistical and inferential methods. The spatial analysis methods in GIS tool are used to define the spatial

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variation of groundwater quality. Some qualities of water are tested instantly in the field and some qualities of water are analyzed the data of groundwater quality by chemical analysis and laboratory test.

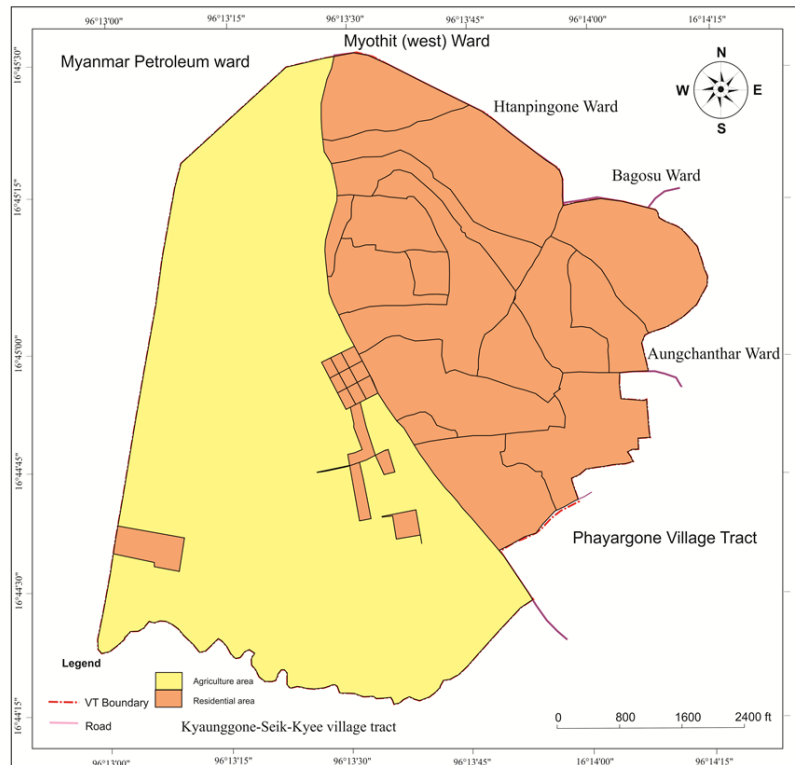


Figure.1.Location of Bogyoke Village Tract

Source: Administrative boundary and road data from UTM topographic map (Myanmar Survey Department, Yangon) and tube well data from field survey.

Table-1 Sample Points and their locations in the study area

No.	Well No.	Village Tract division number	Astronomical		Depth of water level (feet)
			Latitude	Longitude	
1	1	1	16°45'23.26"	96°14'30.63"	100
2	2	2	16°45'18.99"	96°14'30.93"	110
3	3	3	16°45'18.09"	96°14'26.04"	440
4	4	4	16°45'22.09"	96°14'17.87"	100
5	5	5	16°45'27.9"	96°14'16.23"	180
6	6	6	16°45'28.476"	96°14'11.58"	480
7	7	7	16°45'21.48"	96°14'10.51"	250
8	8	8	16°45'21.53"	96°14'12.77"	160
9	9	9	16°44'31.42"	96°13'46.77"	480
10	10	10	16°45'13.57"	96°14'13.81"	130
11	11	10	16°45'10.62"	96°14'16.85"	420
12	12	12	16°44'47.712"	96°14'30.00"	330
13	13	10	16°45'10.46"	96°14'22.24"	300
14	14	13	16°44'59.62"	96°14'36.89"	180
15	15	14	16°45'09.738"	96°14'39.894"	110
16	16	15	16°44'40.32"	96°14'19.94"	260
17	17	13	16°44'49.24"	96°14'51.32"	125
18	18	10	16°45'03.83"	96°14'13.01"	250
19	19	12	16°44'52.30"	96°14'16.26"	80
20	20	11	16°45'03.83"	96°14'48.36"	190

Source: Based on GPS points of Field Survey January, February 2024.

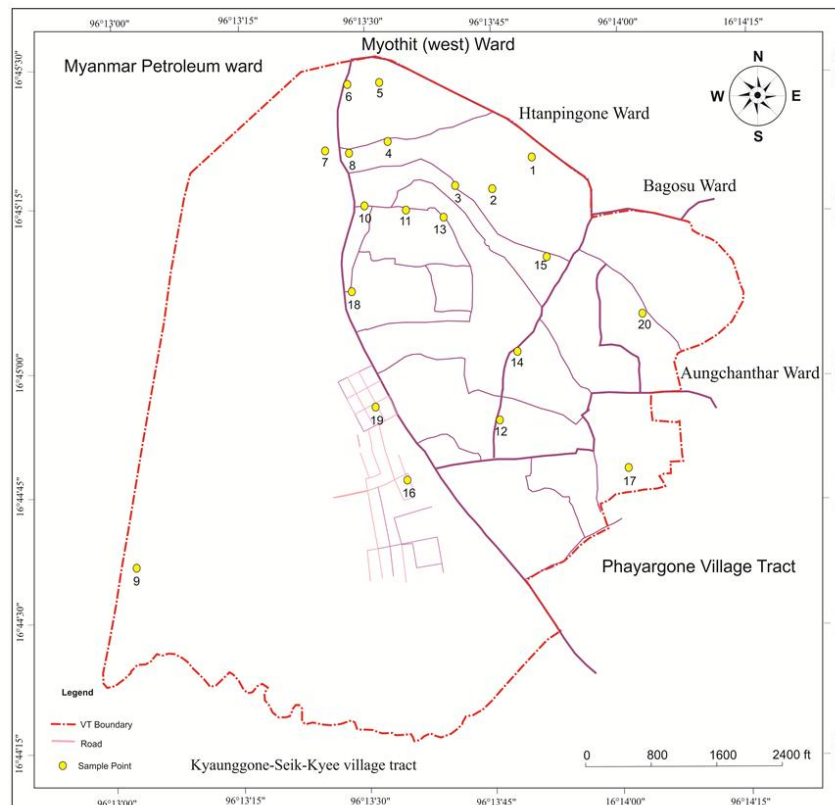


Figure 2 Sample points for groundwater in Bogyoke Village Tract.

Source: Administrative boundary and road data from UTM topographic map (Myanmar Survey Department, Yangon) and tube well data from field survey.

Result and Discussion

Physical Factors

The study area lies on the eastern bank of Yangon River and includes Thanlyin Township. It is located between North latitude $16^{\circ}44'11''$ and $16^{\circ}45'34''$ and East longitude $96^{\circ}13'42''$ and $96^{\circ}14'16''$. It is bounded on the east by Phayargone Village Tract, on the south by Kyaung-gone-seik-kyee Village Tract, on the west by Yangon River, on the north by Myanma Petroleum Ward, Myothit (West) Ward, Htanpingone Ward, Bogosu Ward, and Aungchanthar Ward of Urban Thanlyin.

The study area has two topographic features. Most of the parts are lower flat alluvial plain. Eastern part is higher lateritic ridge. The lateritic ridge is a segment of Thanlyin-Kyuaktan lateritic Ridge.

Within the area, the ridge covers about one-fifth of the village tract area running from northwest to southeast. On the foot of east facing slope, there is a flat low plain that cover about four-fifth of the village tract area. The plain is wider on the northern part than on the southern part of the village tract.

Most of the surface of the village tract is well-drained area Rain water flows along gullies west ward of the slope toward Yangon River. These gullies on the west slope merge together and flow either into Bogyoke Chaunge or Seik-kyi Chaunge and finally enter the Yangon River.

Climate

The study area is a part of lower Myanmar located close to the sea. Therefore, the village tract is under the influence of the Bay of Bengal. The climate of the study area is also largely controlled by the seasonal shifting of Monsoon winds, being a southwest Monsoon in summer months and northeast monsoon in winter months. Thus, the study area experiences the Tropical Monsoon “(Am)” type of climate.

According to temperature records (during 2018 and 2023) of the nearest metrological station of Kaba-aye, average monthly mean temperature is 29.21°C(84.58°F), with highest mean temperature of 30.52°C(86.94°F) in April and lowest mean temperature of 24.66°C (76.39°F) January. The total annual rainfall is 2887mm (113.66 inches).

Table.2. Mean Monthly Temperature and Rainfall of Thanlyin Town (2018 -2023)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total/ Avg
Max Temp(°C)	32.88	34.98	37.08	38.12	35.95	31.8	31.22	31.18	31.75	32.72	33.8	33.2	33.72
Mean Temp(°C)	25.28	26.48	29.25	30.88	30.39	27.68	27.25	27.3	27.58	27.92	27.97	26.22	27.85
Mini Temp(°C)	17.67	17.95	21.43	23.67	24.7	23.55	23.28	23.43	23.42	23.13	22.15	19.23	21.97
Rainfall (mm)	8.67	2.17	8.17	22.17	245.33	628.5	583	535.67	418.5	284.33	75.33	11.5	2823.34

Source: Based on Meteorologic and Hydrologic Department, Kaba-Aye Station, Yangon

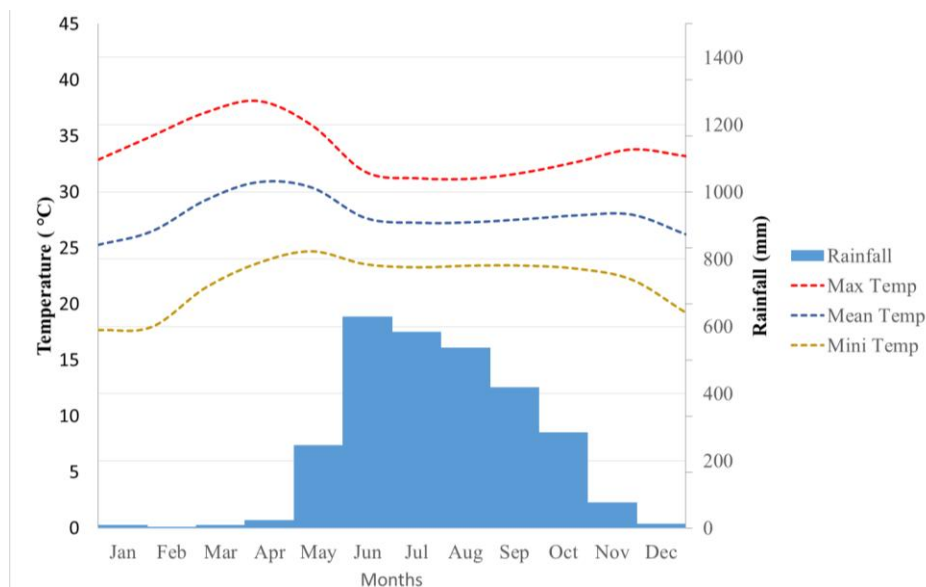


Figure.3. Climograph of Thanlyin Town (2018 – 2023)

Source: Based on table 2

Geology Characteristics

The geologic study is necessary for an evaluation of groundwater sources. The study area includes Thanlyin Township, lies within the Ayeyarwady Delta area and in the southern part of Yangon Region.

Thanlyin Township area is mainly composed of Miocene and Pliocene sedimentary deposits. Miocene deposits (Upper Pegu Group) are widely distributed at the southern portion of the ridge.

The study area is geologically divided into two units, lateritic ridge and western part plain area. The lateritic Thanlyin-Kyauktan Ridge is an anticlinal ridge that forms eastern parts geological unit of Bogyoke Village Tract. The second unit is the Irrawaddy Group formed in Pliocene Epoch. That unit underlines eastern plain of the study area and major rock strata are composed of shale, sand and salt. Underground water is present at the depth of 100 to 200 feet

and over 250 feet within the sandstone layers of the Irrawaddy Group. Groundwater in Irrawaddy formation is generally fresh.

Soil

Generally, two types are mainly found in study area. On the eastern portion of the study area, there are foot slopes of a ridge which trend from Northwest to Southeast. This ridge is covered mainly by lateritic soil. Second type, meadow alluvial soil is found on the plain. Lateritic soils are found near surface and at some depths. They can be occurred in vadose zone of groundwater. Lower layers of that soil are strongly acid with pH 5.06 to 4.96.

A soil that composed mainly of silt in its texture is called alluvial soil. Such meadow alluvial soils are neutral in their pH value, but some may be inclined to alkalinity. Those soils are clayed soil having high pH value and much iron (Fe) content. At lower layer, pH may range from 5.5 to 6.67 or moderately acid to slightly acid.

Spatial Variation of Groundwater Quality in Bogoyoke Village Tract

1. Temperature

In study area, the lowest value of water temperature is 27.3°C at sample point No. 4 and 13 tube-wells. The highest value of temperature is 30.5°C at sample point No. 6 and 9.

2. Potential of Hydrogen (pH)

For drinking water, WHO Guideline range for pH value is 7.0 to 8.5. According to pH value of groundwater quality in the study area, ranging from 4.93 to 7.43.

3. Electrical Conductivity (EC)

The maximum permissible limit of WHO Guideline value for EC is 750 $\mu\text{S}/\text{cm}$. The minimum value of EC in the tube well of study area is showing 2.09 $\mu\text{S}/\text{cm}$ and the maximum is about 1345 $\mu\text{S}/\text{cm}$.

4. Total Dissolved Solid (TDS)

The permissible limit for TDS in WHO Guideline is less than 500 mg/l. Total Dissolved Solid (TDS) in the study area between 1.48 to 950 mg/l.

5. Salinity

WHO maximum drinking water quality limits for salinity is 100 ppt. According to the results are tested instantly in the field, the value of salinity is ranging from 1.06 to 707 ppt.

6. Iron Content Distribution (Fe)

The maximum permissible limit of Fe in WHO Standard (0.3mg/l) and thus the water are unsuitable for drinking on the basic of iron content. Iron (Fe) of the study area varied between 0.093 to 9.513 mg/l

7. Calcium (Ca)

The permissible limit of Calcium in WHO Guideline is less than 250 mg/l. The concentration of calcium ions in study area is found in a range of 0.16 to 25.44 mg/l.

8. Magnesium (Mg)

WHO Standard level of magnesium is 50 mg/l. Most of the tube-well in the study area low in magnesium concentration.

9. Cadmium (Cd)

The permissible limit for Cadmium in WHO Guideline is less than 0.003 mg/l. The concentration of cadmium in study area is found in a range of 0.001 to 0.016 mg/l.

10. Copper (Cu)

WHO Standard level of copper is 1.0 mg/l. Most of the tube-well in the study area low in copper concentration

11. Lead (Pb)

The permissible limit for lead in WHO Guideline is less than 0.01 mg/l. All of the tube-well in the study area is high in lead concentration.

Table 13 Groundwater quality parameters of sample points in Bogyoke Village Tract

No	Well No.	Administrative (division number)	Temp (°C)	pH	EC (µs/cm)	TDS (mg/l)	Salinity (ppt)	Fe (mg/l)	Ca (mg/l)	Mg (mg/l)	Cd (mg/l)	Cu (mg/l)	Pb (mg/l)
1	1	1	27.8	6.38	354	251	171	2.614	2.672	0.579	0.001	0.039	0.203
2	2	2	27.9	5.8	289	205	140	0.503	2.108	0.618	0.001	0.052	0.188
3	3	3	28.9	6	259	185	127	1.537	2.996	0.597	0.003	0.052	0.215
4	4	4	27.3	6.38	354	251	171	0.405	12.35	0.614	0.002	0.052	0.167
5	5	5	28.8	6.2	238	168	115	2.097	1.117	0.593	0.001	0.054	0.161
6	6	6	30.5	5.48	2.09	1.48	1.06	0.213	25.44	0.622	0.002	0.021	0.228
7	7	7	28.8	5.51	107	76.1	55.6	0.093	0.546	0.534	0.008	0.032	0.19
8	8	8	28.3	5.52	97.5	69.4	51.3	0.306	1.723	0.528	0.016	0.028	0.2
9	9	9	30.5	5.63	101.9	72.9	53.7	1.264	0.303	0.469	0.005	0.033	0.183
10	10	10	28.4	4.93	321	228	155	0.117	3.899	0.625	0.001	0.029	0.198
11	11	10	28.4	5.69	282	200	137	0.465	6.338	0.62	0.002	0.042	0.215
12	12	12	28.7	7.43	447	319	218	0.167	18.3	0.603	0.002	0.058	0.188
13	13	10	27.3	6.25	130.9	92.8	66.1	0.358	2.414	0.486	0.001	0.062	0.189
14	14	13	28.9	6.47	336	283	162	0.434	8.944	0.594	0.001	0.061	0.177
15	15	14	29.3	5.45	188.6	134	92.7	0.719	2.006	0.565	0.002	0.065	0.185
16	16	15	29.1	5.81	56.7	40.3	33.7	0.179	0	0.083	0.007	0.021	0.223
17	17	13	28.3	5.42	1354	950	66.7	9.531	0.41	0.655	0.011	0.032	0.252
18	18	10	28.2	5.6	1416	100	707	0.13	8.981	0.644	0.001	0.032	0.206
19	19	12	28	5.49	151.3	107	75.6	0.24	1.379	0.538	0.002	0.025	0.173
20	20	11	28.1	5.87	171.6	122	84.6	1.439	1.234	0.591	0.002	0.038	0.182

Source: Based on Field Survey (January, February 2024)

Natural Occurrence of Groundwater Quality Area in Bogyoke Village Tract

For the groundwater quality in the study area, Inverse Distance Weighted Interpolation (IDW) method of spatial analyst and weighted overlay method were used. IDW and Reclassify Geospatial analysis results are calculated by using the Ranking and weighted percentages of respective water quality parameters that are show in Table 4.

Among the eleven parameters, following seven parameters are used as important parameters to analysis the levels of ground water suitable area.

pH - pH is an important variable in water quality assessment as it influence many biological and chemical processes within a water body therefore it has assigned as highest weight.

EC – The electrical conductivity is a measure to the capacity of water to conduct electrical current. It is directly related to the concentration of salts dissolved in water. Conductivity value somehow affects pH and dissolution of iron in water. As it is, assigned second highest weigh.

Salinity – Salinity is a measure of the content of salt in water. Groundwater contain naturally can be very high in salinity. It is also take in second highest in analysis.

Fe – The presence of iron in natural water can be attributed to the dissolution of rock and minerals. Water containing iron has an unpleasant flavor; a turbid aspect and reddish color which are repellent to the consumer. And also, high level of iron content is found in study area. Therefore, Fe is included in third highest level of weigh.

Pb – High in lead concentration are found in study area. Toxicity of lead, also called lead poisoning, can be either acute or chronic. Thus, Lead is assigned in third highest weigh.

Table 4 Ranking and Weighted Percentage of Water Quality Parameters

No.	Criteria	Parameter Range	Ranking	Class Name	WHO Guideline Range
1	Temperature	0 - 27	1	Poor	25 (°C)
2	pH	4.9 – 7	1	Poor	7 – 8.5
		7 – 7.42	2	Good	
3	EC	3.2 – 750	2	Good	750 (µs/cm)
		750 - 1403	1	Poor	
4	TDS	2.22 – 500	2	Good	< 500 (mg/l)
		500 - 928	1	Poor	
5	Salinity	1.6 – 100	2	Good	100 (ppt)
		100 - 700	1	Poor	
6	Fe	0.09 – 0.3	2	Good	0.3 (mg/l)
		0.3 – 9.2	1	Poor	
7	Ca	0 - 25	2	Good	250 (mg/l)
8	Mg	0 – 0.6	2	Good	50 (mg/l)
9	Cd	0.01 – 0.003	2	Good	0.003 (mg/l)
		0.003 – 0.015	1	Poor	
10	Cu	0.021 – 0.06	2	Good	1.0 (mg/l)
11	Pb	0.16 – 0.25	1	Poor	0.01(mg/l)

Ca, Mg – Calcium and Magnesium mostly cause the hardness of water. The total hardness is the sum of the temporary and permanent hardness. The total hardness of water affects the individual taste and portable use of consumers. So, Ca and Mg are including lowest weigh.

In this analysis out comes there are three levels of groundwater area for potable water use with the geological condition. These levels are:

(1) Suitable area, (2) Fairly suitable area, and (3) Unsuitable area

(1) Suitable Area - Suitable area for potable water use consists of division 6, 7, 8, 9, 12, 16, 19 and 20

(2) Fairly suitable area - Fairly suitable area for portable water use include in the division 10.

(3) Unsuitable area - Unsuitable area of groundwater for potable water use can be found in the divisions of village tract area 1, 2, 3, 4, 5, 11, 14, 17, and 18 as show in Figure 26.

Pollution of Groundwater in Study Area

Groundwater pollution may be defined as the artificially induced degradation of natural groundwater quality. Pollution can impair the use of water and create hazard to public health through toxicity or the spread of disease.

In Bogoyoke Village Tract, some of the physiochemical concentration of Electrical Conductivity (EC), Calcium (Ca), Magnesium (Mg), and Copper (Cu), are within acceptable level by WHO standard. In some tube-well, other physiochemical concentration such as Temperature, Iron (Fe), Salinity, and Potential of Hydrogen (pH) are within unacceptable level the WHO standard. The analysis indicates that the value of Cadmium (Cd) at tube-well No.007,008,009,016, and 017 are within unacceptable level by the WHO standard, but rest of other tube-well are within acceptable level by the WHO standard. Leads are not in the acceptable level. High concentration of Cadmium (Cd) and lead (Pb) implies that the

groundwater pollution really occur in the study area. According to the results from this analysis, the pollution area can be found in division 8, 9, and 13.

The unpolluting areas are division 1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, and 15.

Table 5 Ranking and Weighted Percentage of Groundwater Suitability Parameters

No	Criteria	Parameter Range	Ranging	Class Name	Weighted %	WHO Guideline Range
1	pH	4.93 – 7.00	1	Poor	30%	7 – 8.5
		7.00 – 7.22	2	Moderate		
		7.22 – 7.42	3	Good		
2	EC	2.22 – 200.2	3	Good	20%	400(μs/cm)
		200.2 – 400.75	2	Moderate		
		400.75 – 1415.23	1	Poor		
3	Salinity	1.12 – 50.32	3	Good	20%	100(ppt
		50.32 – 100.23	2	Moderate		
		100.23 – 706.61	1	Poor		
4	Pb	0.16 – 0.25	1	Poor	10%	0.01(mg/l)
5	Fe	0.09 – 0.15	3	Good	10%	0.3(mg/l)
		0.15 – 0.3	2	Moderate		
		0.3 – 9.52	1	Poor		
6	Ca	0.00 – 7.24	3	Good	5%	250(mg/l)
		7.24 – 25.42	2	Moderate		
7	Mg	0.08 – 0.50	3	Good	5%	50(mg/l)
		0.50 – 0.65	2	Moderate		

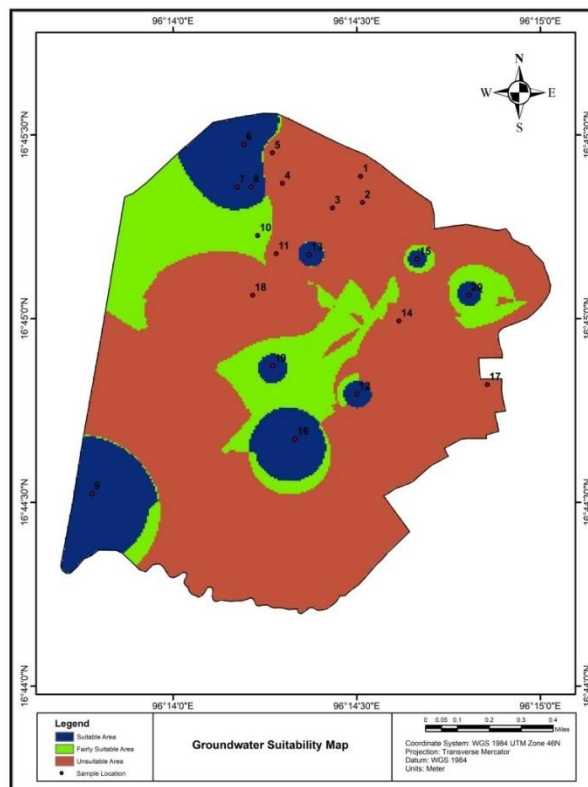


Figure 4 Level of groundwater suitable area

Source: Administrative boundary and road data from UTM topographic map (Myanmar Survey Department, Yangon) and tube well data from field survey.

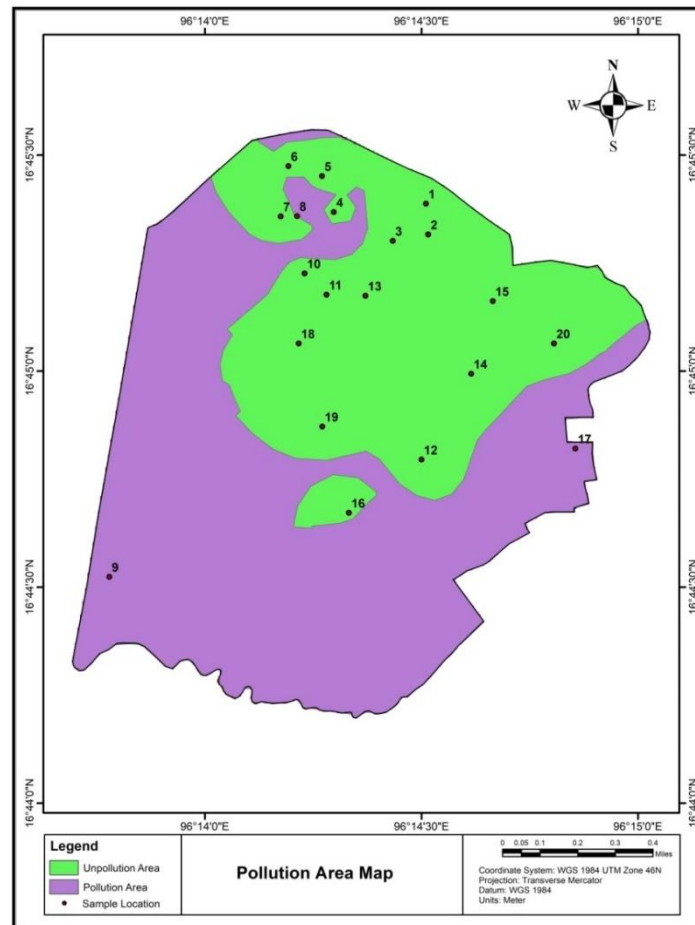


Figure 5 Pollution Areas in Study Area

Source: Administrative boundary and road data from UTM topographic map (Myanmar Survey Department, Yangon) and tube well data from field survey.

Finding and Suggestions

Except the Electrical Conductivity (EC), Calcium (Ca), Magnesium (Mg), and Copper (Cu), other contamination of water quality in the study area are within the unacceptable level by WHO standard. The highest concentration of Cadmium value is 0.016 mg/l at tube-well No.008 in No.8 division village area of Bogyoke Village Tract. The second highest Cadmium value is 0.008 mg/l at No. 007 tube-well in No.7 division village. High contamination can be caused by natural sources such as minerals and rocks or anthropogenic sources including and runoff from roads.

The reason for high concentration of iron (Fe) in most tube-well of Bogyoke Village Tract is related to soil and geology. Therefore, the present study illustrates that Iron (Fe), Cadmium (Ca), and Lead (Pb) contents in groundwater of study area are the main indicator of pollution in groundwater quality.

This situation creates groundwater pollution, it is essential for the above reasons water purification is necessary and there are demand for purified drinking water. Groundwater consumption will be increased; people will be understood for high living standard and hygiene. Most of the people want to use clean, fresh or safe and bacteria free water in order to keep good health. The distance between a tube-well and a polluting source should be less than 25 m (50 feet). Some toilets have been discharging the waste water into the rivers. Government should present these processes, for the safety of the public. Polluted water is biggest threat to public health and environmental degradation. The capacity building for the people should be carried

out village tracts wide through media, likes radio, television to keep public awareness of water quality and sustainable development of our environment.

Conclusion

The study area is situated in Thanlyin Township, Yangon Region. The structure of geologic setting influence on groundwater for extraction especially that composed of shale and sand stone with mixed recent alluvium. Therefore, it provided for the water demand in daily life. The annual total rainfall is about 113.66 inches, is necessary for water consumption. The source of water used in the study area is mainly on tube-walls

The Physiochemical elements of the ground water in the area within desire level of WHO standard level are analyzed and classify the spatial variation of ground water quality condition. The ground water quality values are compared with WHO standard. According to the analysis, there are two levels of groundwater area for domestic use. Deterioration of water is perennial problem at the present time. The high concentration leads (Pb) shows the ground water pollution really occurs in the study area. So, it's important for chemical fertilizer and pesticides so as to reduce further groundwater pollution.

In the study area, buy water from the other area are mainly by the purpose of drinking water. There is no public awareness and environmental water management especially municipal water supply regulation. Water supply works have not yet found in the study area. So, sustainable water management and governmental policy on water that should be implemented by rule and regulations to be better understanding of water resources.

Acknowledgements

First and foremost, we wish to express our sincere words of thanks to Dr. Nay Win Oo, the Head of East Yangon University, ERC of East Yangon University and authority of Research project for their permission to do this research work. I would like to thank Dr. Aung Swe, Professor and Head of Department, Department of Geography for his guidance and valuable suggestions. Our indebtedness must also be shown due to our field for their efforts in making careful measurements. In addition, we express our laborers thanks to local authorities of Bogyoke Village Tract Thanlyin Township

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THE IMPACT ON TRANSPORT INFRASTRUCTURE OF THE LAND VALUE ALONG THE PYAY ROAD AND KABARAYE PAGODA ROAD IN YANGON CITY

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Abstract

Yangon City is the commercial hub of Myanmar and it is located between north latitudes 16° 44" and 17° 5" and between east longitudes 96° 00" and 96° 44", occupying an area of 896 square kilometres. The population of the city has been increasing as well as its areal extent. The expansion of the city has oriented towards the north as it is separated by the river in the south of the extension of Yangon City. This research will focus on the value of land along Pyay and Kabaraye Pagoda Roads and the increasing importance of road transportation due to the residential expansion of Yangon City. There are roads that connect from south to north and from used to east in Yangon City. The study two main roads that connect downtown area with the sub urban to north. So, the main roads like the satellite towns and the downtown areas have become more important. The Pyay and the Kabaraye Pagoda roads are connected to the downtown area and the satellite towns. The problem of traffic congested and traffic jam occurs every day along these main roads, especially at the traffic light posts. Under the supervision of YCDC, overpasses and traffic light have been constructed at the suitable places to reduce traffic jam and accidents. This research paper studies the positive and negative impacts of overpass and traffic lights for the local people. To examine the impact of transport infrastructure on land value along Pyay and Kabaraye Pagoda Road in Yangon City area. The change before and after the construction of the overpass will be studied with GIS and satellite images along the areas concerned.

Keywords: overpass, traffic congested, traffic light, land value

Introduction

Yangon, the former capital city of Myanmar and its main gate-way to the world, has been considered as the most suitable location for the majority of non-agricultural activities in Myanmar in the last decade. This research work will study the impact of transport infrastructure on the land value of the adjacent areas along the Pyay Road and the Kabaraye Pagoda Road. Transport infrastructure includes road, railway, water way, airport, port, overpass, traffic light etc. In this paper, we will study how the installation of Overpass and traffic light affects the economic and social lives of the local people. Among the 8 overpasses in Yangon, a total of 5 overpasses are located in the two main roads under the study. The upgrading of transport infrastructure is necessary with the expansion of new settlements. Investment on the transport infrastructure supports the economic development of Yangon city. In order to solve the problem, YCDC has upgraded the transport infrastructures with Intelligent Traffic System (ITS) and Traffic Impact Assessment (TIA) methods, by installing more traffic light posts and the construction of overpass. Overpasses were constructed at the junction of Hleden road and Insein road in 2014, at the junction of Myenigone in 2014 and at the junction of Kokkine and at the junction of 8 mile in 2015. Road infrastructure public service facilities, industrial structure and transportation affect the value of land (Lastina Fojor Prastion, 2022). This research will study the change of land value and economic activities the transport infrastructure.

The construction of Overpass causes noise pollution around the area. Nowadays, noise pollution is a major health problem around the world. Noise pollution causes slap disorder, learning impairment, hypertension, ischemic heart disease and annoyance. Therefore, it needs noise measurement plan when constructing overpass. Noise occurs from car tyres and vehicle

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speed. Level of noise decreases with the increasing height of the bridge. According to the bottom material, it depends on different overpass heights and different road structures. Infrastructure is one of the important aspects in national growth. If more capital is invested on road transport action, economic sector will improve. Leading to regional economic growth the land value will rise and the transportation is good. Transport infrastructures affect land value (Nicolous Tideman 2017). However, after the construction overpass, one of the transport infrastructures, the land values around the bridges decreased markedly and the economic activities retarded. The land values around the traffic light increased markedly and the economic activities retarded. This paper will study to find relevant means which can reduce the fall of land value and negative impact of the overpass and positive impact of the traffic light.

Research Background

This study essentially focuses on annual change of land value and the causes of spatial variation of land use change along the Pyay Road and the Kabaraye Pagoda Road. Although new towns were established within Yangon City, most townships did not have full urban infrastructural facilities. Most townships have to depend on the commercial hub of the city, located in the southern extreme. Under such situation, the main connection lines between the northern townships and the business centre of the south have become more important and the land values of the wards adjacent to the main roads have risen sharply and drastically changed. The extension of Yangon City has enhanced the importance of the Pyay Road and the Kabaraye Pagoda Road as the main transportation routes. Although new towns were established within Yangon City, most townships did not have full urban infrastructure facilities. Most townships have to depend on the commercial hub of the city, located in areas of the southern extreme. Under such situation, the main connection lines between the northern townships and the business centre of the south have become more important and the land value of the wards adjacent to the main roads have risen sharply and drastically changed. The changes in the land value also change the socio-economic and land use pattern along these roads. Among the north-south trending roads, this study focuses only on the change and development of the Pyay Road and the Kabaraye Pagoda Road with emphasis on the effects of changes in land values. The Pyay Road and the Kabaraye Pagoda Road are also important as they connect downtown with the newly expanded townships. The economic activities and foreign investment projects have also increased in the study along the Kabaraye Pagoda Road and the Pyay Road. Downtown area does not have international standard office space, so it is investing in land along the Pyay Road and the Kabaraye Pagoda Road, which has good infrastructure and accessibility. The economic activities of the study along the Pyay Road and the Kabaraye Pagoda Road have changed and the lifestyle of the residents has improved a lot.

Land value are considered as the key driving force behind regional development. The change in land-use type also changes the value of land. With high population density and job opportunity, traffic jam problem occurs along the main roads of Yangon City everyday.

Objective

To examine the impact of transport infrastructure on land value along the Pyay Road and Kabaraye Pagoda Road in Yangon City area.

Research Question

What is the impact of transport infrastructure on land value and economic activities along the Pyay Road and the Kabaraye Pagoda Road.

Study Area

Yangon City is located between north latitude 16° 44" and 17° 5" and between east longitude 96° 00" and 96° 44". The areal extent of Yangon City in 2023 is 896 square miles

(2320.6 square kilometre) and the population is over 6 million. It is bordered with Hmawbi Township on the north, Hlegu Township on the northeast, Thanlyin Township on the south of Yangon City, Twantay Township is situated in the southeast and Htantapin Township in the west. The Yangon river and the Bago river flow in the southwest and Hlaing River, Yangon River, Bago River and Ngumoeyeik creek flow through the city. Yangon City constitutes 33 townships. The Overpass along the Pyay road and the Kabaraye Pagoda road in Yangon City will be studied in details. The Pyay road starts from the Thayettaw traffic light post and ends at Khayepin branch road. The Kabaraye Pagoda road starts from the U Htaung Bo round and ends at 8 mile junction of Mayangone Township. There are 8 townships that adjacent to the Pyay road and 3 overpass Mayangone Overpass in Sanchaung Township, the Hledan Overpass in Kamaryut Township and 8 mile Overpass in Mayangone Township. Four townships are adjected to the Kabaraye Pagoda road. The road has two Overpasses and these are the Shwegondaing Overpass and the Kokkine Overpass located in Bahan Township. This esearch focuses on the causes fall of land value after the construction of the Overpasses.



Fig 1 Location of Yangon Region in Myanmar
Source: Myanmar Survey Department



Fig 2 Location of Study area in Yangon City
Source: Yangon City Development Committee

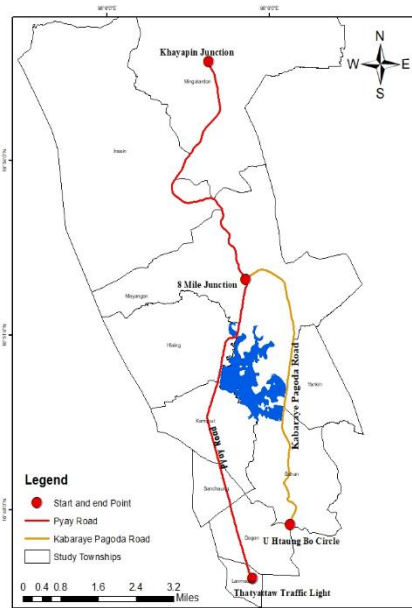


Fig.3 Location of Study Area
Source: Yangon City Development Committee

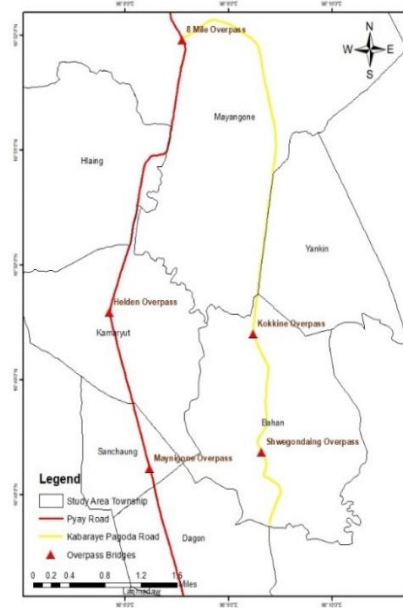


Fig.4 Location of Overpass in Study Area
Source: Yangon City Development Committee

Methodology

This research focuses on the fall of land and the changes of economic activities along the Pyay road and the Kabaraye Pagoda road due to the construction of overpass. It will use both the primary data and the secondary data. The primary data include the responses of the real estate dealer and land owners, the local residents to know the price of land value change, the construction of Overpass and the entrepreneur to know the economic conditions before and after the construction of Overpass. The secondary data include the recognition of the Pyay road and Kabaraye Pagoda road the years, the objectives and the method used in the construction of the bridges, and the government fixed prices of the areas concerned with the Department of Human Settlement and Housing Development. When comparing the land value of the intersection where the overpass is located and the land value of the intersection without the overpass, in this research studied using Euclidean distance analysis. The changes of land use before and after the construction of the Overpass will be identified by field observations and satellite images. The land use changes the approach road sections of the overpass and the road junctions that have no Overpass will be studied in overpassing before and after the construction of the bridges. It will also study how the changes of land use affect the value of land.

Findings and Discussion

The values of land were highest along the two main roads. The prices of land value around the Maynigone junction, the Hledan junction and the 8 mile junction were higher from 50000 kyats to 80000 kyats per square feet than other sections of these roads. However, after the construction of Overpass the land prices of these areas have fallen from 50000 kyats to 100000 kyats per square feet. At the junction point between the Pyay road and the Barkayar road, there were City Mart and Dagon Centre 1 and it was crowded with buyers and other economic activities before the construction of Overpass and the price of land value around the junction point was much higher than other places. The construction of the bridges was completed in 2014. By that time there was no change in the land use pattern around the bridge. However, the land use of the area between the Pyay road and the Manawhari road has changed

After the construction of the bridge, the Pyay Garden and the Jasmin Palace emerged between the Barkayar road and the Hantharwady Round. The area around the Hledan Overpass was a festive place. After the construction of the bridge, several international universities were opened around the area. However, the learning centres had to close due to difficulty in parking car and being distant from the bus-stop. After the construction of Hledan and 8 mile Overpass, the area between the two Overpasses have developed rapidly with the emerging of Market place, Lotteia Hotel, Kantharyar Hospital and Shwehinthar condominium because of smooth transportation to Yangon International Airport. To improve the transportation service, the government installed more traffic light posts by using Traffic Impact Assessment method. Before the construction of the Kokkine Overpass, traffic jam usually occurred around the junction of the Kabaraye Pagoda road, the Saya San road and the Kokkine Overpass, the Myanmar Plaza and the Mellia Hotel emerged beside the approach road of the bridge due to smooth flow of transport vehicles. The staff of the Plaza and the Hotel relocated in area near their worksites, increasing the land price of the nearby wards. The objective of the construction of shwegondaing Overpass was to reduce the problem of traffic jam. After the construction of the bridge, the transportation is smooth along the road, but the price of land decreases around the area and it also affected the economic activities, due to having no space for car parking and other essential purposes and high level of noise pollution, causing negative impact to the local residents around the bridge. Future construction of Overpass should be considered meticulously not to affect negative impact over the residents of the nearby area. When comparing the land price where the overpass is built before and after the overpass, the land

price located in the area where the flyover is not built is found to be around 50,000 kyats to 100,000 kyats more than per sq ft compared to other intersections along the road before the construction of the overpass. When the overpass was built, the land price of those areas decreased significantly by 50,000 kyats to 100,000 kyats per 1 sq ft compared to the land price at the intersection before overpass.

The area to be studied, the Pyay Road and the Kabaraye Pagoda Road, are the main roads in Yangon City which connect the satellite town and the downtown area. Overpasses were built to solve the problem of daily traffic congestion on those highways. Then, development stopped at the intersections where the overpass was located, and business growth developed more because overpasses were built in areas where there were no overpasses. Along the Pyay Road, the section of the road between the Maynigone Overpass and the Hledan Overpass are become more convenient due to the construction of the overpass, and the land use has also changed a lot. In that part of the road, the Junction Square, the Novotel Hotel, and other mixed-use buildings, such as car showrooms, banks, insurance companies, and other local and foreign investment projects, have emerged. In addition, the Lottie Hotel and the Kanthayar Hospital are situated in the area between the 8-mile overpass and the Helden Overpass. Domestic and foreign investments like the Shwehinhthar Condo and the Market Palace have emerged. In order to facilitate the communication between international-level buildings and businesses, Yangon City Development Commette, replaced traffic light in the congested junction and installed traffic light systems with ITS and TIA technology.

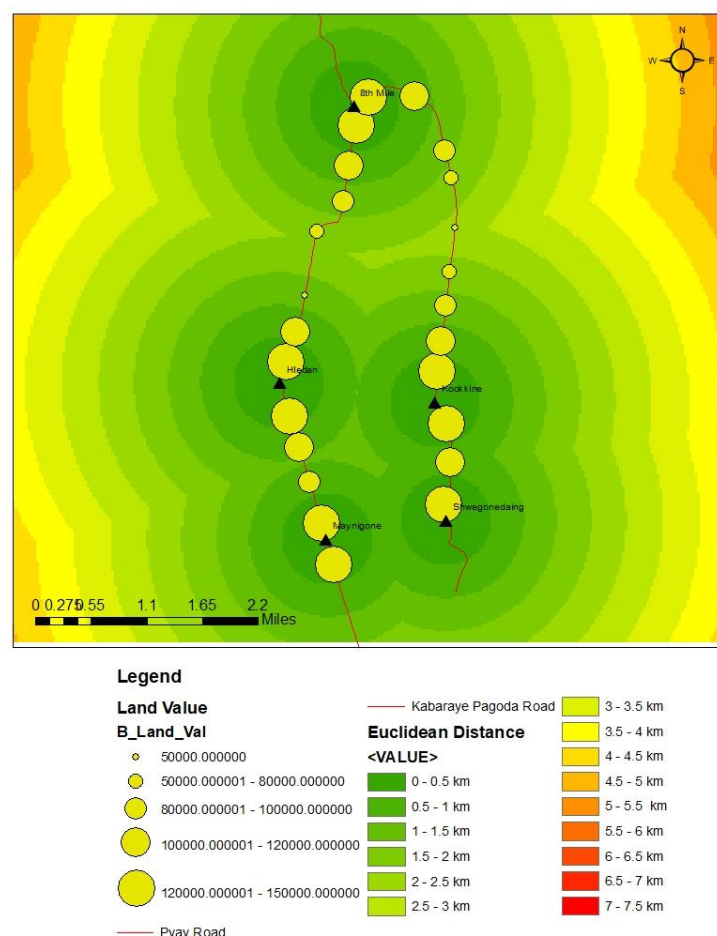


Fig (5) Before the construction of Overpass and the condition of Land Value

Source: Field Observation

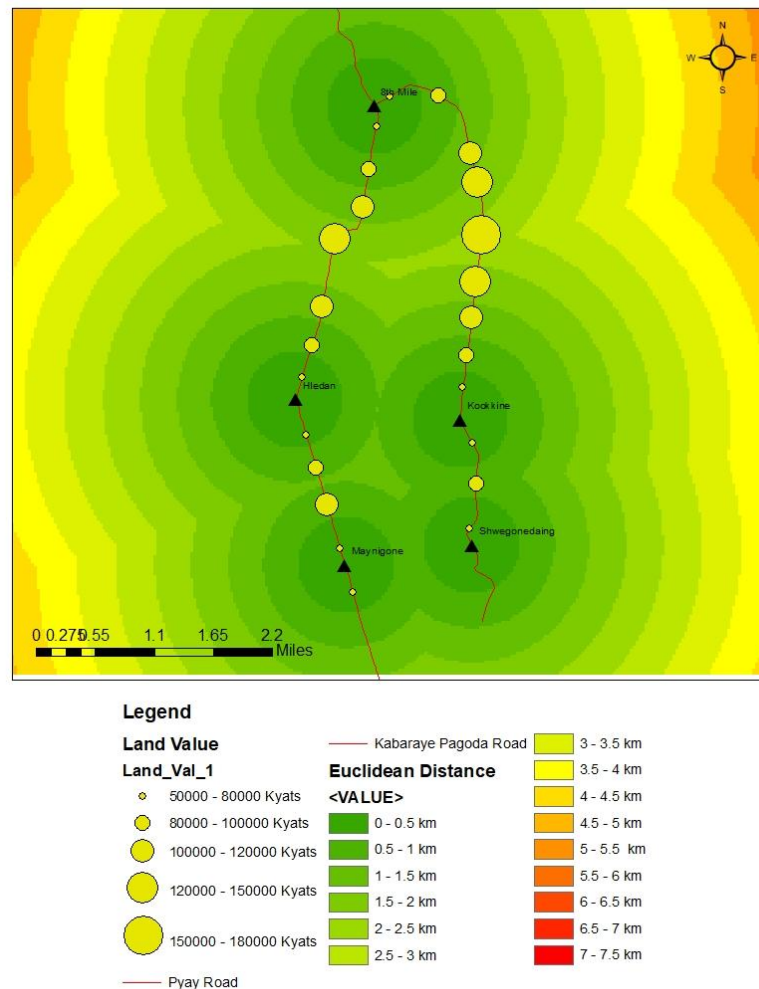


Fig (6) After the construction of Overpass and the condition of Land Value
Source: Field Observation

Therefore, the transportation of that road area is easy and convenient, and business development can be seen due to the transportation infrastructure. In the area between the Shwegondaing Overpass and the Kokkine Overpass, more mixed-use buildings and businesses have been developed along the Kabaray Pagoda Road. In the area between the Kokkai overpass and the 8-mile overpass, the Myanmar Plaza, the Central, Mellia Hotel, the Gamonpwint Shopping Center, and the mixed-use buildings such as local and foreign investment businesses have emerged, so it has been observed that traffic lights have not been installed like the Pyay Road, although blocks have been placed to slide the traffic to facilitate transportation. However, that section of the road has been seen more business developments than the section of road where the overpass was built. Therefore, if traffic lights like Pyay Road are installed in a systematic manner, it will make traffic easier and more convenient in that section of the road and business activities will also improve. Due to the construction of the overpasses, traffic has improved and land use patterns have changed, and compared to the land price in the area where the overpass has been built, it has been observed that there is a difference of 50,000 kyats to 100,000 kyats per sq ft. According to the interview, before and after the construction of the overpass, the difference in land prices between the area where the overpass is located and the area near the overpass is shown in Figures 5 and 6 by using Euclidean analysis.

Conclusion

The road junctions along the Pyay road and the Kabaraye Pagoda road were festive and the land value was much higher before the construction of Overpass. After the construction of the bridge, the road infrastructures have improved and cars can move smoothly and it supports the development of economic activities. However, it causes negative impact on the land price and economic activities in the areas close to pollution havening no space for car parking, obstruction of visibility and being distant from the bus-stops. The land-use pattern of the area close to the bridges has not changed. According to field observation, when the overpass was built, the development stopped at those intersections, and due to the construction of the overpass, the land use pattern changed in the road areas that made transportation more convenient. Then, the land value at the crossroads also increased and it has been described by using Euclidean distance analysis. Noise pollution is caused by different building materials and different height of the overpass. It is learnt that if the height of the overpass increase, the level of noise decreases. Therefore, overpass should be constructed in accord with the noise measurement plan. Then only will there be no negative impact of noise on the residents living close to the bridge and on the social and economic activities and on the value of the land.

The installation of traffic lights has made the traffic more convenient, and businesses have increased on that stretch of the road. As the population of Yangon has increased day by day, the city area has also expanded to provide housing, which is what people want to live in. Therefore, the highways that connect the satellite town and the downtown area have also become important. Overpasses have been built to facilitate traffic on those highways and to solve traffic problems. However, air pollution and noise pollution measurement plans should be systematically measured. However, due to the fact that there is no systematic consideration of the positive and negative impacts that will be caused by the overpasses, it has been observed that there are negative effects on business activities and land prices under the overpasses. However, due to the systematic use of ITS and TIA technology in the installation of traffic lights as transport infrastructure, transportation will become easy and convenient, and the commercial activities of the plots of land in that section will change, and the land use pattern will change, and the land price of those plots will increase from 30,000 kyats to 50,000 kyats per 1 sq ft. Therefore, in supporting transport infrastructure, which is essential for urban development, the positive and negative impacts that may affect on the interests of the local people should be carefully considered.

Acknowledgements

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YCDC ၂၀၁၃။ မဟာရန်ကုန်မြို့ပြဖွံ့ဖြိုးမှု မဟာဗျူဟာစီမံကိန်း၊

ရန်ကုန်တိုင်းဒေသကြီးအစိုးရအဖွဲ့၊ ၂၀၁၉။ရန်ကုန်တိုင်းဒေသကြီးဖွံ့ဖြိုးတိုးတက်မှုမဟာဗျူဟာစီမံကိန်း

GEOGRAPHICAL STUDY ON ROADSIDE COMMERCIAL ACTIVITIES ALONG THE KYAIK KHAUK PAGODA ROAD IN THANLYIN

Kyi Kyi Phyto Wai*

Abstract

Thanlyin Kyaik Khauk Pagoda Road is one of the two main roads. Commercial activities along that road have been developing. Commercial activities are activities intended for exchange in the market with the goal of earning an economic profit. This research aims to analyze the temporal changes of commercial activities along Kyaik Khauk Pagoda Road from Aung Thukha Station to Phayar Gyi Market. Along the Kyaik Khauk Pagoda Roadside, commercial activities were being changed according to socio-economic condition and township improvement plan of the Thanlyin Township. The commercial activities of Thanlyin Kyaik Khauk Pagoda Road were classified into three types of commercial activities. In a relationship between good or bad network accessibility were computed. According to the population growth, good network accessibility, and landmarks have been developed in the study area. After the development of commercial activities along the Kyaik Khauk Pagoda Road, land value is risen. According to this study, the factors of changes in the Thanlyin Town commercial activities will be helpful for the township's development activities.

Keywords: commercial activities, population, network accessibility, landmarks, land value

Introduction

Thanlyin is situated in the southern part of Yangon Region, is relatively developed in commercial activities. The commercial activities of Thanlyin are grouped into three main types. Although agriculture is still the most dominant commercial activities in the rural area, secondary and tertiary commercial activities have been expanding in urban area of Thanlyin. Most of commercial activities in the study area have been depended on the landmarks. Moreover, Thanlyin have been established as Thilawa Special Economic Zone after 1993 Yangon-Thanlyin Bridge was opened. This paper is about the temporal changed of the roadside commercial activities along the Kyaik Khauk pagoda Road in Thanlyin. Urban population has increased year by year. Therefore, commercial activities of study area have been changed gradually. Especially, Roadside commercial activities along the Kyaik Khauk Pagoda Road developed because of the good network accessibility and landmarks. Commercial activities might provide some insights on the understanding of distribution for many dwellers of the study area. After the State Government has practised open market economy, rapid changes occurred in various commercial activities. As the regional development plans were implemented as a state policy, infrastructure development was effectively carried out in Thanlyin. The local population has increased job opportunities and incomes.

Aim and Objectives

The aim of this paper is to study the types of commercial activities along the Kyaik Khauk Pagoda Road in Thanlyin. The objectives of this paper are to study whether the commercial activities are related to the population, to study whether commercial activities are related to the network accessibility is good or bad, and to study whether the existence of commercial activities is related to the landmarks and the price of the land value.

Materials and Methods

Primary data is based on commercial, tertiary activities and governmental offices, and those are derived from the field observation between the year 2014 and 2023. Based on these statistics (the location of the shops/ the government department and the offices) are conducted to get the information and the analysis for those activities and the arrangement of public

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buildings (public and institutions). It is concerned with the degree of the spatial concentration of economic activities how they are concentrated near a local business area of the township or on the main road.

Secondary data is obtained from the Township Administrative Office, Thanlyin Township and it consists of the ward areas, the population data, the town characteristics as well as the concerned department and the libraries. Available data and facts are calculated, tabulated and employed for the application of GIS. To show spatial the distribution and the concentration of particular economic activities, the Network Accessibility, the Landmarks and the Land value are calculated by Arc GIS 10.8. Finally, mapping and analytical study are illustrated for this study.

Result and Discussion

Location, Size, Shape and Boundary

Thanlyin is the biggest town of Thanlyin Township and Thanlyin District in Yangon Region. It is located at the corner where the Bago River and the Yangon River meet. It lies between the north latitudes 16° 40' and 16° 59' and the east longitudes 96° 13' and 96° 25'.

The town has an area of 15.33 square kilometers (5.92 square miles). The town is bounded by Thonegwa Township and Khayan Township in the east, the Yangon River in the west, Kyauk Tan Township in the south and the Bago River in the north. Thanlyin Town is formed of (17) wards, and there are two main roads, they are the Kyaik Khauk Pagoda Road and the Bogyoke Nay Win Road. See Figure (1). Kyaik Khauk Pagoda Road is 4.2 miles long from the Aung Thukha Station to the Phayar Gyi Market. Thanlyin is only 6 miles away from Yangon. It is 12 miles far from Thanlyin to Kyauk Tan Township. It is 22 miles from Thanlyin to Thonegwa Township and 34 miles to Khayan Township. Thanlyin Kyaik Khauk Pagoda Road connects the Bogyoke Road, the Thauk Taw Kwin Road, the Thane Kyaung Road, the Thaik Pan Road, the Hospital Road, the Myo Pat Road, the Thama Kyaung Road, the No-6 Road and the Thanlyin Kyauk Tan Road.

Total Population and Growth Rate of Thanlyin (2014-2023)

The population is one of the important factors for the study. In this study area, the population data are based on two years period in Thanlyin. The first year started on 2014 census population data. According to 2014 census data, the total and the growth of the population during 2014, was 68,063 persons, with 30,537 males and 37,526 females. According to 2023 population record, there were 78,805 persons in the study area. The male and the female population were 37373 and 41432 in 2023. The population increased 10742 persons during the period between 2014 and 2023. Therefore, the growth rate is 15.78 percent, as shown in Table 1. The population was an increase partly due to natural increase and the small immigration. The higher population growth rate was due to the rapid development commercial activities Thanlyin.

Table 1 Total population and Growth Rate of Thanlyin (2014-2023)

Sr. No.	Year	Population (person)			Increase of Population	Growth Rate (%)
		Male	Female	Total		
1	2014	30,537	37,526	68,063	-	-
2	2023	37373	41432	78805	+10742	15.78

Source: General Administration Department, Thanlyin

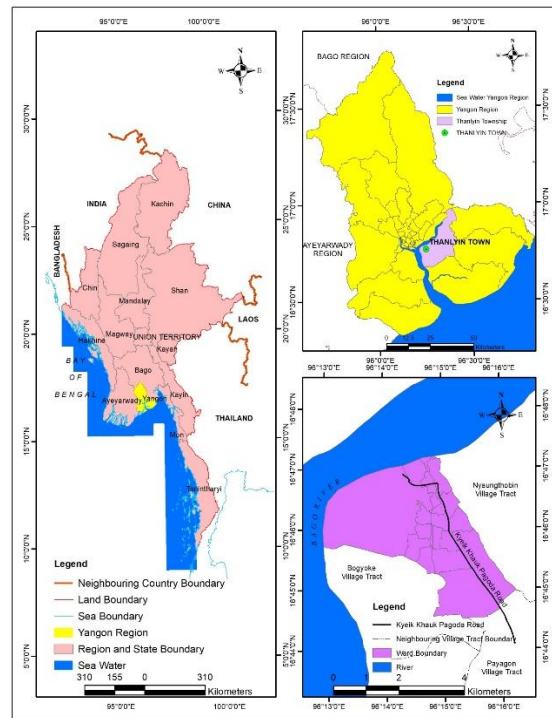


Figure 1 Location of the Study Area
Source: Myanmar Survey Department, Yangon

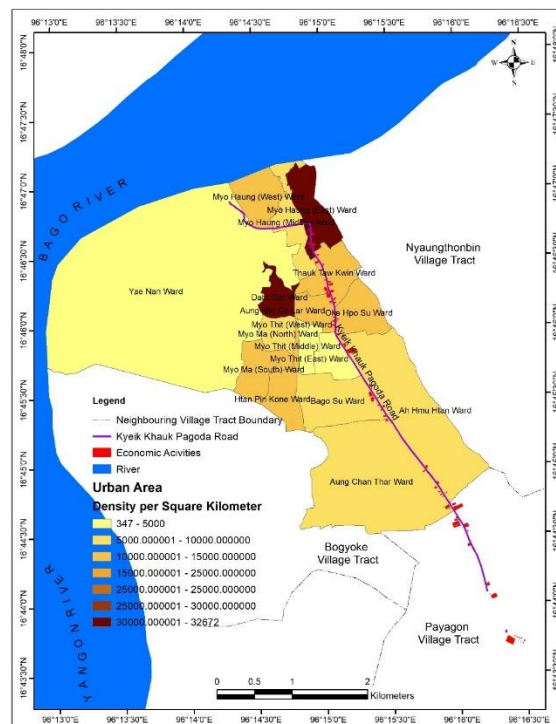


Figure 2 Population Density in Thanlyin (2022)
Source: General Administration Department, Thanlyin

Classification of the Economic Activities in Thanlyin Town

Primary Economic Activities

The Primary economic activities are concerned with the extraction of raw material from nature. These activities are the beginnings in further development of other economic activities.

(R. Boice, 1978). The primary economic activities include agriculture, livestock, fishery, forestry and mineral resources.

Secondary Economic Activities

The Secondary Economic activities involves the transformation of raw materials into goods. The Secondary economic activities are mainly associated with manufacturing and industry. Examples of secondary economic activities are textile, leather industry, ceramic industry, cash crop industry etc. Thanlyin is much more developed than other townships. Most of the secondary economic activities involve producing products from the raw materials or the semi-finished products.

Tertiary Economic Activities

Tertiary economic activities are the service sector of the economy. Services of various kinds like education, health, banking, insurance, trade are included in this area. The study area is divided into urban area. People in urban area have the main enterprises by dealing and trading tertiary economic activities, and they support the urban economic development.

Commercial activities

In this study area are found several types of commercial activities. Commercial activities consist of 12 categories, and these are bazaar (market), shop-miscellaneous (store, dry goods, personal goods), food stalls (rice, oil, restaurant, tea, cold drinks, bar, liquor), hardware (building material, vehicles and parts), shop catering other goods (clothing, electrical goods medicine, chemical products, shoes, sporting equipment, other shops), petroleum pump (gasoline station), financial institution is composed of (bank, insurance), professional service (clinics), skilled services (beauty salon, photo studio), repairs (workshops and service stations, bicycle repairs, watch repairs, other repairs), recreational services (sports stadium, cinema, theater), other services (royal express, printing services, guest house, motel). These commercial activities are found in Table 2, and the annual turnover of the commercial activities is shown in the Table 3, on the Kyaik Khauk Pagoda Road in Thanlyin.

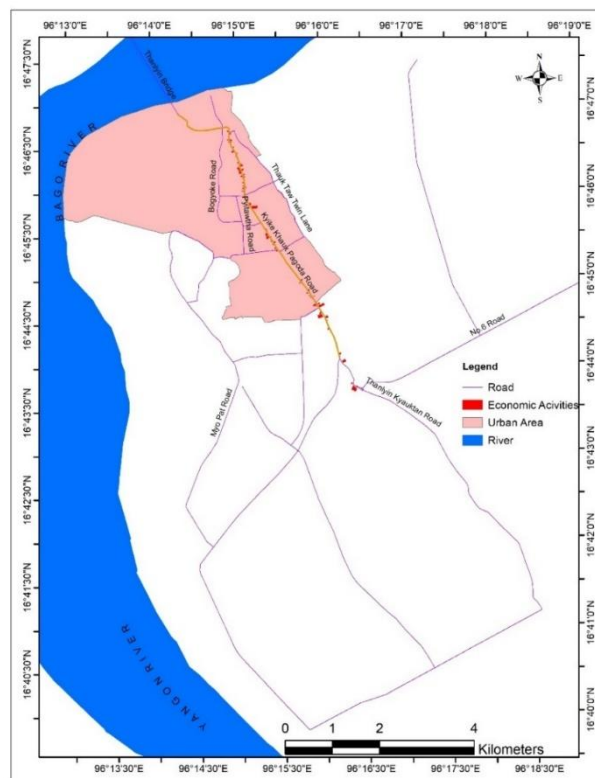


Figure 3 Roadside commercial activities along the Kyaik Khauk Pagoda Road in Thanlyin (2001-2022)

Source: Township Municipal Development Committee

Table 2 Classification of commercial activities along the Kyaik Khauk Pagoda Road in Thanlyin (2001-2023)

No.	Categories	Sub classified	Sector
1.	Bazaar	Market	(Tertiary)
2.	Shop	store, dry goods, personal goods	(Tertiary)
3.	Food Stalls	rice, oil, restaurant, tea, cold drinks, bar, liquor	(Tertiary)
4.	Hardware	building material, vehicles and parts	(Secondary)
5.	Shops catering other goods	clothing, electrical goods medicine, chemical products, shoes, sporting equipment, other shops	(Tertiary)
6.	Petroleum Pump	Gasoline station	(Secondary)
7.	Financial institutions	bank, insurance	(Tertiary)
8.	Skilled Services	beauty salon, photo studio	(Tertiary)
9.	Repairs	workshops& service stations, bicycle repairs, watch repairs, other repairs	(Tertiary)
10.	Recreational Services	Sports stadium, cinema, theater	(Tertiary)
11.	Other Services	royal express, printing services, guest house, motel	(Tertiary)
12.	Professional Services	Clinics, Hospital	(Tertiary)

Source: Field Training, Geography Department

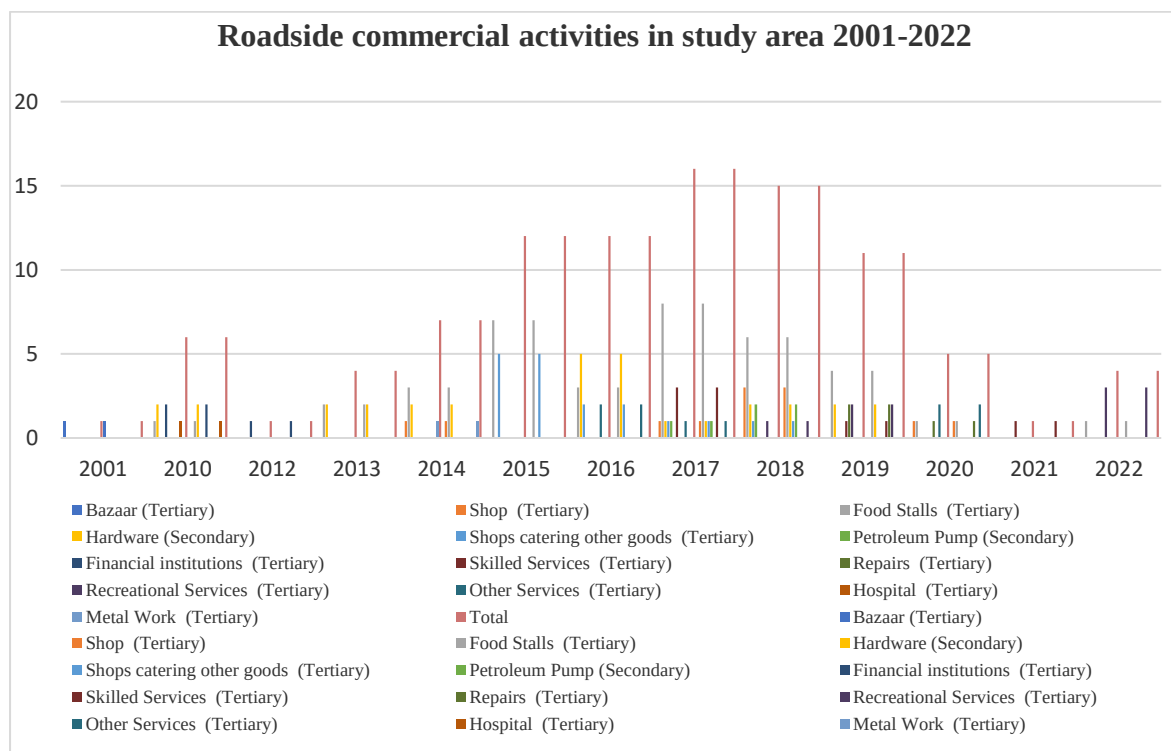


Figure 4 Roadside commercial activities along the Kyaik Khauk Pagoda Road in Thanlyin (2001-2022)

Source: Field Survey

Relationship between the Road Network Accessibility and the Location of the Commercial Activities in the Study Area

Thanlyin is composed of 17 wards. There are two main roads in Thanlyin. They are the Kyaik Khauk Pagoda Road and the Bogyoke Nay Win Road. The total population of Thanlyin is 78805 persons. 95 commercial activities exist in the Kyaik Khauk Pagoda Road. Therefore, in the conducting of the network analysis to find out the best accessibility of the commercial activities of Thanlyin.

Theoretically, Different individual elements either vertices or edges have different characteristics or relationships throughout the network. Therefore, it is necessary to analyze the characteristics of each of these elements. In general, the procedure is to evaluate the accessibility of individual element in regard to the entire network.

Traditionally, network analysis literature uses vertices or nodes as the basic elements of analysis. Conceptually, using links or edges as the basis elements is also appropriate because the accessibility results are now applied to the edges but not the vertices.

A simple analysis is to identify how many edges a given edge is directly connected to node. If the edge is well connected, then many edges will be linked to it directly.

However, the number of direct links to an edge may not accurately reflect the accessibility of an edges. An edge with a small number of direct links may still be quite accessible, depending on its relative (topological) location of the network. For instance, an edge may have a small number of direct links but may be centrally located in the network, so that it is still well connected to other edges. To capture the relative location of a given edge in the network, we need to find out how many links are required to reach the farthest part of the network from that edge.

It is quite easy visually to derive the numbers of links or steps required to reach the farthest edges. Therefore, even if the two edges have very different numbers of direct links, their locations in the network are equally desirable. Note that: 1 plus the highest number of links or steps required to reach the farthest edge of the entire network is also known as the diameter of the network.

An analysis based solely on the number of direct links is not the most reliable. An edge may not have many direct links, but because of its location, it may be reached for other edges indirectly and thus may be reasonably accessible. Besides direct linkages, our analysis should take indirect linkages into consideration. But obviously, a direct link is better than an indirect link: therefore, the two types of links should be treated differently. Indirect links also have different degrees of connectivity.

On the basis of this idea, we can derive the number of direct and indirect links that will require all edges to be joined together for each given edge, but the indirect links will be weighed by the number of these total links, the less accessible is the edge. A small number of total links implies that the edge is well connected directly and indirectly to other edges.

There are two basic elements (or) value in Network Analysis: Connectivity and Accessibility. In the calculation of accessibility, the good or the bad location are found out according to the number of direct links, steps and all-links. Thus, the commercial activities which distribute to 41 edges include the primary roads, the secondary roads and the tertiary roads in Thanlyin are examined.

If the above mentioned the three variables are reviewed, theoretically, places highest number of commercial activities the place which has the best accessibility can conclude as the place which have direct links, and the lowest number of steps and all-links. The place Kyaik Khauk Pagoda Road near the clock tower ID No. 6 is the best accessibility which has direct links (5), steps (9), and all-links (181) in Thanlyin Town. It has (32) commercial activities. See table 4 and figure 5.

Table 4 Direct Links, Steps and All Links in Study Area

No	Direct Links	Steps	All-Links
1	3	11	254
2	3	13	263
3	4	12	227
4	3	9	204
5	4	6	154
6	5	9	181
7	5	10	213
8	4	10	219
9	5	13	216
10	5	13	214
11	3	6	140
12	4	16	286
13	4	14	228
14	4	12	222
15	4	9	177
16	4	9	171
17	4	6	144
18	4	10	186
19	4	7	162
20	4	6	136
21	4	10	180
22	3	9	215
23	3	9	212
24	4	8	145
25	4	8	159
26	4	8	154
27	4	9	168
28	4	9	169
29	4	10	205
30	2	10	209
31	2	11	245
32	2	11	245
33	2	11	224
34	4	10	198
35	4	10	198
36	4	10	182
37	3	13	244

No	Direct Links	Steps	All-Links
38	2	10	229
39	3	9	195
40	4	8	176
41	4	8	175

Source: Calculated by Author

Importance of the Landmarks

Thanlyin Town has two main roads where buses are used by the public. Those two main roads are the Kyaik Khauk Pagoda Road and the Bogyoke Nay Win Road. This paper is a study of the commercial activity on the Kyaik Khauk Pagoda Road, which is the main road of Thanlyin Town. The commercial activities of Thanlyin in the study area is rapidly developing based on the landmarks. These are administrative landmarks, religious landmarks, transportation landmarks, commercial landmarks, and service landmarks. Thanlyin covers 15.39 square kilometer wise in 17 wards. In studying the analysis of urban functions in Thanlyin, The majority of religious landmarks were located on the Kyaik Khauk Pagoda Road near the Phayar Gyi Market. Other cultural buildings such as the ancient portuguese church is situated within the Myanmar Yanen Ward.

Administrative landmarks, such as the building of the police station, the fire station, Yangon City Development Committee, the information department, the supaung yone and the social welfare department, Township Law Office, the Electricity Office etc. They are found in the Bagosu ward, Ahmuhtan ward, Myoma (North) ward, Aungmingalar ward and along the Kyaik Khauk Pagoda Road.

Residential functions like numerous one storey buildings, two storey buildings, three storey buildings have been replaced by an increasing number of multi storey buildings. There are many condos, apartments and other high-rise buildings in Thanlyin. Residential function is found along the main road and other streets.

Industrail landmarks included the Thilawa Special Economic Zone and many other industries. The landmarks are located on outskirts of Thanlyin and other landmarks are found Myanmar Yanen, Aung Chan Thar, Thauktawkwins Wards.

Commercial landmarks are remarked as market; its economy depends on trading business in commercial functions. These commercial landmarks are found along the Bogyoke Nay Win Road and along the Kyaik Khauk Pagoda Road.

Services landmarks are defined as education that includes the schools, the preschool, the shopping center and universities. These landmarks are found in Oakphosu, Myothit (East), Bagosu Wards and near Kyaik Khauk Pagoda Road.

The other services landmarks are mainly included buildings hospitals, buildings health care centers, and buildings clinics. The number of buildings private hospitals, the pharmacy and other services shops have emerged in the services landmarks. The majority of service landmarks are located on the Kyaik Khauk Pagoda Road.

Recreational landmarks are the golf resorts, the cinema halls, the lakes, and the parks. Recreation centers is necessary for urban dwellers to relax and reduce their stress. Recreational landmarks are found along on the Kyaik Khauk Pagoda Road.

Transportation landmarks is remarked accessible to Yangon and Thanlyin by road transport and by railway. These landmarks are the Thanlyin Bridge No.1 and the Aungthukha railway station. This landmark is located in the Myohaung (West) ward. Transportation landmarks play the important role for the development of the town.

The Kyaik Khauk Pagoda Road commercial activities increased year by year because university students, employees, employees of Thilawa Special Economic Zone,

foreign investors from the Thilawa Special Economic Zone and pilgrims buy at these shops. Among the many commercial activities along the Thanlyin Kyaik Khauk Pagoda Road, the number of restaurants is the most, because foreign investors from the Thilawa Special Economic Zone flock to these shops. The University, the pagoda and the Thilawa Special Economic Zone have become the main attraction for people coming to the area.

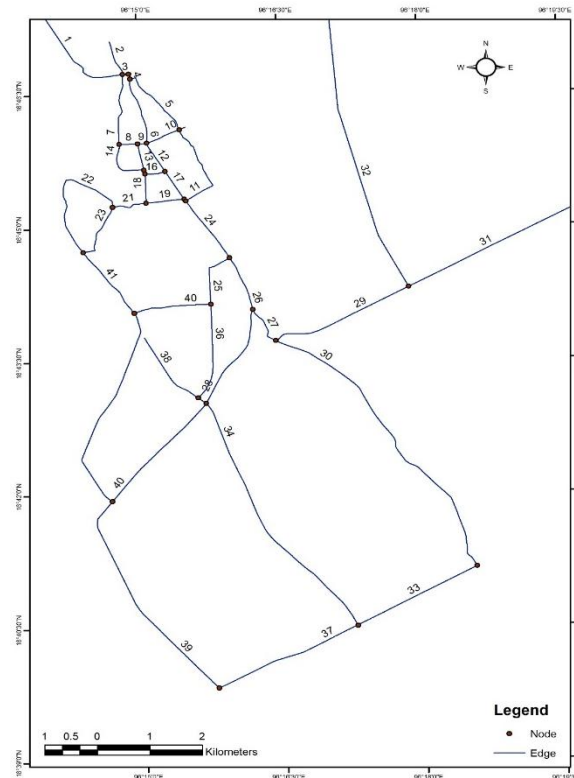


Figure 5 Node and Edge of the Selected Road in the Study Area

Source: OSM (2023) and Field observation (2023)

Land Value

Thanlyin Township has two main roads where buses are used by the public. Those two main roads are the Kyaik Khauk Pagoda Road and the Bogyoke Nay Win Road. This paper is a study of the commercial activities on Kyaik Khauk Pagoda Road, which is the main road of Thanlyin Township. In 1993, when the Thanlyin Bridge No.1 was built, which connected Thaketa Township and Thanlyin Township, the road became economically important. Since 2000, 4 Universities have been opened in Thanlyin Township. In 2015, the opening of the Thilawa Special Economic Zone has become the main attraction for people coming to the area. Investors have been buying plots of land along the Kyaik Khauk Pagoda Road because it is good for doing business. Then commercial activities increased on the Kyaik Khauk Pagoda Road. As commercial activities increased the price of the land were the highest along the Kyaik Khauk Pagoda Road year by year.

Before 2013-2014, Thauk Taw Kwin land price was 17,500 kyats per 1 square feet. The land price of the Myo Thit (middle) ward is 18,000 kyats per 1 square feet. The Aungmingalar ward land price 18,000 kyats per 1 square feet. The Ahmhuhtan ward land price 18,000 kyats per 1 square feet. The Bago Su ward land price 17,000 kyats per 1 square feet. The Yanen ward land price 11,500 kyats per 1 square feet. The Myo Haung (Middle) ward land price 11,500 kyats per 1 square feet. The Myo Thit (East) ward land price 11,500 kyats per 1 square feet.

The Htan Pin Kone ward land price 11,500 kyats per 1 square feet. The Myo Haung (East) ward land price 11,500 kyats per 1 square feet. The Aung Chan Thar ward land price 4,500 kyats per 1 square feet. The Oke Hpo Su ward land price 4,500 kyats per 1 square feet. The Dahar Gar ward land price 4,500 kyats per 1 square feet. The Myo Haung (West) ward land price 4,500 kyats per 1 square feet. The Myo Ma (North) ward land price 4,500 kyats per 1 square feet. The Myo Ma (South) ward land price 4,500 kyats per 1 square feet. The Phayar Kone Village land price 200 kyats per 1 square feet.

After 2020- 2021, The Thauk Taw Kwin land price 20,833 kyats per 1 square feet. The Myo Thit (middle) ward land price 20,833 kyats per 1 square feet. The Aungmingalar ward land price 20,833 kyats per 1 square feet. The Ahmhuhtan ward land price 20,833 kyats per 1 square feet. The Bago Su ward land price 20,000 kyats per 1 square feet. The Yanen ward land price 18,000 kyats per 1 square feet. The Myo Haung (Middle) ward land price 18,000 kyats per 1 square feet. The Myo Thit (East) ward land price 18,000 kyats per 1 square feet. The Htan Pin Kone ward land price 18,000 kyats per 1 square feet. The Myo Haung (East) ward land price 18,000 kyats per 1 square feet. The Aung Chan Thar ward land price 5,400 kyats per 1 square feet. The Oke Hpo Su ward land price 4,500 kyats per 1 square feet. The Dahar Gar ward land price 4,500 kyats per 1 square feet. The Myo Haung (West) ward land price 4,500 kyats per 1 square feet. The Myo Ma (North) ward land price 4,500 kyats per 1 square feet. The Myo Ma (South) ward land price 4,500 kyats per 1 square feet. The Phayar Kone Village land price 833 kyats per 1 square feet. It is observed that there is a difference between the land prices by the government.

Conclusion

Thanlyin is situated in the southern portion of Yangon Region. It is also located on the left banks of the Bago River near Yangon City. It is 12 miles far from Thanlyin to Yangon. Thanlyin is formed of seventeen wards. There are two main roads in Thanlyin. They are the Kyaik Khauk Pagoda Road and the Bogyoke Nay Win Road. This paper aims to study the roadside commercial activities along the Kyaik Khauk Pagoda Road in Thanlyin. There are 7 wards and a village along the Kyaik Khauk Pagoda Road. They are the Myo Haung (East) ward, the Thauk Taw Kwin ward, the Aungmingalar ward, the Oke Hpo Su ward, the Ahmu Htan ward, the Bago Su ward, the Aung Chan Thar ward and the Phayar Kone village tract. The foreign investors, Universities students and city dwellers are the main users of that road. Economic development is necessary for city developments. After Thanlyin Bridge had been built, Thanlyin began to develop. As the population of Thanlyin increases the number of commercial activities also increases year by year. It is found that there are two types of commercial activities in the study area. They are secondary commercial activities and the tertiary commercial activities. Theoretically, there are 12 categories commercial activities. Among the 95 commercial activities, 32 are the largest along the Kyaik Khauk Pagoda Road in the Thauk Taw Kwin ward.

After studying the relationship between good or bad network accessibilities and commercial activities development, ID No-6 is the best network accessibility. There are the major administrative landmarks, the religious landmarks, the transportation landmarks, residential functions, the services landmarks, the commercial landmarks, the industrial landmarks and the recreational landmarks. It has been observed that these major landmarks are closely related to the changes in the economic development of the Kyaik Khauk Pagoda Road. Since the Kyaik Khauk Pagoda Road is the main road, business investors have been investing along the road. As a result, the price of land value along that road is rising. Comparing 2014 and 2023, it is seen that the land value of the wards and the village along that road is rising.

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METHOD OF TRUTH IN PRAGMATISM

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Abstract

The aim of this paper is to show American pragmatic outlook of truth and to know the weakness and supplement what is lacking in it. The research question of this paper is why one can seek for the truth in a solution by using pragmatic approach but an ultimate truth will never be reached. Pragmatic approach attempts to validate all participatory variables in a solution to a disagreement. The task of this method is to find solutions that make the most sense in the simplest way possible. But the pragmatic criterion of truth does not accept truth as an end but it accepts as a means, and as a process. In this paper, descriptive method and evaluative method are used to answer the research question. This paper contributes to knowledge that a pragmatic approach to conflict resolution that emphasizes on the empirical and individual could lead to disharmony especially in society.

Keywords: Pragmatism, Method of Truth, Individualism, Ultimate Truth

Introduction

Pragmatism is a new philosophy which is an important philosophical movement in the twentieth century. The word pragmatism comes from the Greek word “pragma” which have “The meaning of active” (or) “The meaning of efficient”. it is a theory of truth. In other words, it studies the setting metaphysical dispute. Metaphysical arguments are usually found to involve notions or ideas about which one can always ask whether they lead to any practical consequences. According to pragmatism, an idea must be shown to make a difference in practical life, if it is to be meaningful. So, it is a revolt against rationalism. It is a theory about the knowledge.

Charles Sanders Peirce (1839-1914), an American philosopher, mathematician and scientist was one of the pioneers of pragmatic movement. “He was the first to use the name “pragmatism”. Peirce’s pragmatism popularized through the work of William James and John Dewey which come to dominate the American intellectual world realistic.

According to Peirce, pragmatic method pointed out much to the foundation of symbolic logic and to the theory of meaning. Peirce uses his pragmatic method in testing whether a given term is meaningful or not. Peirce’s famous pragmatic maxim: “Consider what effects”, which might conceivably have practical bearings, people conceive the object of their conception to have. Then, their conception of these effects is the whole of their conception of the object. That is to understand a thing, people have to conceive, through the use of the senses, the effects of the action of the thing. So, pragmatic method holds that the meaning and validity of conception daily life must be examined by their practical results.

Knowledge, according to pragmatism, is rooted in experience. But the meaning of experience is ambiguous. For most of the English empiricists, experience means sense-experience alone. It is the basis of knowledge and foundation of their philosophy. James also begins his empiricism by accepting sense-experience as the only ultimate source of knowledge and sensible things as the only realities directly known. The function of sense-experience, he says, is to resemble reality. But James gradually modifies this position and takes a wider view of experience to include within it, not only sensation, but also the higher mental activities.

This pragmatic empiricism of James is further developed by Dewey. He brings out more clearly the biological character of knowledge and develops what he likes to call experimental empiricism. According to experimental empiricism nature does not consist of ready-made

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realities whose properties are accepted by knowing, but is a moving whole of interacting parts which has to be actively interrogated in order that it can be controlled for human purposes. The attitude of acceptance is thus replaced by that of control, and attitude of discovery, by one of experimenting. In this sense knowing goes forward by doing.

As Dewey says,

Action, when directed by knowledge, is method and means, not an end. The aim is the securer, freer and more widely shared embodiment of values in experience by means of that active control of objects which knowledge alone makes possible.¹

In short, for Pragmatism, knowledge is not passive, but active; it is not a copy of pre-existing things, but rather an anticipation of future experience; and it is thus an instrument for practical life; it is necessary for imparting efficient direction to future activity.

Nevertheless, pragmatism relies on experience and follows the method of investigation and observation based on experimentation. It is a practical approach to discovering the truth about the world.

Findings and Discussion

Peirce's Pragmatic Method

Peirce's pragmatic method of truth holds that true propositions are directly connected with facts of experience. Peirce's method never makes these propositions whereas this method never makes moral and religious propositions. Peirce's method tends to reject moral and religious values as meaningless. He holds that a form of inference is validated by its power to convey truth from premise to conclusion, whether we recognize that it has this power or not. At the same time, he does not treat the truth of the premises and conclusion themselves as something altogether independent of the acceptance of them. So it can be said that Peirce does not hold truth to be objective.

Peirce points out that there can be no such as an absolute guarantee of truth and therefore no virtue in appealing to self-evidence. Even the proposition which is considered to be true with complete confidence may not be free from mistake and error. Thus, Peirce says, "Your problems would be greatly simplified, if, instead of saying that you want to know the 'Truth' you were simply to say that you want to attain a state of belief unassailable by doubt. But how is this state of belief to be attained?"²

Peirce declares that there are just four methods of stabilizing one's opinions. These are the method of tenacity, the method of authority, the apriority method and the method of science. The method of tenacity is that of holding on to one's beliefs. In Peirce's view, this method is ineffective because if one comes into contact with other people, one is bound to discover that some think differently, and then one's confidence in one's belief will be shaken. The method of authority is the traditional method of securing agreement on matters of religious, political and moral doctrine. The defect which Peirce ascribes to the method of authority is that no institution can undertake to regulate opinions upon every subject.

The third, a priori method has been mainly practiced by philosophers. It is that of accepting a system of belief on the ground that their fundamental propositions seemed "agreeable to reason" or "self-evident". However, it is even less effective as a means of fixing beliefs. Thus he does not accept the first three methods.

Peirce said that the method of science is the only perfect way because of showing distinctive circumstances. First, there is the attempt to make it *independent* of individual fancies and caprices. Second, there is to be no reliance on what is peculiar to anyone who is making the inquiry. It is a *public* standard of truth. Third, because of this public character, the *social impulse* will not undermine the opinion that is settled in this scientific way. Moreover, Peirce argues that the method of science has had the most success in the way of settling opinion.

It would be hard to quarrel with this as a statement of historical fact, but in the present context it does raise two problems. The first is that if a method of fixing belief is to be justified by an appeal to fact, then one has to consider how the existence of the facts themselves is being determined. The second is that one has also to consider whether the fact that a method has been successful in the past is a sufficient basis for concluding that it will also be successful in the future. Thus even the method of science has its weak points.

James' Pragmatic Method

According to James, truth is not based on some objective, external reality. It is not also based on coherence with other beliefs. James regards human being as wishing to use the practical consequences of belief to decide truth and validity. Truths, James asserts, come into being from facts; they combine with facts again; and then these new facts create new truths. This process continues indefinitely. The facts are not exactly true; they merely are. Truth is the function of beliefs, which rise from them and terminate among them.

Fact and truth are eternally interacting, and determine one another. This process takes place within human experience, not outside it. This leads to the question of whether there exists a reality independent of thinking. This is the insoluble, perennial problem of philosophy. James' intention is to resolve this problem in terms of the Pragmatic theory of truth. Reality is what human ideas have to take account of. James holds that reality is a datum which cannot be explained because experience conveys it inadequately.

From this principle, James's pragmatic method leads him to the view that scientific theories are instruments for future action, rather than finally acceptable answers to questions about nature. Each word must thus be closely examined to know its 'cash-value'. From this it is only one future step to the pragmatist definition of truth as that which has fruitful consequences.

James's pragmatism is both a method and a theory of truth which can be used by philosophers of different views. Its major function is to settle metaphysical dispute. According to James, all true processes must lead to verification of sensible experiences somewhere.

Dewey's Pragmatic Method

Dewey's pragmatic method as a problem-solving tool became popular in the twentieth century. It is sometime called instrumentalism. According to which all our intellectual constructions (concepts, laws, theories) have the status of tools for solving problems. His instrumentalism gives an account of how concepts function and how action is taken in accordance with these functions in interacting, predicting and controlling human interaction with the world of experience.

Dewey's experimental method does not accept traditional metaphysics which holds that ideas stand apart from the natural world of effort and change. He rejects the bifurcation of thoughts, feelings and action from the natural world. He maintains that the primary task of philosophy is to use one's reasoning to understand the possibilities of human experience, especially collective human experience. Both experience and reason are necessary for investigating knowledge and truth. So, in solving human problems the experimental method plays an important role. Thinking is thus an instrument for knowing the truth and realizing human aims.

Knowledge, ideas, truth are nothing but instruments for successful action. Ideas are responses to a given situation and if an idea works then it is called Knowledge. Dewey says knowledge is a practical response to a particular situation in experience which is always changing, ongoing, and continuous. So knowledge is an instrument for adaption to experience and this instrument should not be inflexible.

Dewey believes that man is constantly confronted with problematic and conflicting situations. So he introduces his theory of inquiry to solve these problems and also change the

environment. The problematic situation is an indeterminate situation in which somebody finds himself out of harmony with his environment. For Dewey, problem solving on the common sense level and problem solving on the technical expert level are essentially the same.

An indeterminate situation is problematic because its various elements are scattered and chaotic. So the first step is to find out their interconnections, and identify which conditions are necessary and which are necessary as well as sufficient. This will clearly show where the problem lies. What Dewey means is sufficiently unified to enable means is that the object of inquiry is to transform an indeterminate situation into one that is sufficiently unified to enable meaningful assertions that are sound and lead to appropriate action. He presents the five phases of reflective thought or inquiry in **Logic** as follows:

1. The Antecedent Conditions of Inquiry; The indeterminate Situation.
2. Institution of the Problem.
3. The Determination of a Problem-Solution.
4. Reasoning
5. The Operational Character of Facts-Meanings ³

The process of inquiry begins with an indeterminate situation which brings about inquiry to resolve the problem. It is a situation that has ambiguous, confused, unsettled conditions. Somebody finds himself out of harmony with the environment and calls for a need to restore the balance or harmony. This need is what motivates the process of inquiry itself.

The second phase is the recognition of certain facts to determine what the problem is. This phase involves the isolation of the data or subject matter which defines the frameworks within the reconstruction of the initiating situation which must be addressed. In this step, the facts as well as the identification of the problem are important because if the facts and the identification of the problem are mistaken, the problem does not become a settled or unified situation.

The third phase is to suggest a possible relevant solution by the determination of factual conditions which are obtained from experience by observation. It must be a fruitful hypothesis which will be able to forecast some further consequences under certain further conditions. It is essential that the hypothesis is based on the actual facts of the situation. Otherwise attempting to solve the problematic situation is fruitfulness.

Reasoning, the fourth process, consists of the deductive development of the hypothesis. It is composed of developing the meaning-contents of ideas in their relations to other ideas. The last phase has to do with testing of hypothesis by action. Dewey explain the relationship of reasoning and experimental actions as follows:

The pre-cognitive unsettled situation can be settled only by modification of its constituents. Experimental operations change existing conditions. Reasoning, as such, can provide means for effecting the change of conditions but by itself cannot affect it. Only execution of existential operations directed by an idea in which ratiocination terminates can bring about the re-ordering of envioning conditions required to produce a settled and unified situation.⁴

In Dewey's process of inquiry, the ideal experiment of natural science is visible. The working hypothesis directs the observation or constituents of the situation, which lead to facts that contribute to a specified working hypothesis.

Following the model of the method of experiment of natural science, Dewey regards observation and data on one hand, and inference and suggestion (idea) on the other, as key elements in reflective thinking. Although he underlines the operative nature of both ideas and facts, it remains unclear how a working hypothesis is transformed into the "existential operations" need for the reconstruction of the situation. Dewey's theory of inquiry does not deal with how a future-oriented working hypothesis is turned into tools and rules that make the practical transformation of a situation possible. It can be said that to solve this problem by referring to the operative nature of ideas and facts is not sufficient.

A Critical Analysis of Pragmatic Approach to Truth

Peirce's pragmatic approach, in general, consists in holding that the meaning and validity of distinction in thought must be tested and justified by their consequences. Experimentation, for Peirce, was the preferred method of fixing belief, entailing the test of hypothesis against public and verifiable. All knowledge is developing, growing through experiences and there is no possibility of attaining absolute certainty or absolute truth according to Peirce.

The essential of Peirce's method can be summarized as; (1) An idea can be clarified only through action, (2) It must also be public, i.e. people must agree on what it means that is his criterion and (3) The purpose of clarifying idea is for use in the future. His method is somewhat narrow and rigid. This is because what is usually meant by truth is relative to individuals or cultures in the everyday world. When Peirce's method of truth is analyzed, it is found that he focused on scientific experimentation, and truth dependent upon practical consequences.

James accepted the pragmatic method as the pointed method of the stream of experience which is a continuous, ever-changing process. For James, since the stream of experience is the whole of reality, there are may be different understanding of the same reality by different people. Reality is the ever-changing, on-going stream of experience. Therefore, it can be said that in accepting the stream of experience as the whole of reality and the source of all knowledge, James' thinking is the practical thinking based on relative value.

His attention to the affective elements of experience, such as feeling of volition, intention and personal identity mark the breaking point from Peirce's version of pragmatism. As a method, James claims that pragmatism favors the utilitarian emphasis on what is useful and the positivists' dislike of metaphysical speculations and merely verbal solutions of problems. He does not accept the old metaphysical views. James uses two criteria for testing the truth or meaningfulness of sentences.

- (1) A sentence is meaningful if it leads to practical consequences or observable consequences in experience.
- (2) A sentence is meaningful if one's belief in it leads to behavioral consequences.

The first one is useful when people are dealing with factual sentences in daily life and in the natural sciences. The second criterion is applicable when we are dealing with moral and religious statements. The second criterion means that the sentence leads to some benefit or advantage in the psychological life of the believer and guides him to do certain things then it is meaningful. So, he opens the new way in social, moral and religious scope. According to James, a sentence is true if it gives happiness, satisfaction and etc., if so, a single statement is true for someone but it may be false for the other. It is logically impossible. Hence it is impossible from the logical point of view. Therefore, it can be said that James' view is subjective which leads to disagreement in society.

It is at the point that Dewey disagrees with James and introduces the social basis in the search for truth in order to circumvent over-emphasis on the individual of James's pragmatism.

In Dewey's philosophy, truth or knowledge is socially based. He accepted the role of the individual as part of the social milieu, but did not accept the over-individualism of the times. As an instrumentalist, Dewey maintained that knowledge is a practical instrument for solving human problems. This instrument must be able to adapt itself to the ever-changing process of experience. Truth or knowledge cannot be static must be pliable. This shows that in Dewey's pragmatic view, truth is sought for the process of social and moral implications of life and society are not overlooked. Thus, it may be said that Dewey's pragmatic approach to truth is individualistic but not subjective. The weakness of his view lies in the implication that human life and experience is one long process of problem-solving and adapting to changing environmental conditions that knowledge is merely a practical instrument for problem-solving.

Conclusion

It is generally believed that knowledge is necessary for life and human beings always attempt to have knowledge of facts around him as much as possible. So it is required that what is known must be true and that a distinction can be made between true knowledge from that which is false. In everyday life all sorts of statements are affirmed without pondering the question of truth. Since things are not always so clear, it is important to get clear about what truth means, particularly in the search for the truth about self and others.

One of the important task of philosophy is to promote critical and creative thinking in the search for knowledge. To put it generally philosophy is a thinking activity. Good thinking provides guidelines for the future and well-being of this world. The increasing complexity of demands and opportunities of the today world will require even better thinking. Good thinking is therefore essential for survival, competition and success. The role of thinking thus becomes a vital part of the social process. The world today is called the Age of Information or Knowledge Age. People need to think in order to make the best use of the given information and to deduce 'what ought to be' from 'what is'.

The pragmatists hold that there is no such thing as Absolute Truth and that truth is man-made and is therefore an ever-changing reality. The pragmatic approach by its very nature allows for dynamic interplay between theory and practice. So the process is always under construction. In a conflict resolution the pragmatic approach, it would not be assumed that a static result would be achieved, but that a dynamic understanding could be reached but that a dynamic understanding could be reached allowing for changes to occur naturally as they evolve.

Another advantage of a pragmatic approach to conflict resolution is that time is not wasted on designating blame for a problem all share some relationship to the problem and to the solution, and so the issue of who is to blame is problematic.

The weakness of pragmatic approach is that it could take longer to achieve a result when these are many complex variables to consider in a conflict resolution. When all the components of a problem must be considered in reaching the solution, the time it takes could be prohibitive. Another problem with the pragmatic method is that it assumes there is a solution that makes sense to all and that there is a simplest way to reach that solution. These assumptions do not work well with every problem, because religious or cultural values are not the same between groups. There is the problem if how we measure "simple" from one group to another group. Determining whose values will measure what "simple" is and what is the most reasonable solution is not a pragmatic process but a very dualistic 'is /ought' process. So it can be said that only the pragmatic approach is unsatisfactory sufficient to work at all.

Pragmatic emphasizes the practical aspect of truth and agrees that truth is not an end itself. Pragmatists do not accept ultimate truth and firmly believe that the truth or falsity of an idea lies in its workability. Their accent an individual achievement, individual judgement and individual interest has come to the forefront for subjective and egoistic aspect. In fact, pragmatism has with its balance view of avoiding the extremes of self-interest and the interest of others managed to preserve to some extent the perennial moral and spiritual values that are conducive to harmony in society.

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A STUDY ON THE RELATIONSHIP BETWEEN PSYCHOLOGICAL CAPITAL AND TEACHERS' JOB COMMITMENT

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Abstract

The purpose of the present research is to study the relationship between psychological capital (PsyCap) and job commitment among teachers who are working at Dagon University and East Yangon University. The main objectives of the study are to identify the level of PsyCap and commitment among university teachers. The sample consists of 221 teachers with their ages ranging from 24 to 61 years old, with a mean age of 39.67. The data was collected using Luthans et al.'s Psychological Capital Questionnaires (2007) and Allen and Meyer's (1990) Commitment Questionnaires. The psychological capital questionnaire consists of four dimensions: hope (4 items), efficacy (3 items), resilience (3 items), and optimism (2 items), and the commitment questionnaire contains three dimensions: affective commitment (6 items), continuance commitment (6 items), and normative commitment (6 items), respectively. The data was analyzed through descriptive statistics, the Pearson correlation method, and the "t" test using the SPSS 16 version. It was discovered that there was a significant positive correlation between psychological capital and commitment among university teachers. Also, there was a significant difference between the sub-dimensions of psychological capital among teachers. This study also offers valuable knowledge for the benefit of various stakeholders and psychological capital and organizational commitment research.

Keywords: psychological capital, commitment

Introduction

Organizational management is increasingly focused on human resources to achieve organizational objectives. Psychological capital, a key factor in employee performance, is a key management tool that contributes to organizational assets. Schools, as subsystems within the education system, need motivated individuals who are highly identified with their institutions. High organizational commitment levels are crucial for employees to adopt and internalize their organizations, ensuring a livable place for them. School managers and teachers play a significant role in achieving school objectives. Their commitment to the school, their work, and effective communication with students, parents, and teachers are essential for a school's success. The commitment of these individuals significantly impacts their performance, job satisfaction, organizational climate, and success.

Psychological Capital

The changes faced by each area in today's competitive world are also reflected in the classes of capital that provide competitive advantages to organizations. Economic capital is related to the financial conditions of organizations and their financial resources. This capital answers the question "What do you have?" Organizations can achieve success through the efficient use of financial resources. Employees who operate at all organizational levels and use their knowledge, expertise, and experience to advance their organizations are referred to as human capital. Human capital answers the question "What do you know?" Employing the right people in the right positions and developing employees with continuing education will ensure more effective use of human capital (Luthans & Youssef, 2004). On the other hand, social capital is a social network inside and outside an organization that answers the question "Who does know?" Social capital will accelerate the process of achieving goals along with human relationships which is difficult to do as an individual.

The concept of psychological capital originates in "postmodern positive psychology, Martin Seligman discussed these concepts in 1999. They were subsequently developed by

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Luthans and his colleagues in 2004 in the USA. Psychological Capital (PsyCap) is one of the resources (or "capitals") that are required for organizations of all types seeking sustainable growth and competitive advantage. Luthans defined psychological capital as the ability of employees in the organization to trust themselves in accomplishing difficult tasks, to always have a positive thinking structure to achieve success, to persevere in the face of problems, and to be resistant even in the face of negative consequences (Luthans, F., Luthans, K., & Luthans, B., 2004).

The concept of psychological capital does not take what individuals are currently doing into consideration but how they will be in the future, and it answers the questions of "who we are" and "what we can be". PsyCap is characterized by: (1) persevering towards goals and, when necessary, redirecting paths to goals (hope) to succeed; (2) having confidence (self-efficacy) to take on and put in the necessary efforts to succeed at challenging tasks; (3) when beset by problems and adversity, sustaining and bouncing back and even beyond (resilience) to attain success", and (4) making a positive attribution (optimism) about succeeding now and in the future (Luthans, Youssef, & Avolio, 2007). Hope, efficacy, resiliency, and optimism - known as the "HERO Within" - are the resources that make up the value of PsyCap.

Commitment

New employees entering organizations have different goals and values which they seek to satisfy through employment. The more congruence employees perceive between their values and beliefs and those of the organization, the stronger their propensity to commit to the organization. Commitment is an individual's desire to remain focused and attached to his work. Commitment has been defined in many ways and numerous researches have been done regarding job commitment and satisfaction in higher educational institutes.

The idea of job commitment has been examined from different points of view. In this present review, the idea of job responsibility will be confirmed from the psychological approach. This approach looks at institutional commitment from the view of the attachment of employees to the institution where they work. Employee commitment is strongly affected by the level of motivation, which is necessary for boosting the employee's attitude towards the job. The model of Meyer and Allen (1997) utilized as a part of this present review proposed a three-segment model of institutional duty as per the way of the bond that exists between a worker and business as Affective commitment (AC), Continuance commitment (CC), and Normative commitment (NC).

It has been demonstrated that there is a high correlation between organizational commitment and different psychological commitments. (Avolio, Avey, Luthans & Norman, 2006) According to a study by Jain et al. (2017), organizational commitment and psychological Capital are positively correlated. It was thought that the positive correlation resulted from the increased likelihood of higher self-confidence, greater resiliency to unfavorable circumstances, optimism in the face of adversity, and greater commitment to the organization among employees with high levels of self-efficacy, hope, optimism, and resilience.

Etebarian, Tavakoli, and Abzari (2012) discovered a strong and positive correlation between affective commitment and psychological capital in another investigation. According to a study by Jain et al. (2017), psychological capital is more of a personal resource that may be utilized to enhance attitudinal outcomes, such as organizational commitment. This could explain the association between psychological capital and organizational commitment. Their study has demonstrated the relationship between hope self-efficacy and organizational commitment.

Furthermore, research by Luthans et al. (2005) titled "The relationship between psychological capital and the performance of Chinese workers" discovered a favorable correlation among the three positive psychological behavior types, hope, optimism, and resilience _ in their jobs. McColl Kennedy and Anderson (2005) discovered a relationship

between commitment and optimism in their investigation. Additionally, Sinja et al. (2002) examined the relationship between organizational commitment and self-efficacy and discovered a positive correlation between the two.

Objectives of the Study

1. To explore the level of psychological capital and job commitment among university teachers
2. To study the relationship between psychological capital (Hope, Efficacy, Resilience, and Optimism) and job commitment (Affective Commitment, Continuance Commitment, and Normative Commitment) among university teachers.

Hypotheses

The hypotheses that follow are formulated:

- H1: There is a significant positive relationship between psychological capital and its dimensions among university teachers.
- H2: There is a significant positive relationship between commitment and its dimensions among university teachers.
- H3: There is a significant positive relationship between psychological capital and commitment among university teachers.
- H4: There is a significant difference in psychological capital between university teachers who are working at Dagon University and East Yangon University.

Definitions of Key Terms

Hope

The concept of hope was developed by Charles R. Snyder and consists of two parts: pathway and agency (willpower). In the face of adversity, hope permits a person to have the agency to set and pursue meaningful goals as well as to create alternative routes to achieve them. Hope is the “will “to succeed as well as the capacity to recognize, define, and follow the “path”.

Efficacy

The concept known as "efficacy" describes an employee's conviction or confidence about his or her abilities to mobilize the motivation and cognitive resources or courses of action needed to successfully execute a specific task within a given context."

Resilience

"Resilience" is a notion that includes adaptive behavior and positive coping in the face of risk or adversity. It can be described as the "positive psychological capacity to bounce back"—that is, to "bounce back" after conflict, hardship, failure, or even from advancement, good change, and increased responsibility. Resilient people often possess a strong sense of purpose in life, a solid acceptance of reality, and the ability to adapt and change course as necessary.

Optimism

The concept of “optimism “is defined as having an optimistic result, outlook, or attribution, together with positive motivations and feelings, all the while keeping a realistic perspective. Those who remain optimistic in the face of difficulty, believing that their greater effort will lead to a desired outcome, are known as optimists.

Affective Commitment

It is a psychological bond that his employees develop for the company. This component of commitment motivates staff members to keep working very hard to achieve their goals. Their goal is to be part of the organization. To be accepted in an institution, a teacher needs to be committed and a dedicated practitioner in his field.

Continuance Commitment

Continuance commitment is defined as understanding the expenses involved in quitting the organization. According to Meyer and Allen (1991), a person's primary connection to the institution is their ongoing commitment to remain there out of necessity.

Normative Commitment

Normative commitment is described as "a feeling of obligation to continue employment" by Meyer and Allen (1997). According to their indication, "staff members who exhibit normative commitment believe they should stay with the organization." Regarding the normative dimension, the reason why the employees stay is because it is the right thing to do or because they should.

Method

Participants

In this study, a total of 221 teachers who were working in various specializations of Dagon University and East Yangon University were used as participants, including the tutor, demonstrator, assistant lecturer, lecturer, associate professor, professor, and pro-rector. Their ages ranged from 24 to 61 years old, with a mean age of 39.67. All teachers are willing to participate in the study.

Measures

In this paper, a set of questions was used for data collection, based on the literature survey.

(1) Socio-demographic data concerning gender, age, position, name of university, and instructions to answer the questionnaire were printed on the cover of the questionnaire.

(2) Psychological Capital Questionnaire

The Luthans, Youssef, and Avolio (2007) Psychological Capital Questionnaire was used to measure the psychological capital (PsyCap) construct. It consists of 24 items, but for this study, a short version of a 12-item PCQ was used. This version of PCQ uses a 5-point Likert scale ranging from 1-strongly disagree to 5-strongly agree and uses items such as "I feel confident analyzing a long-term problem to find a solution." The PCQ takes about 10 minutes to complete and consists of four scales: hope, efficacy, resilience, and optimism.

(3) Commitment Questionnaire

The three-component questionnaire of commitment developed by Meyer and Allen (1997) was used to measure teachers' job commitment: affective commitment, continuance commitment, and normative commitment. This questionnaire consists of 18 items, six items for each of the three dimensions. All the items are measured using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Procedure

The sample was collected from Dagon University and East Yangon University. Demographic data such as age, gender, position, and instructions were printed on the cover of the questionnaire. The participants were instructed to answer all questions and also informed of the purpose of the current study with permission from the authorities of the institutions and all responses were confidential.

Data analysis

The descriptive analysis such as mean and standard deviation of all variables was performed to see the level of psychological capital and Job commitment of university teachers. In addition, to explore the relationship between psychological capital and teachers' commitment, the Pearson correlation was computed. Then, the "t" test was used for hypothesis testing.

Results

Table (1) Distribution of variables in this study.

N= 221

Sr.	Variables	Number of Subjects	Percentage%
1	Gender		
	Male	15	6.8 %
	Female	206	93.2 %
2	Age		
	Under 30 years	75	34 %
	31-40 years	48	21.9 %
	41-50 years	44	20.1 %
	51- 60 years	53	23.5 %
	61 above	1	0.5 %
3	Position		
	Tutors/ Demonstrator	88	39.8%
	Assistant lecturer / Lecturer	66	29.9%
	Associate Professor/ Professor / Pro-rector	67	30.3%
4	University		
	Dagon university	59	26.7 %
	East Yangon University	162	73.3%

Table (2) Reliability estimates for psychological capital and commitment Questionnaires

Measures	No of Items	Cronbach's alpha
Psychological Capital Questionnaire	12	.562
Commitment Questionnaire	18	.744

Table (3) Mean and Standard Deviation of Participants on variables of study N= 221

Sr.	Factor	Mild	Moderate	High	Very High	M	SD
1.	Psychological Capital	12-23	24-35	36-47	48-60	41.89	5.163
2.	Hope	4-7	8-11	12-15	16-20	14.82	2.030
3.	Efficacy	3-5	6-8	9-11	12-15	11.99	2.532
4.	Resilience	3-5	6-8	9-11	12-15	9.30	1.639
5.	Optimism	2-3	4-5	6-7	8-10	5.77	1.714
6.	Commitment	18-35	36-53	54-71	72-90	56.47	10.033
7.	AC	6-11	12-17	18-24	24-30	18.91	2.499
8.	CC	6-11	12-17	18-24	24-30	17.65	5.229
9.	NC	6-11	12-17	18-24	24-30	19.90	5.502

Table (4) Relationship between Psychological Capital and its Dimensions among University Teachers N=221

Factor	Psychologic al Capital	Hope	Efficac y	Resilienc e
Psychologic al Capital				
Hope	.766**			
Efficacy	.832**	.590**		
Resilience	.483**	.215**	.189**	
Optimism	.414**	.150**	.150**	-.035

*p < 0.05

**p < 0.01

*** p < 0.001

Table (5) Relationship between Dimensions of Psychological Capital and Dimensions of Commitment among University Teachers N=221

Factor	Commitment	AC	CC
Commitment			
AC	.435**		
CC	.799**	.061	
NC	.867**	.280**	.478**

*p < 0.05

**p < 0.01

*** p < 0.001

Table (6) Relationship between Psychological Capital and Commitment among University Teachers

Factor	Psychological Capital
Job Commitment	.365**

*p < 0.05

**p < 0.01

*** p < 0.001

Discussion

This section describes the results, analysis of the data, and discussion and interpretation of the findings. In this study, a total of 221 teachers who were working at Dagon University and East Yangon University were used as participants. They were administered the Psychological Capital Questionnaire (PCQ) and Job Commitment Questionnaire (JCQ). Psychological Capital consists of the following sub-dimensions: hope, self-efficacy, resilience, and optimism. Job Commitment contains affective commitment, continuance commitment, and normative commitment. Table 1 shows the distribution of variables in this study. Table 2 shows the reliability estimate of the psychological capital questionnaire and the commitment Questionnaire.

Table 3 shows the level of psychological capital and commitment among university teachers. According to this table, the mean and standard deviation of psychological capital were 41.89 and 5.163. As regards Hope, the mean score of the sample was 14.82 with a standard deviation of 2.030. Concerning efficacy, the mean score of the sample was 11.44 with a

standard deviation of 2.532. The mean and standard deviation for resilience were 9.30 and 1.639, respectively. Concerning optimism, the mean score of the sample was 5.77 with a standard deviation of 1.714.

Table (7) Differences in Psychological Capital and Commitment between university teachers

S r.	Factor	DU (N=59)		EYU (N=162)		t-value	P value
		Mean	Mean	Mean	SD		
1.	Psychological Capital	42.25	41.75	41.75	5.377	0.637	.524(NS)
2.	Hope	14.93	14.78	14.78	2.108	0.499	.618(NS)
3.	Efficacy	12.22	11.91	11.91	2.685	0.812	.418(NS)
4.	Resilience	9.76	9.14	9.14	1.418	2.547**	.012
5.	Optimism	5.34	5.93	5.93	1.469	2.297**	.023
6.	Commitment	57.39	56.14	56.14	9.107	.821	.412(NS)
7.	AC	19.03	18.87	18.87	2.716	0.430	.668(NS)
8.	CC	17.90	17.56	17.56	4.722	.422	.673(NS)
9.	NC	20.46	19.70	19.70	5.724	.901	.369(NS)

The mean and standard deviation for commitment of the sample data were 56.47 and 10.033, respectively. The mean score in affective commitment was 18.91, with a standard deviation of 2.499. The mean and standard deviation of the sample data for continuing commitment were 17.65 and 5.229, respectively. Likewise, the mean and standard deviation for normative commitment were 19.90 and 5.502, respectively. As shown in Table 3, it can be seen that Dagon University and East Yangon University teachers have high levels of psychological capital and hope, efficacy, resilience, and optimism, as well as high levels of commitment, affective, continuous, and normative commitment. According to the findings, Dagon University and East Yangon University teachers have the desire to succeed. The finding supported the previous findings of Jain et al,2017: if you encounter problems, you can see factors such as the ability to cope, the ability to overcome difficulties, be a good communicator, be goal-oriented, and have high expectations.

Table 4 shows the intercorrelation matrix calculated between psychological capital and its dimensions. The four sub-dimensions were summed up to produce a total score for psychological capital. Regarding psychological capital, significant correlations were found with hope ($r = .766$, $p < 0.01$), efficacy ($r = .852$, $p < 0.01$), resilience ($r = .483$, $p < 0.01$), and optimism ($r = .414$, $p < 0.01$). In addition, hope was significantly related to efficacy ($r = .590$, $p < 0.01$), resilience ($r = .215$, $p < 0.01$), and optimism ($r = 0.48$, $p < 0.01$), respectively. For efficacy, significant correlations were found with resilience ($r = .189$, $p < 0.01$) and optimism ($r = .150$, $p < 0.01$). Therefore, hypothesis 1 is accepted.

Table 5 shows the intercorrelation matrix calculated between Commitment and its dimensions. The three sub-dimensions were summed up to produce a total score for Commitment. Regarding commitment, significant correlations were found with affective commitment ($r = .435$, $p < 0.01$), continuance commitment ($r = .799$, $p < 0.01$), and normative

commitment (.867, $p < 0.01$). In addition, affective commitment was significantly related to continuance commitment (.061, $p < 0.01$), and normative commitment (.280, $P < .0.$) According to Table, 5, continuance commitment was significantly related to normative commitment (.478, $p < 0.01$). Hence, hypothesis 2 can be accepted. According to the findings in Table 4 and Table 5, teachers with high psychological capital and organizational commitment will be high in these dimension

The third hypothesis was that there is a significant positive relationship between psychological and commitment among university teachers. Table 6 shows the correlation matrix calculated between psychological capital and commitment among teachers who are working at Dagon University and East Yangon University. According to Table 4.2, psychological capital was significantly related to commitment ($r = .365$ $p < 0.01$). The research findings of Jain et al. (2017), who examined the connection between psychological capital and commitment using a sample of 147 middle-level managers employed by public and private banks, support the findings of the present research. The results of this study indicated a strong correlation between commitment and psychological capital. Employees who have psychological capital are more likely to exhibit higher self-confidence, resilience to difficulties, optimism in the face of adversity, and consequently higher levels of commitment to their organization in terms of cognitive and behavioral traits.

Table 7 shows the comparison of psychological capital and commitment between university teachers who are working at Dagon University and East Yangon University. This table indicates the summary of means and standard deviations calculated for teachers who are working at Dagon University and East Yangon University and the “t” value that emerged from this analysis. According to “t” analysis, there were no significant differences in psychological capital ($M = 41.75$, $SD = 5.093$ vs. $M = 42.25$, $SD = 5.377$, $t = .637$) and hope ($M = 14.78$, $SD = 2.006$ vs. $M = 14.93$, $SD = 2.105$, $t = .499$) in the means for university teachers who are working at Dagon University and East Yangon University.

Comparing the efficacy mean and standard deviation between the two universities, there was no significant difference. $M = 11.91$, $SD = 2.477$, $t = .812$ vs $M = 12.22$, $SD = 2.685$. Teachers at Dagon University and East Yangon University displayed means and standard deviations in resilience that are significant at the .012 level ($M = 9.76$, 1.418 vs. $M = 9.14$, $SD = 1.685$, $t = 2.547$). Likewise, there were notable differences in the means and standard deviations of optimism across the two campuses.

At the 0.023 level, $M = 5.34$, $SD = 1.469$, vs. $M = 5.93$, $SD = 1.773$, $t = 2.297$, are statistically significant. Thus, the results provide some credence to hypothesis 4. Resilience to coworkers, as demonstrated by Luthans (2004) and Master and Reed (2002), aims to be more realistic in this group so that they can succeed and pick up some new skills.

Conclusion

The results of the study found a strong association between teachers' organizational commitment and their positive psychological capital levels. The cause for the teachers' great organizational commitment may be that they have high amounts of positive psychological capital. According to the findings, among university teachers, psychological capital and job commitment have a strong positive relationship. In addition, this study found that teachers at Dagon University exhibit greater levels of resilience than those at East Yangon University. Furthermore, compared to teachers at Dagon University, those at East Yangon University have a higher level of optimism.

We need training programs to be given to teachers both before and after joining to enhance their positive internal qualities. Frequent counseling sessions for teachers are also important to know about the satisfaction state regarding their job and to find ways to overcome the negative mindset.

Limitations

The sample of the study is limited to Dagon University and East Yangon University. Therefore, this study does not accurately represent all university teachers. Future research should include athletes, office workers, and professionals from various job environments.

Implication and Recommendation

This study explores the correlation between university teachers' psychological capital and job commitment. It suggests that enhancing employees' psychological capital and job commitment can benefit various stakeholders, including governments, businesses, athletic coaches, human resource managers, and educational counselors, by providing regular training and development, good working conditions, and a comfortable atmosphere.

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GENDER EQUITY IN EDUCATION

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Abstract

Gender equity refers to treating each gender equally and in accordance with their specific needs. One gender is not equal to another in terms of gender equity. By ensuring equity and justice in the allocation of resources to all genders, it seeks to enable equal opportunity for all genders to overcome their historical and social disadvantages. Encouraging justice in education is referred to as gender equity. Every student ought to be allowed to pursue their education without worrying about facing harassment or discrimination due to their gender. In addition, teachers need to be knowledgeable about how to motivate all students, regardless of gender, by fostering understanding of gender variations in education and teaching methodologies. On the other hand, important concerns like inequalities, discrimination, and disputes between sexes in the community are reduced when gender equality education is attached, whether formally or informally. The objectives of this study are to identify the primary obstacles to attaining gender equity in education, to emphasize the significance of gender equity in achieving gender equality, and to explicitly or implicitly incorporate gender education into the curriculum. In 2023, key informant interviews and documentary analysis were employed in this work to accomplish its goals. The study's conclusion is that, despite the fact that current laws and customs recognize gender equality, some gender discrimination still occurs unintentionally in educational environments.

Key words: gender equity, gender equality, fairness and justice, discrimination.

Introduction

Equity, in its simplest terms, means meeting communities where they are and allocating resources and opportunities as needed to create equal outcomes for all community members. Gender equity means respecting all people without discrimination, regardless of their gender. It also means addressing gender inequalities that limit a person's ability to access opportunities to achieve better health, education and economic opportunity based on their gender. Gender equity is important because, historically, societies around the world have deemed females, transgender people, and nonbinary people as "weaker" or less important than males. Two guiding principles are at the core of gender equity: fairness and impartiality. Fairness has to do with just treatment without favoritism or prejudice, while impartiality is defined as treating all parties equally. Gender equity is important because it ensures opportunities are not limited on the basis of gender. If true gender equity can be reached in education all students will be able to encounter equitable access and use of resources, Equitable participation and Safety or freedom from violence. Throughout the world, devotion is focused on the status of women and the essential to improve opportunities for women and girls to participate in all aspects of economic, social and political life. Gender equity is the process of being fair to women and men. Although gender equality is the ultimate goal, it is only through gender equity that it can be achieved. This is to say, equity leads to equality. Gender Education can help to reduce the risk of gender-based violence and promote gender equality in other areas of life. Education institutions such school and university have a special role in promoting gender equity between girls and boys. They are bound to ensuring that what is taught and learned contributes in a

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positive way to the lives of both girls and boys. It is important to ensure that female students and male students have equal access to the knowledge, skills and opportunity which are being provided by the educational policy. Developing gender equity which supports the interests of both girls and boys, requires the commitment of educators at all levels of education. It also aims to increase students' awareness of how even implicit or unconscious gender-based prejudices and biases prevent individuals from leading an ethical life and focuses on gender-based marginalization of women. This is not to suggest that men cannot be discriminated against. However, as recognized by the United Nations' Sustainable Development Goals (SDGs), women are overwhelmingly subjected to several types of gender-based discrimination and violence throughout the world. All human beings are born free and equal in dignity and rights, as stated in the Universal Declaration of Human Rights, which is addressed in depth in Integrity and Ethics. Ethical behavior involves treating people in this spirit, regardless of their gender. The aim and objectives of the research are to educate the importance of gender equity in achieving gender equality; to integrate the gender education in the curriculum expressly or impliedly; to determine the main challenges in achieving gender equity in education; to evaluate the key areas to monitor in ensuring that gender equity is being implemented in education, to provide girls and boys with education on healthy relationships and gender equality, to understand the ways in which people are marginalized based on gender, to reduce the risk of gender-based violence, to promote the gender awareness in educational institutions.

Research Methodology

This paper is designed by using literature review, interview, collecting data by using questionnaire that focuses on Gender, Equity, Diversity and Inclusivity. Analyses on national laws and policies, international human rights standards and rule of law principles. The mix of qualitative and quantitative research methodology is used in the analysis.

Findings

There are some unintentional gender discriminations in education. When it comes to admission to higher education institutions, gender discrimination ought to be eliminated.

Discussion

Definitions of Gender Equity and Gender Equality

Gender equity means respecting all people without discrimination, regardless of their gender. It also means addressing gender inequalities that limit a person's ability to access opportunities to achieve better health, education and economic opportunity based on their gender. Gender equity, defined by the European Institute for Gender Equality, is the "provision of fairness and justice in the distribution of benefits and responsibilities between women, men and all genders."⁴

Equality is a providing everyone with the same number of resources regardless of whether everyone needs them. In other words, each person receives an equal share of resources despite what they already have, or don't have.

Gender equality designates that the interests, needs and priorities of both women and men are taken into consideration, thereby recognizing the diversity of different groups of women and men. Gender equality is not a women's issue but should concern and fully engage men as well as women.⁵

⁴ <https://eige.europa.eu/>

⁵ <https://eige.europa.eu/>

‘Gender equality’ means equal outcomes for women, men and gender-diverse people. ‘Gender equity’ is the process to achieve gender equality. Gender equity recognizes that women and gender-diverse people are not in the same ‘starting position’ as men. This is because of historical and social disadvantages.⁶

Gender equality means that an individual’s rights, responsibilities and opportunities will not be determined by the sex they are assigned at birth. While gender equity is the equal treatment or treatment that might be considered equivalent in terms of rights, benefits, obligations, and opportunities.

Gender Discrimination

The term "discrimination against women" shall mean any distinction, exclusion or restriction made on the basis of sex which has the effect or purpose of impairing or nullifying the recognition, enjoyment or exercise by women, irrespective of their marital status, on a basis of equality of men and women, of human rights and fundamental freedoms in the political, economic, social, cultural, civil or any other field.⁷ Gender discrimination is when someone is treated unequally or disadvantageously based on their gender but not necessarily in a sexual nature. This includes harassment or discrimination based on sex, gender identity, or gender expression.

Laws Relating to Gender Equity

Article 10 of the Convention on the Elimination of All Forms of Discrimination against Women:

States Parties shall take all appropriate measures to eliminate discrimination against women in order to ensure to them equal rights with men in the field of education and in particular to ensure, on a basis of equality of men and women:

- (a) The same conditions for career and vocational guidance, for access to studies and for the achievement of diplomas in educational establishments of all categories in rural as well as in urban areas; this equality shall be ensured in pre-school, general, technical, professional and higher technical education, as well as in all types of vocational training;
- (b) Access to the same curricula, the same examinations, teaching staff with qualifications of the same standard and school premises and equipment of the same quality;
- (c) The elimination of any stereotyped concept of the roles of men and women at all levels and in all forms of education by encouraging coeducation and other types of education which will help to achieve this aim and, in particular, by the revision of textbooks and school programmes and the adaptation of teaching methods;
- (d) The same opportunities to benefit from scholarships and other study grants;
- (e) The same opportunities for access to programmes of continuing education, including adult and functional literacy programmes, particularly those aimed at reducing, at the earliest possible time, any gap in education existing between men and women;
- (f) The reduction of female student drop-out rates and the organization of programmes for girls and women who have left school prematurely;
- (g) The same opportunities to participate actively in sports and physical education;
- (h) Access to specific educational information to help to ensure the health and well-being of families, including information and advice on family planning.⁸

Article 26 of the Universal Declaration of Human Rights:

⁶ <https://16daysactivism.genwest.org.au/>

⁷ Article 1 of the Convention on the Elimination of All Forms of Discrimination against Women, 1979.

⁸ Article 10 of the Convention on the Elimination of All Forms of Discrimination against Women, 1979.

1. Everyone has the right to education. Education shall be free, at least in the elementary and fundamental stages. Elementary education shall be compulsory. Technical and professional education shall be made generally available and higher education shall be equally accessible to all on the basis of merit.
2. Education shall be directed to the full development of the human personality and to the strengthening of respect for human rights and fundamental freedoms. It shall promote understanding, tolerance and friendship among all nations, racial or religious groups, and shall further the activities of the United Nations for the maintenance of peace.
3. Parents have a prior right to choose the kind of education that shall be given to their children.⁹

Article 13 of the International Covenant on Economic, Social and Cultural Rights, 1966:

1. The States Parties to the present Covenant recognize the right of everyone to education. They agree that education shall be directed to the full development of the human personality and the sense of its dignity, and shall strengthen the respect for human rights and fundamental freedoms. They further agree that education shall enable all persons to participate effectively in a free society, promote understanding, tolerance and friendship among all nations and all racial, ethnic or religious groups, and further the activities of the United Nations for the maintenance of peace.
2. The States Parties to the present Covenant recognize that, with a view to achieving the full realization of this right:
 - (a) Primary education shall be compulsory and available free to all;
 - (b) Secondary education in its different forms, including technical and vocational secondary education, shall be made generally available and accessible to all by every appropriate means, and in particular by the progressive introduction of free education;
 - (c) Higher education shall be made equally accessible to all, on the basis of capacity, by every appropriate means, and in particular by the progressive introduction of free education;
 - (d) Fundamental education shall be encouraged or intensified as far as possible for those persons who have not received or completed the whole period of their primary education;
 - (e) The development of a system of schools at all levels shall be actively pursued, an adequate fellowship system shall be established, and the material conditions of teaching staff shall be continuously improved.
3. The States Parties to the present Covenant undertake to have respect for the liberty of parents and, when applicable, legal guardians to choose for their children's schools, other than those established by the public authorities, which conform to such minimum educational standards as may be laid down or approved by the State and to ensure the religious and moral education of their children in conformity with their own convictions.
4. No part of this article shall be construed so as to interfere with the liberty of individuals and bodies to establish and direct educational institutions, subject always to the observance of the principles set forth in paragraph 1 of this article and to the requirement that the education given in such institutions shall conform to such minimum standards as may be laid down by the State.¹⁰

Article 28 of the Convention on the Rights of the Child, 1989:

1. States Parties recognize the right of the child to education, and with a view to achieving this right progressively and on the basis of equal opportunity, they shall, in particular:
 - (a) Make primary education compulsory and available free to all;

⁹ Article 26 of the Universal Declaration of Human Rights, 1948.

¹⁰ Article 13 of the International Covenant on Economic, Social and Cultural Rights, 1966.

(b) Encourage the development of different forms of secondary education, including general and vocational education, make them available and accessible to every child, and take appropriate measures such as the introduction of free education and offering financial assistance in case of need;

(c) Make higher education accessible to all on the basis of capacity by every appropriate means;

(d) Make educational and vocational information and guidance available and accessible to all children;

(e) Take measures to encourage regular attendance at schools and the reduction of drop-out rates.

2. States Parties shall take all appropriate measures to ensure that school discipline is administered in a manner consistent with the child's human dignity and in conformity with the present Convention.

3. States Parties shall promote and encourage international cooperation in matters relating to education, in particular with a view to contributing to the elimination of ignorance and illiteracy throughout the world and facilitating access to scientific and technical knowledge and modern teaching methods. In this regard, particular account shall be taken of the needs of developing countries.¹¹

The Constitution of the Republic of the Union of Myanmar, 2008 provides the Union shall guarantee any person to enjoy equal rights before the law and shall equally provide legal protection.¹² The Union shall not discriminate any citizen of the Republic of the Union of Myanmar, based on race, birth, religion, official position, status, culture, sex and wealth.¹³

As stated above international conventions and the Constitution of the Republic of the Union of Myanmar guarantee the gender equity but there are some unintentional gender discriminations in education.

Conditions for admission to Higher Education Institutions (2023)¹⁴

Number for Admission

University	Male	Female
Naypyidaw Technological University	162	108
Yangon Technological University	220	180
Mandalay Technological University	235	185

Percentage for Admission

University	Male	Female
University of Community Health	80%	20%
Technological University (Mandalay) and other Technological Universities	60%	40%
The University of Dental Medicine	60%	40%
University of Nursing	10%	90%
Myanmar Aerospace Engineering University	70	30
Myanmar Maritime University	80	20
University of Forestry and Environmental Science	80	20
B.Sc (Sport)	60%	40%

¹¹ Article 28 of the Convention on the Rights of the Child, 1989.

¹² Section 347 of the Constitution of the Republic of the Union of Myanmar, 2008.

¹³ Section 348 of the Constitution of the Republic of the Union of Myanmar, 2008

¹⁴ Guide Book for admission to Higher Education Institutions, 2023.

Female percentage for admission of Geology Major is 10% of the total number for admission to the relevant University. Existing teacher of a geology department said that, it should not be unequal number between male and female students. Because also female students can perform necessary activities of Geology Degree.

Equal Percentage of Male and Female for Admission (50% - 50%)¹⁵

University	The Lowest Total Marks in English, Chemistry and Biology Subjects	
	Male	Female
University of Medicine 1 Yangon	256	264
University of Medicine 2 Yangon	256	264
University of Medicine Mandalay	256	264
University of Medicine Taunggyi	258	265
University of Medicine Magway	258	264

It can be seen that in the case of equal percentage of male and female students for admission, gender equity is lost. Due to the possibility of favoring the admission of less qualified male students over more qualified female students, this approach creates gender inequality. As a result, a large number of these female students who want to go to medical schools abroad do so, with some never stepping down in Myanmar.

Interviews (2023)

In order to know the awareness of stakeholder relating to gender equity this study used a qualitative design based on analyzing the views of stakeholders through interviews in 2023. The semi-structured interviews, each about 40 minutes long, were carried out with teachers and students from universities and secondary level.

Each of the twelve interviews with university teachers (male one and female eleven) were made face-to-face and via e mail. Their knowledge and awareness of gender equity in education can be seen as follows.

Gender equality is governed by provisions of human rights law in the areas of employment and education. However, boys are given preference in work. It is impossible for there to be university admissions policies that treat men and women differently. There ought to be no distinction made between men and women. Gender-specific restrictions are unlikely apply, unlike at other foreign colleges. Inequalities based on gender may unintentionally result from some tasks that must be completed in accordance with traditions. Girls may lose their enthusiasm and prospects and find it difficult to seek jobs if there is a lack of gender equity. Equal rights should apply to both genders. Students need to understand gender justice and equality. Men are the only ones permitted to work in physical jobs and enter certain parts of pagodas. At sporting competitions and in certain physically demanding activities, gender is not treated equally. Women are capable of engaging in physical activity as well. One way to describe gender diversity is "it is different since birth." Due to its benefits for social, economic, and familial issues, gender equity should be a distinct focus in curriculum.

Although gender differences are perceived as differences based on metabolism, opportunities may differ based on gender due to cultural assumptions. Each session covers study findings on gender differences from Biological, Psychological, and Social perspectives, even though there are less particular gender-related issues covered. For instance, the incidence

¹⁵ Ministry of Health, Notification dated 7-11-2023.

of psychological diseases varies by gender, as do the cognitive abilities associated with each gender, such as intelligence, verbal skills, and spatial ability. There are variations in gender roles and sports performances based on culture.¹⁶

Additionally, ten in-person interviews with students who are 13 years of age and older were conducted (four with females and six with males). They claim that their school does not discriminate against gender. But girls in Grade 10 are not permitted to play football; only boys are. The only girls permitted to play are those in lower grades. Schoolgirls who are roughly 15 years old reported that they don't want to learn about reproduction with boys. They are irritated and unable to completely participate in the session. They object to the current system for admittance to professional colleges because it does not fairly balance the needs of boys and girls. A female student must put in more effort than a boy student to get into the University of Medicine. They consider it to be unfair.

Following their interviews, university students (nine female and two male) revealed the following about their understanding of gender equity.

They have never been taught or heard of gender equity. Every student ought to be aware of gender equity. To ensure gender equality in the workplace and other settings free from discrimination, gender equality topics should be covered in curricula and syllabuses, whether directly or indirectly. Due to customs and beliefs, male and female students may experience unequal treatment at times. In addition, the majority of teachers believe that boys are intellectually and physically stronger than girls. However, female students desire a prejudice-free, equitable society. Unintentionally gender discrimination may occur as a result of outdated traditions and an archaic society. For instance, girls are not permitted to wear pants; if they do, they risk being penalized and unable to dress as they like.

Conclusion

In conclusion, one of the most common bases of exclusion, historically, has been gender. Consequently, females are overwhelmingly subjected to several types of gender-based violence and discrimination. This is not to suggest that male cannot be discriminated against them. However, since men have historically asserted power over women, structural inequalities place women at a disadvantage in terms of access to rights and opportunities. Women are subjected to biases and prejudice in the community, in their own homes, and in their work places in several ways, ranging from under payment and gender segregation to harassment and sexual assault. Hence gender equality and empowerment for women and girls has been designated as Goal 5 of the SDGs adopted by the United Nations in 2015. This is recognized by the United Nation's Sustainable Development Goals (SDGs), which set out to achieve gender equality and empower all women and girls by 2030. The Constitution of the Republic of the Union of Myanmar, 2008 has guaranteed not to discriminate based on race, birth, religion, official position, status, culture, sex and wealth. Equal rights and nondiscrimination are guaranteed by Article 26 of the Department of Higher Education's University Charter Template. When it comes to admission to higher education institutions, gender discrimination ought to be eliminated. After completing the Grade 12 exam, students are considered to be of legal age and are able to choose the subjects they want to learn. Furthermore, every student ought to be allowed to pursue their education without worrying about facing harassment or discrimination due to their gender. Therefore, teachers take care to prevent discrimination when discussing teachings by granting all students, regardless of gender, equal opportunities to speak and present. On the other hand, in order to encourage the motivation of all students, regardless of gender, they need to be knowledgeable about gender inequalities in education and about

¹⁶ Interview with Psychology Professor via e mail in 2023.

methods of teaching. Formal or informal gender education will help to address important issues like gender inequalities, discrimination, and conflicts within the community between the sexes. Additionally, the ethics of caring and respect for one another must be fostered. Higher education institutions ought to incorporate a gender development department. In order to achieve actual gender equality in schools and universities, there needs to be equal access to and utilization of resources, equal participation, and safety or lack of violence. As mentioned before, while female students are permitted to enroll in smaller percentages at universities like the University of Technology and Medicine than male students, some universities have female rectors. The 2024 International Women's Day theme, "Invest in Women: Accelerate Progress," states that education about women's rights and gender equality must be carried out. While achieving gender equality is the ultimate aim, gender equity is the only way to get there. Stated differently, equality follows equity.

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GENDER EQUALITY AND WOMEN'S RIGHT TO FREEDOM FROM VIOLENCE

Khine Myat Tun¹, Khin Myo Win², May Moe Thu³

Abstract

Men and women should have equal authority and access to chances for personal growth, education, and financial independence. This is known as gender equality. Living without violence is a fundamental human right for all women. When males are more powerful than women and can exert control over them in various areas of life, there is gender inequality. Gender inequality, which includes inflexible gender roles, norms, and hierarchies, unequal power interactions between men and women, and the socialization of women into lower status, is the root cause of violence against women. The term "violence against women" refers to any act of gender-based violence that causes physical, sexual, psychological, or economic harm or suffering to women. It also includes threats of such acts, coercion, or arbitrarily depriving women of their freedom, whether the acts take place in public or in private. Throughout their lives, women have been the target of violence as a result of historically uneven power dynamics between men and women. These include insufficient attempts by public authorities to raise knowledge of and uphold existing laws and the women's lack of access to legal information, assistance, or protection. Women who experience violence against them have less access to resources, services, and social activities in all spheres of their lives. Preventing violence against women requires a strong emphasis on advancing and attaining gender equality. States have a duty to end violence against women and take reasonable precautions to avoid such flagrant abuses of women's human rights, particularly as a signatory to international treaties. Since the government of Myanmar also ratified the CEDAW Convention in 1997, special legislation is required to advance the rights of Myanmar women to equality and to stop threats of violence.

Keywords: Gender Equality, Women's Rights, Freedom from Violence

Introduction

When treated equitably, people have equal chances and resources. Nations must ensure gender equality. On December 10, 1948, the UN General Assembly passed the Universal Declaration of Human Rights, which included gender equality. Gender inequality occurs when one sex or gender is consistently favored over another. Sex discrimination violates the human right to gender equality. All forms of discrimination against women must be abolished, and barriers to women's rights and equality must be removed. One of the biggest challenges is violence against women. According to the Beijing Platform for Action, "Developing a holistic and multidisciplinary approach to the challenging task of promoting families, communities, and States that are free of violence against women is necessary and achievable." Violence against women stems from historically uneven power dynamics that led to men's dominance, discrimination, and the stifling of women's progress. It is both a cause and consequence of gender inequality and is an abuse of the power imbalance. It perpetuates the idea that women

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are inferior and that males have more authority than women. Violence against women enforces gender roles and norms by assuming men should control women and that women are inferior to men. Children and women are most harmed by violence. Gender inequality is the main source of violence against women because it normalizes men using violence to preserve their authority. This research underscores the necessity for a gender-equal society with universal human rights and equal access to opportunities, resources, and freedoms.

Research Question:

1. As a signatory to CEDAW, does Myanmar's Laws protect women against gender discrimination and violence in line with human right standards?

Gender Equality

The socially created traits of males, women, girls, and boys are referred to as gender. This encompasses the expectations, customs, and roles that come with being a woman, man, girl, or boy, as well as interpersonal relationships. When people are treated equally, they have access to the same opportunities and resources. Gender equality entails that an individual's rights, duties, and opportunities will not be contingent on their gender, age, race, or location—rural or urban, white or black. It is essential to the realization of everyone's human rights and is inextricably tied to sustainable development. Gender equality aims to create a society where men and women have equal rights, duties, and opportunities in all areas of life.

Nature of Gender Equality

'Gender equality' entails equal outcomes for women, men, and gender-diverse persons. Equality implies treating everyone equally, regardless of differences. Equity implies everyone gets what they need to prosper.⁴ Equity recognizes that we all start from different places and must address inequities, whereas equality entails giving everyone the same.⁵ Gender equality is "women and men, and girls and boys, enjoy the same rights, resources, opportunities, and protections," according to the United Nations Children's Fund (UNICEF). It is not necessary for women and men, or girls and boys, to be identical or to get the same treatment.⁶ The process of treating men and women fairly is known as gender equality. To maintain equity, it is frequently necessary to provide methods and measures that make up for the historical and social disadvantages faced by women, which hinder them from competing on an equal footing with males.⁷ Gender equality improves community safety and health by reducing violence against women and girls.⁸ The training course Gender Equality in the 2030 Agenda for Sustainable Development seeks to raise knowledge of women's empowerment and gender equality concerns in relation to the 2030 Agenda for Sustainable Development.⁹

Gender Discrimination

Understanding bias requires distinguishing "sex" from "gender". Gender and sex are often confused in social practice. People begin to believe gender inequality is biological rather than social. Separating these beliefs shows that male superiority is cultural, not biological. Equality means everyone is born free and equal. For equality, everyone must have the same rights and respect. Everyone deserves fairness. This suggests that public officials should not discriminate or arbitrarily apply or enforce laws, policies, or programs. A crucial part of equality is non-discrimination. It assures no rights are denied based on race, gender, sexual

⁴ <https://risetowin>

⁵ <https://www.nacweb.org>

⁶ UNICEF, Gender Action Plan, 2021-2025, Jul 1, 2021.

⁷ <https://www.unfpa.org>

⁸ <https://www.vic.gov.au>

⁹ <https://portal>

orientation, language, religion, political opinion, national or social origin, property, or birthplace. Other reasons may also make discrimination illegal. These reasons include age, nationality, marital status, disability, residence, and sexual orientation. The right to equality and non-discrimination has both positive and negative aspects, including the obligation to protect and promote the realization and enjoyment of these rights for all.¹⁰ CEDAW defines discrimination as any sex-based distinction, exclusion, or restriction that prevents or undermines women's political, economic, social, cultural, civil, or other rights and freedoms, regardless of marital status (Article-1).

Gender-based Violence (GBV)

Violence based on gender, usually for not following gender norms, is called gender-based violence. This violence generally stems from gender power abuse. GBV may affect anyone, even men and boys who aren't manly. Women are the main target. One of the most serious human rights breaches in all cultures is gender-based violence, which stems from gender inequity.¹¹ Gender-based violence focuses on gender. Men and women face gender-based violence, but women and girls are more vulnerable.¹² Gender-based violence includes discrimination and human rights violations. Gender-based violence increases gender inequality. Gender-based violence and violence against women are sometimes used interchangeably since men generally abuse women and girls.¹³ Women are disproportionately affected by private and public gender-based violence. From online hate speech and verbal abuse to rape and murder, gender-based violence can be sexual, physical, verbal, psychological, or socio-economic.¹⁴ Many factors contribute to the prevalence of gender-based violence, including the perpetrator's sense of entitlement, control, and power; drug abuse; cultural norms and traditions about masculinity and femininity; and victim-blaming behaviors on the part of the perpetrator.¹⁵ UNFPA is attempting to incorporate psychosocial and mental health treatments into its offerings for victims of gender-based violence.¹⁶

Violence against Women

Violence is not easy to define because it occurs in different forms. Violence against women happens in all cultures and religions, in all ethnic and racial communities, at every age, and in every group. Violence against Women has a long history though the incidents and intensity of such violence has varied over time and even today varies between societies. According to the UN Declaration on the Elimination of Violence against Women 1993, violence against women is a social (economy, health, welfare, politics) problem and not a private problem of each individual woman or a family. It means any act of violence that results in or is likely to result in physical, sexual or psychological harm or suffering to women.

Common Forms of Violence

The WHO defines violence as the worldwide use of physical force or power, whether actual or threatened, against oneself, another person, or a group or community to cause harm, injury, death, psychological distress, underdevelopment, or deprivation.¹⁷ Women and girls are abused in numerous ways, depending on their communities, nations, cultures, and religions.

¹⁰<https://www.ag.gov.au/rights-and-protections/human-rights-and-anti-discrimination/>.

¹¹An Introduction to Human Rights in Southeast Asia, Volume-2, Southeast Asian Human Rights and Peace Studies Network (SEAHRN), p.39.

¹² Ibid., p.46.

¹³ <https://eige.europa.eu>

¹⁴ Council of Europe, combating violence against women: Stocktaking study on the measures and actions taken in Council of Europe member States, 2006.

¹⁵ <https://www.wvi.org>

¹⁶ <https://www.unfpa.org>

¹⁷ <https://www.who.int>

¹⁸Violence against women can be sexual, emotional, physical, or pecuniary. It's important to recognize its main phrases and, if possible, their variations.¹⁹

(a) Domestic Violence

"Domestic violence" refers to any acts of physical, sexual, psychological, or financial abuse that take place inside a family, domestic unit, or between partners or spouses, regardless of whether the offender and victim live together.²⁰ The phrase "domestic violence" refers to violence against women and girls by other family members as well as intimate partners, including cohabiting partners, whether the abuse takes place within or outside the house. Actually, rather than referring to the location of the violent act, the term "domestic" describes the kinds of relationships that are involved. In both developed and developing nations, harsh treatment and punishment inside the family are prevalent practices. Domestic violence against women has serious negative effects on women as individuals, as well as on families, communities, and the state from a physical, psychological, social, and financial standpoint.²¹ Domestic violence in our nation is caused by power abuse between spouses and families. The following are some of the sentiments from interviewing women who have experienced domestic violence.

Some feelings of Domestic Violence against Women

Women regard patience and silence as a marital duty, and they suppress their sorrows and wounds.
Women who receive help from a circle of friends tend to protect themselves from the danger of an aggressive husband.
Some women refused to fight their abusive husbands, but most were bitterly wounded and consequently understood the power imbalance between them.
Women used to talk about violence with their friends and their family members. But they usually get a lot of different advice.
When the victims of violence filed the report to the administrators or the police station, they took action on a few cases. Sometimes they do nothing. It was found that when they reported the case to the authorities concerned or legally supportive services. Because crime reporting is not confidential, social prevention services are unable to function. Women believe that a child should live with both parents.

(b) Mental Violence

Psychological and emotional abuse are synonymous with mental abuse. Any deliberate behavior that gravely compromises the psychic integrity of another individual by compulsion

¹⁸ UN Women, United Nations Entity for Gender Equality and the Empowerment of Women, The United Nations Fourth World Conference on Women, Beijing, China-September 1995.

¹⁹ National Domestic Violence Hotline, National Center for Victims of Crime, and WomenLaw.org.

²⁰ Article 3 (b), Council of European Convention on preventing and combating violence against women and domestic violence, 12 April, 2011.

²¹ Gender equality and women's rights in Myanmar: A situation analysis, Mandaluyang City, Philippines, Asia Development Bank, 2016. P.139.

or threats is considered mental violence. When someone is mentally abused, they may behave in ways that are intended to manipulate, control, or isolate them. Emotional abuse is another term for psychological abuse. Any action that harms a person's mental health. Examples of psychological violence include coercion, verbal insults, slander, and harassment.²² Different forms of psychological attacks exist. They include emotional abuse, psychological abuse, seclusion, abusing children, and financial exploitation. Psychological violence is when someone takes control of another person by intimidating them and instilling dread in them.

Types of Mental Violence

Types of Mental Violence	Interviewing with victims
Yelling	'If he's angry, he'll shout at me loudly.' (33 years old teacher) 'If he's drunk, he would scream and yell at our children.' (45 years old vendor)
Threats of bodily or financial harm	'He always threatened me and told me that he was going to beat me to death.' (30 years old maid) 'If he has money, sometimes he gives it all. But if he gets angry, he asks for everything,' (43 years old housewife) 'If he doesn't beat me, he breaks things.' (26 years old tailor)
Humiliation or insults, including in front of other people	'He uses abusive words in front of others and yells and screams.' (19 years old waitress) 'My husband is very cruel to me. He always insults and body shame me.' 'He defamed me with horrible words.' (33 years old housewife)
Abandonment	'He left me when our baby was a month old. He married another woman.' (30 years old staff) 'My husband left us several times. If I tell him that I am in urgent need of money, he will not come to us. He said we were not important.' (29 years old janitor)
Neglect	'During the ten years we were together, he went out with other women and ignored me. I have to pretend I don't know about it.' (41 years old seller)

(c) Physical Violence

When someone tries to control another person's behavior with an item or a portion of their own body, it is called physical violence. Any deliberate act of intentionally injuring or traumatizing another person or animal by physical contact is considered physical abuse. Physical abuse often affects children, but it can also happen to adults, as in the case of aggressive behavior at work or spousal abuse. Other phrases that are occasionally used include physical abuse, physical assault, and physical violence. Multiple abusers and victims may be involved in physical abuse. Sexual violence can occur in a variety of ways and in a wide range of contexts. Both psychological and bodily harm can result from violence.²³

²² Convention on preventing and Combating Violence Against Women and Domestic Violence. Council of Europe, 2011.

²³ <https://www.who.int/iris/bitstream>.

Types of Physical Violence

Types	Interviewing with victims
Hitting	'He beat me because I didn't prepare food for him. And then he slapped me and punched me in the face.' (26 years old staff)
	'He hit me on the head with a chair. It is lucky that I did not die of those injuries.' (22 years old maid)
Kicking	'I did not give him money when he asked me. When I told him no, he kicked me and my hand broke.' (22 years old worker)
Strangling	'He hit me and put his hands around my neck and tried to strangle me.' (24 years old worker)
Physical abuse during pregnancy	He always hit me and kicked me. 'I was three months pregnant at the time.' 'He kicked me like a ball when I was pregnant.' (30 years old vender)

(d) Sexual Violence

When someone is coerced into engaging in sexual intercourse against their will, it can lead to sexual assault. Sexual violence is frequently experienced during military conflicts and times of war. In particular, it is common practice to utilize sexual torture and rape as tools to weaken the opposition. When a sexual act is performed or attempted on a victim who has not freely provided consent or who is incapable of giving consent or refusing, it is considered sexual violence. Sexual assault also includes coercing or compelling a victim to do sexual actions with a third party.²⁴

Types of Sexual Violence and Martial Rape

Sexual Violence and Martial Rape	Interviewing with victims
Forced sex acts	'He made me stay in many positions. I think he imitated watching foreign movies. When I refused to have sex, he accused me and satisfied himself anyway.' (30 years old housewife)
Physical or verbal abuse if women refused to have sex with their husbands	'When I refused to have sex, he would become aggressive.' "Have you found another person? You don't want to have sex with me because I'm a leper to you?" (28 years old staff)
Sex when she was unable to resist	'He put sleeping pill in my coffee. Drowsily fell asleep. I fell asleep. When I woke up, he was having sex with me.' (20 years old seller)
Continued sex when asked to stop	I yelled but he did not stop. When I resisted, he grabbed my hands and feet, and had sex with me.' (22 years old housewife)

²⁴ WHO Guidelines for Medico-care of victims of Sexual Violence.

(e) Socio-economic Violence

Economic violence occurs when people or organizations prey on the economically downtrodden. When someone is made financially dependent, either intentionally or unintentionally, through complete control over their financial resources, access to money is withheld, or attendance at work or school is prohibited, this is known as economic violence. Socioeconomic violence often takes the form of robbing the victim of their wages, preventing them from having a second source of income, or physically abusing them in a way that renders them unsuitable for employment.²⁵

Types of Economic Abuse

Types	Interviewing with victims
Denying food/basic	‘Our children did not get enough nutrition. The money I earned was not enough. My husband did not give his money to me. He just used it for himself and his drink every day.’ (39 years old teacher)
When her husband realized that he did not have enough money, he refused to fund the household expenses.	Sometimes, there were times when he refuses to give me money, ‘when I needed some. He didn’t bring any money back home. I’m in debt, he did not know that.’ (25 years old women)
Controlling access to employment	‘He did not allow me to work. I also wouldn’t dare to leave my children.’ (26 years old staff)
Stealing from wife	‘My husband takes money from me and does nothing but spend it outside the family.’ (33 years old seller)

Main Causes of Violence

Some women perpetrate gender-based sexual harassment, physical or psychological threats, abuse, and coercion. Violence affects women of all ages. Eventually, they suffer unneeded trauma, impairment, damage, and death. Acts of violence against women is of committed by individuals, groups, and communities. Mental, physical, and social issues plague them. One in three women worldwide will be physically or sexually abused.²⁶ In Asian and South-East Asian countries, women are still oppressed by tradition, custom, and religion. Violence against women is caused by men's domination over women, who view their mistreatment of women as normal.²⁷ Human rights are a worldwide issue, and men and women should have equal freedom, resources, and social rights. The government, police, and non-governmental organizations have made attempts to reduce domestic violence, yet the problem remains severe.

Consequences of Violence against Women

Abuse by husbands or other men harms women's mental, physical, and sexual health. These consequences harm women's health, ability to work within and outside the home, ability to raise children, and ability to participate in society. A Myanmar proverb says, "You will love your wife more if you beat her until her bones are broken." Violence against women data shows how this aphorism hides and distorts the reality of violence in women's lives. Women

²⁵ <https://www.coe.int/en/web/gender-matters/socio-economic-violence>.

²⁶ <https://www.unfpa.org/gender->

²⁷ Behind the Silence, Violence Against Women and their Resilience Myanmar, Research Report, Gender Equality Network, February 2015, p.13.

interviewed highlighted the psychological, physical, sexual, and social effects of abuse. Every woman who had been abused described many repercussions on her and her children's health. Women often highlighted the mental impacts of violence. Mental health issues lower women's quality of life, even if they're not obvious. There are all forms of abuse—verbal, physical, sexual, and non-partner sexual violence—harm mental health. Several women complained about others' indifference to violence's mental health impacts.²⁸

Consequences of domestic violence against women

Women experience violence from their partners and other men, psychologically and physically. Many physical and sexual health consequences are experienced.
Those consequences have a negative impact on women's lives and their health. Ability to work indoors and outdoors; It affects their ability to care for children, and their active participation in society
Although the mental health consequences are not always visible or obvious, abuse can seriously affect women's mental health, leading to depression, It leads to emotional stress and in some cases suicide attempts. Some women experienced social consequences, including community stigma and social isolation, which affected their ability to talk about their experiences and find support.
Children often witnessed violence against their mothers or experienced abuse themselves.

Women's Rights Movement

Women have human rights. They address health, education, political engagement, economic well-being, and violence, among other issues. Women's full and equal enjoyment of all human rights and freedom from discrimination are essential to human rights, peace and security, and sustainable development. The Beijing Declaration and Platform for Action²⁹ state that countries must defend and promote human rights as their top priority and that the UN must do so. The Platform for Action firmly grounds gender equality within a human rights framework and emphasizes State accountability for delivering on promises. Women and men have equal rights under the UN Charter. All important international human rights accords prohibit sex discrimination. All important international human rights accords prohibit sex discrimination.³⁰ While the history of the women's rights movement focuses on two events, women's suffrage in Europe in the early 1900s and feminism in the 1960s, there have been discussions and movements for additional rights throughout history. Ohn Locke and Thomas Paine explored women's rights during the European Enlightenment when human rights originated. Women convened national and international conferences and advocated for war, equality, the right to vote, and alcohol prohibition throughout the 19th and 20th centuries. Perhaps the most famous early movement was the Suffragettes, who fought for women's suffrage. The ILO's constitution preamble also supports equal compensation for equal effort.³¹ In the 1960s and 1970s, the women's movement spread worldwide. As humans, women and

Behind the Silence, Violence Against Women and their Resilience Myanmar, Research Report, Gender Equality Network, February 2015.p.38.

²⁹ <https://beijing20.unwomen.org>

³⁰ UN Women, United Nations Entity for Gender Equality and the Empowerment of Women, The Beijing Platform for Action Turns 20, Human Rights of Women.

An Introduction to Human Rights in Southeast Asia, Volume-2, Southeast Asian Human Rights and Peace Studies Network (SEAHRN),p.32.

girls deserve an education, a safe living, a decent income, and the right to vote. Despite their human rights, many women and girls worldwide are denied them. Women's rights must be recognized, safeguarded, and realized to ensure society's well-being and rights.

Effects of Legal Protection on Women in Myanmar

Many of the laws that relate specifically to women are outdated and sometimes explicitly discriminatory, not only tolerating gender discrimination but arising out of it. In Myanmar, though there has been no specific law to cure the violence against women, some provisions in the general laws that have already been enacted could support equal rights with men. There are different kinds of laws relating to the protection of violence and equal rights for women.

Protection on the Violence Against Women under CEDAW Convention

The Convention on the Elimination of Discrimination Against Women is the primary international women's rights law. The UN General Assembly passed the CEDAW Convention on December 18, 1979, and it took effect in 1981. A total of 189 states approved its 30 articles. Myanmar government papers address women and labor, usually to enhance family income. Substance equality, non-discrimination, and government commitments against violence against women are CEDAW's main aims. Any discrimination against women regardless of marital status, that hinders their ability to exercise their human rights and fundamental freedoms is considered "discrimination against women."³² The CEDAW treaty represents a significant advancement in defending women's human rights. The main takeaway is that men and women must have the same rights in every area of their lives. Myanmar is required by CEDAW to end all kinds of discrimination against women and do "due diligence" to ensure that rights are not violated.

Myanmar Customary Law for Violence Women Victims

Most legislation is enacted, save the Myanmar Customary Law. Like other laws, the Myanmar Customary Law is binding. Most laws favor gender equality. Myanmar women generally try to divorce their husbands if they can no longer bear their abuse. That's her only way out. Myanmar Customary Law recognizes three types of divorce. There are mutual consent, husband's priesthood, and marital fault divorce. There are two types of marriage flaws for divorce: ordinary and terrible or serious. Ordinary marital fault includes misrepresentations, husband adultery, desertion, and cruelty. Serious marriage defects include wife adultery and abuse. According to Myanmar customary law, violence against women is protected.³³ Myanmar Buddhist women and non-Buddhist men can marry under the Myanmar Buddhist Women's Special Marriage Law 2015.³⁴ Marriage does not grant the right to inherit from the first and second wives.³⁵ As Myanmar has no special statute regarding violence against women, the best recourse for a married woman who was abused is divorce under the Myanmar Customary statute. Thus, even if her spouse was nasty or violent, she can seek divorce in court. Human rights-violating violence may not be in accordance with Myanmar Customary Law.

Protection on Women under Penal Code

The broad Penal Code protects Myanmar's women and girls against physical and emotional abuse. The Penal Code criminalizes the abuse and transfer of women and girls. Myanmar followed the India Penal Code, established by the first India Law Commission. Since 1 May 1861, Myanmar has followed this Code. The Penal Code criminalizes the abuse and transfer of women and children. Assault occurs when someone makes a gesture or preparation

³² Article 1 of the Convention on the Elimination of all Forms of Discrimination against Women (CEDAW) 1979.

³³ U Mya Sein, "Myanmar Customary Law", 10th edition, 2004, p.129-130.

³⁴ Section 2 of the Myanmar Buddhist Women's Special Marriage Law 2015.

³⁵ Ibid., Section 16.

with the intent or knowledge that it will cause others to suspect him of using unlawful force.³⁶ The Penal Code lists miscarriage-causing offences in Sections 312–312. The Penal Code included harm crimes under Sections 319–338. The Penal Code listed criminal force and assault charges in Sections 349–358. Myanmar's Penal Code penalizes all offenders according to the law. The Penal Code is one of the most significant laws protecting women from all sorts of assault. The Penal Code is one of the most significant laws protecting women from all sorts of assault. A Penal Code provision for violence against women is lacking. There are no Myanmar women-specific provisions. Myanmar's criminal law may not be enough to address violence against women, which is a human rights violation.

Provisions under the Code of Criminal Procedure for Women

The following parts of the Criminal Procedure Code protect women against assault. When searching for a lady, another woman must do so with dignity.³⁷ Myanmar's Criminal Court recognizes crimes in three ways. A magistrate can take cognizance of an offence based on a complaint, a written report by a police officer, information from a non-police officer, or personal knowledge or suspicion.³⁸ Section 552 of the Code of Criminal Procedure protects women against assault. In the case of a woman's kidnapping or wrongful imprisonment, the District Magistrate may order her immediate release and enforce compliance after investigating the allegation.³⁹ Under Section 561 of the Criminal Procedure Code, only District Magistrate can take cognizance of rape offenses involving a man and his wife and commit the man for trial. Subsection 2 If a District Magistrate directs a police officer to investigate an offense described in sub-section (1), no police officer below the rank of police inspector shall be employed to make or participate in the investigation. If a death-sentenced woman is pregnant, the Supreme Court will postpone execution and may reduce the sentence to lifetime transportation.⁴⁰ Women and girls in Myanmar are protected against violence by the Criminal Procedure Code. Section 561 of the Criminal Procedure Code states that only a District Magistrate can try a man for raping his wife.⁴¹ The Code also protected pregnant women under section 382.

Rights of Women in 2008 Constitution

The Republic of the Union of Myanmar's 2008 Constitution states that the Union would ensure that everyone has equal rights under the law and will also give equal protection against it.⁴² It further declares that the Union will not treat any citizen of the Republic of the Union of Myanmar unfairly on the grounds of money, sex, official rank, official position, race, or religion.⁴³ Women should be paid the same wages and have the same rights as men for work of a comparable kind.⁴⁴ According to the legislation, mothers, kids, and expecting mothers all have equal rights.⁴⁵ It states that nothing shall harm a person's life or personal freedom unless it complies with current laws.⁴⁶ According to the law, the accused is entitled to a defense.⁴⁷ There was no explicit definition of discrimination against women in the 2008 Republic of the

³⁶ Ibid., Section 350

³⁷ Section 52 of the Criminal Procedure Code.

³⁸ Section 190 of the Criminal Procedure Code

³⁹ Ibid., Section 552.

⁴⁰ Ibid., Section 561.

⁴¹ Ibid.

⁴² Section 347 of the Constitution of the Republic of the Union of Myanmar 2008.

⁴³ Ibid., Section 348.

⁴⁴ Ibid., Section 350.

⁴⁵ Ibid., Section 351.

⁴⁶ Ibid., Section 353.

⁴⁷ Section 375 of the Constitution of the Republic of the Union of Myanmar 2008.

Union of Myanmar Constitution, despite the assumption that it grants equal rights to men and women as formal illustrations in other constitutions. The Constitution does not cover the definition of discrimination against women or the distinction between direct and indirect discrimination. Furthermore, section 352 of the Constitution expressly states that specific jobs are solely appropriate for males, implying that gendered cultural conceptions limit the professional options available to women.

Anti-trafficking in Persons Law

The Anti-trafficking in Persons Law 2022 shields women in Myanmar against the crime of human trafficking. As per the Anti-trafficking in Persons Law, Section 3, the term "trafficking in persons" refers to the recruitment, transfer, sale, purchase, lending, hiring, harboring, or receipt of persons who have committed any of the following acts to abduct, abuse, or using force against another person, abduction, fraud, deception, abuse of power or position, taking advantage of a person's vulnerability, and giving or receiving money or benefits in exchange for the consent of the person in control of another person.

In accordance with Section 16 of the Anti-trafficking in Persons Law, the Central Body and pertinent Working Groups are required to -

- (a) provide exceptional protection of their identity and dignity, as well as the necessary security and support, to women, children, and youth who are victims of human trafficking.
- (b) take action to return them to their guardian or parents if examination reveals that this is in their best interests. When there are no conditions for returning to the parent or guardian or improper conditions for returning,
- (c) seek alternative safe and secure protection.
- (d) Make arrangements that priorities their age and maturity-appropriate freedom of choice and expression of their desires.
- (e) implement particular plans for treating their psychological and physical injuries, including vocational training based on knowledge and skill, medical evaluations, and therapy administered with their permission.
- (f) protect them by maintaining their privacy and any information about them.

Although the Persons Law's anti-trafficking provisions safeguard women's rights against trafficking, these protections are insufficient for trafficked women, who also require a review of this law's punishment provisions section in order to receive more effective punishment. This study should result in recommendations on how to create an efficient legal system or mechanism and how to put preventative measures in place for victims of violence at both the family and community levels.

Conclusion

Women's lack of power and equal involvement in society are mostly caused by violence against women and the fear of violence. But they don't get reported or recorded very often, so they don't get fixed. When stress and violence rise in society as a whole, as they have in the transition region, women's safety at home, at work, and in the community is often greatly compromised. It is a serious and wrong abuse of human rights that hurts women in Myanmar's health, ability to make a living, and chances. Gender stereotypes and harmful cultural practices make it hard to stop discrimination and make sure that men and women have real equality in Myanmar. It is more possible for women and girls from vulnerable groups to have their basic human rights violated than for men, even men from the same vulnerable groups, and for other women. The general public doesn't know much about violence and its effects. This is made worse by the fact that there isn't a lot of information available at the national level about the amount, causes, and effects of violence against women, broken down by age, disability, race, and other factors. More and more people in civil society, the government, and other countries are becoming aware of how big this problem is across the whole country. According to this study, the government should come up with ways to make the legal system work better and

ways to stop crime in families and communities. It is up to the appropriate government agencies and organizations to set up successful national-level mechanisms in line with international standards and CEDAW so that the legal mechanisms for protecting women's rights and ending gender inequality can be implemented.

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LEGAL PROTECTION OF COPYRIGHT IN MYANMAR

Khin Kay Khaing¹

Abstract

Intellectual Property, IP refers to the literary and artistic work created by the mind, ranging from artwork to commercial patents and trademarks to newly developed computer programming work. The intangible capabilities of the human mind find manifestation through Intellectual Property Rights (IPRs), offering creators in Myanmar the opportunity to benefit from their inventive efforts. These rights, akin to other property rights, empower innovators by safeguarding patents, trademarks, and copyright works. In a developing context, the strategic utilization of IPRs in Myanmar holds significant advantages, fostering economic growth and facilitating the transfer and development of technology and science within the country. Copyright, which is a branch of the Intellectual Property Rights, protects the literary and artistic work of the creator by granting the creator access to the protection of their work and ensuring the benefits reached to the creator. Myanmar also sets up and implements laws and regulations to protect the intellectual property rights, particularly copyrights of its citizen. Despite the existence of the copyright law since 1914, the newly enacted 2019 Copyright Law have included significant changes to better benefit the residents of Myanmar regarding copyrights and related rights matters. Thus, this study explores international instruments on copyright as well as the status and practices of copyright in Myanmar by referring to the historical law and the recently promulgated 2019 Copyright Law and to protection and get remedies for infringement of copyrights.

Keywords: Intellectual Property Rights, Copyright Law in Myanmar, 2019.

Introduction

The Intellectual Property (IP) in its most basic sense is a thing created by a person with his own intellect. Its meaning will become broadly extended if such an intellectual property contains commercial value, productivity or benefit to human.

Intellectual property, IP refers to creations of mind the entirety from works of art to innovations, literary and artistic works, designs, and symbols, name and images used in commerce. Intellectual property rights are exclusive rights given to the result generated by intellectual activities of human being and they mean intangible rights which have economic values. According to the World Intellectual Property Organization, absolutely “Intellectual Property Right, encompassing copyrights and trademarks are considered distinct property rights. These rights empower creators of intellectual property to derive benefits from their work or investment by granting them control allows them to dictate how their creations are used, ensuring fair compensation and protecting their creative or innovative endeavors.

Copyright relates to literary and creative creations, such as books, song, artwork and sculptures, films, and generation-based totally completely works, inclusive of computer programs and digital databases. It is a kind of the Intellectual Property that gives its owner the exclusive rights to replicate and make a contribution an innovative work usually for a limited time.

Myanmar, like different countries across the world, also set up and implements legal guidelines and regulations to protect intellectual property rights. Myanmar did indeed adopt a new copyright law in 2019, replacing the outdated 1914 Copyright Act. This was a significant step to modernize intellectual property regulations in the country. IP is also being evolved,

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which includes the status of a national IP office, a new IP court, and collective management organization. The new copyright law introduces many important modifications.

Objective of the Study

The objectives of the study research paper are as follows-

- To understand the nature of Copyright Law
- To study the basic of copyrights and related rights
- To study the legal protection of copyright in Myanmar

Research Methodology

The study was carried out through desk reviews of secondary data sources can provide valuable insights. Exploring international instruments on intellectual property rights and copyrights laws in Myanmar sounds interesting.

Findings and Discussion

Nature of Intellectual Property

Intellectual property refers to property rights in creations of the mind. Intellectual property rights refer to the legal rights given to the inventors or creator to protect his invention or creation for a certain period of time. These Legal rights confer an exclusive right to the inventor or creator or his assignee to fully utilize his invention or creation for a given period of time. Just like physical goods, intellectual property can be protected against theft by other people. Intellectual Property comprises two main branches, industrial property and copyrights. Industrial property includes trademarks, industrial designs, patents and geographic indications and copyright includes literary and artistic works and neighboring rights.²

Property indeed encompasses the right to use, and dispose of tangible assets like land or chattels. Tangible property involves physical items with a specific ownership. Intellectual property, however, differs as it isn't constrained by the types of excludability.³

- **Trademark;** Protect distinctive symbols, names, or expressions identifying products or services.
- **Industrial Designs;** Safeguard the visual design of objects, enhancing their aesthetic or ergonomic aspects.
- **Patents;** Grant exclusive rights to inventors for their inventions.

Indeed, intellectual property encompasses a board spectrum, including literary, artistic, and scientific works. It reflects the culmination of human creativity and innovation, influencing the products and services we encounter daily. The evolving landscape of technology, globalization, and societal changes has shaped and redefined the concept of intellectual property over time "Related rights" further extend protection to performances, phonograms and broadcast, showcasing the intricate web of creations safeguard under intellectual property law.⁴

The Intellectual Property in its maximum primary experience is an element created by means of a person together with his very own mind. Its which means turns into extensively extended if such an intellectual property includes commercial fee, productivity or advantage to human.

² <https://www.law.georgetown.edu>

³ C L Bansal, Business and corporate law, 2010, P-723

⁴ Ibid.

Historical of Copyright in Myanmar

Myanmar isn't always signatory country inside the Berne Convention. Although Myanmar wishes to enforce and subjects to between Article 1 and 12, Article 19 of the Paris Convention and the phrases of TRIPs by no later than 1st July 2021.

It's interesting to note Burma's historical Copyright Act of 1911, rooted in the UK's 1911 Copyright Act. Despite not being a signatory to the Berne Convention, Burma is part of the World Intellectual Property Organization and has signed the TRIPs Agreement. The absence of a formal copyright registration process and the Act's non-recognition of foreign copyrights reveal unique aspects of Burma's intellectual property landscape. The ongoing efforts, including the draft copyright law based on the WIPO model, demonstrate a commitment to modernizing and aligning with international standards. The expected adoption in May 2019 signifies a step towards updating Burma's copyright framework.

International Instruments on Copyright

Provided a comprehensive overview of international copyright, highlighting key agreements such as the Berne Convention, TRIPs Agreement, WIPO Copyright Treaty.⁵ These agreements play crucial roles in extending copyright protection beyond national borders, fostering collaboration and respect for creators' rights globally. Any country can become its signatory, and the convention was adopted on September 9, 1886, and enforced from December 4, 1887, onward. Up to now, 181 out of 195 countries are signatories to the Berne Convention though Myanmar is not included. Three fundamental principles of the Convention are – (a) the same national treatment in copyright protection has to be given by other remaining member countries for the work produced in one of the member countries. (b) Automatic protection has to be granted. (c) When the work produced in one of the member countries has been used in other member country/countries, the work will be directly protected in the countries' legislation where the work is used.

The Trade-Related Aspects of Intellectual Property Rights agreement established by the World Trade Organization came into force on April 15, 1994. The TRIPS agreement covers many types of intellectual property including copyright, patents and trademarks, trade secrets, and so on. Any member country of the WTO is automatically obliged to follow the agreement even though a specific time for enforcement of the TRIPS Agreement was given. Thus, it can be said as the most fundamental international agreement on intellectual property rights. As Myanmar is also a member country of WTO since January 1, 1995, it is automatically bound by the TRIPS Agreement. Meanwhile, the TRIPS transition period for Myanmar to apply its terms was July 1, 2021. However, it has been extended from this time to July 1, 2034.

Article 12 of section 1 of the TRIPs Agreement outlines the duration of protection for works, stating that, besides photographic works or applied art; the protection lasts throughout the life of the creator and extends for fifty years after their death. Article 14(5) of the same section specifies that performers and producers of phonograms are protected for exactly 50 years from the start of production, ensuring a consistent timeframe for their rights.

The World Intellectual Property Organization Copyright Treaty (WCT) was adopted in 1996. It is a special agreement under the Berne Convention. What makes it unique from Berne Convention is the inclusion of specific economic rights in addition to the rights granted by the convention. Some examples of economic rights granted to authors are the rights to distribute, rent, and communicate to the public. The term of protection is granted at least 50 years for any

⁵ WIPO National Seminar on Intellectual Property, "the main international treaties administered by WIPO in the field of Copyright" Yangon, Myanmar, WIPO/IP/YGN/97/4,p.2.

kind of work eligible under the protection of this treaty. Furthermore, the WCT also handles copyright protection relating to computer programs and databases. The WCT was implemented in 2002. The treaty is available for WIPO member countries and European Community.

Intellectual Property Laws in Myanmar

The Union of Myanmar once British Colony certainly and inevitably needed to accept and apply the law in English. Evidently, relevant law as well as official ruling recognizing and enforcing the principles of intellectual property rights in Myanmar had timely advanced to a great extent.⁶ Some existing laws on or relating to intellectual property are Penal Code 1861, Merchandise Marks Act 1889, Registration Act 1909, Specific Relief Act 1877, Patents and Designs (Emergency Provisions) Act, Myanmar Copyright Law 2019, Control of Money Laundering Law 2002 and Television and Video Law, 2015.

Myanmar acceded to the World Trade Organization (WTO) in January 1995 and thus has to comply with the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIP Agreement). Consequently, Myanmar has the obligation to respect and abide by the provisions of the relevant Intellectual Property Conventions. As a result, intellectual property Laws need to ensure compliance with international and intergovernmental obligations of Myanmar. On 15th February 2019, the Pyidaungsu Hluttaw passed four intellectual property laws, specifically as Trademark Law, Industrial Design Law, Patent Law and Copyright Law. Enforcing Copyright Law on October 31, 2023, signals a recent legal development aimed at protecting intellectual property rights.

Definition of Copyright

Under Myanmar Copyright Law of 2019, copyright refers to the exclusive rights of the creators of a literary or artistic work.⁷ Section 2(j) defines Related Rights as the privileges of performers, phonogram producers, and broadcasting organizations outlined in Chapter 14 of the law. Section 2(k) specifies that creators of copyright include the original creator, someone who has acquired rights lawfully, and someone transferred as a creator according to regulations.⁸

The owner of related rights is defined as individuals or successors, including performer, phonogram producer, and broadcasting organizations. Copyright, in this context, pertains to the rights of intellectual creators in various forms such as books, paintings, or drawings, extending to the physical embodiment of these works.⁹

But a number of them exist without embodiment in a physical item. Exactly, copyright recognizes the creative efforts of authors, encompassing works like music, poems and other forms even before they are formally documented through musical notation or written words. The essence of copyright lies in granting the author the exclusive right to reproduce their literary creations and to prevent others from doing so. This legal protection extends to various cultural, informational, and entertainment productions, covering the creations of authors, playwrights, composers, artists, film directors, and even computer programs.¹⁰

Law Relating to Copyright in Myanmar

In Myanmar, the Myanmar Copyright Law of 2019 provides copyright protection, and additional laws complement this framework. The Broadcasting Law, enacted on August 28, 2015, establishes regulations for television and broadcasting services.

⁶ <https://www.wipo.int/edocs/myanmar.pdf>

⁷ Section-2(i) of Myanmar Copyright Law, 2019.

⁸ Section-2(k) of Myanmar Copyright Law, 2019.

⁹ "WIPO Intellectual property Handbook; Policy, law and use," 2nd edition, 2008, P-40.

¹⁰ C L Bansal, Business and corporate law, 2010, P-781.

According to Section 50 of the Broadcasting Law, 2015, individuals or organizations cannot own and operate more than one business for television and broadcasting area, but this does not impact the operation of services and distribution processes.

Section 51 outlines limitations on co-ownership of private newspaper carriers or private television and broadcasting services, restricting ownership to not more than 30% of other services if they own 100% of a particular service.¹¹

Section 92 of this Law, mandates that operating a television and broadcasting service requires a license issued by the State government. Furthermore, continuation of such services after the license termination is prohibited unless renewed by the State government.

The Broadcasting Law, 2015 provided information about a law related to television and broadcasting services, including penalties for violations.

It provided information on various sections of the Printing and Publishing Enterprise Law, Computer Science Development Law, and The Law Amending the Television and Video Law. According to Section-33(A) of the Law Amending the Television and Video Law, a person who commits any offence provided in sections 32 and 33 of this Law shall, after a previous conviction, be punished with imprisonment for a time period which may also make bigger from no less than twelve months to a maximum of five years, and shall also be liable to an excellent now not exceeding three million kyats. In addition, the properties which relate without delay to committing offence shall be confiscated.”

It appears that there has been an amendment to section 34 of the Television and Video Law in Myanmar, specifying different terms for punishment. It’s interesting to note the focus on intellectual property protection through various laws, including the Copyright Law.¹²

So, Myanmar has intellectual property laws to protect various rights, including copyright. The Copyright Act of Myanmar is designed to safeguard the rights of creators and encourage the development of intellectual property.

Terms of Copyright in Myanmar

According to section 17 of the Myanmar Copyright Law, 2019 the protection period for business rights is not explicitly mentioned, it’s recommended to consult the specific provisions of the law or seek legal advice for accurate information on the protection duration for business rights in Myanmar.

Under section 17 of the Myanmar Copyright Law 2019;

1. The protection period for copyright is 50 years from the year of the author’s death, unless the authentic inventor is alive, in which case protection continues until their death.
2. If it’s the copyright of the original related proprietor, the protection lasts for 50 years from the year of their death, unless the last authentic creator is alive, extending protection until their death.
3. For works of picture/sound or movies, protection is for 50 years from the year they are publicly enjoyed with the permission of the original creators or from the year the handiwork is created if not publicly enjoyed.
4. If copyright is published without identifying the original creator, the protection is 50 years from the year it is lawfully enjoyed by the public. However, if the original inventor is identified before the end of that period, it follows the rules in subsections (1) and (2).

¹¹ Section 51 of the Broadcasting Law, 2015

¹² The Law Amending the Television and Video Law, 2018.

5. Works of applied art are protected for 25 years from the year the handiwork is made.

Type of Work	Protection Term	Starting Date
Literary works or Artistic works	Lifetime of the author + 50 years	Date work first published
Works pseudonym	50 years	Date work first published
Audiovisual works	50 years	Date work first published
Collective works	50 years	Date work first published
Works of applied art	25 years	Date work was published
Performer	50 years	Date work first published
Phonogram producer	50 years	Date work first published
Broadcasting Organizations	20 years	Date work first published

Section 17(c) specifies that the calculation of the protection period includes counting from January 1st of the year combining with the year the original creator passed away, created the handiwork, or lawfully enjoyed it when first published.

Scope of Application to be protected

Those eligible for the protections may be categorized into four different themes according to section 12 of the 2019 Copyright Law. The legal protection for Literary and Artistic Work, as outlined in the law, extends to authors who are citizens or residents of the Union. Additionally, it covers works first published in the Union or a Member State, as well as those published in a third country but also in the Union within thirty days. Protection is also granted to an audiovisual works and film productions if the producer has their headquarters or habitual residence within the Union. Moreover, structures erected within the Union and other creative works included in a contracting or similar forms located in the Union are safeguarded by this provision.¹³

Certainly, the 2019 law protects the performer who is a citizen of or resides in the Union as well as a foreign performer whose work is made in the Union and involves in broadcasting qualified under the protection of the Copyright Law.

Thirdly, the 2019 Copyright Law also protects a phonogram produced by the citizen of the Union; or if the sound is first fixed in the Union; or the phonogram produced by a non-citizen or non-residents, but whose work is first produced in the Union or produced in the Union within the 30 days of the first production elsewhere. Lastly, under the theme of Transmission, the 2019 law protects the transmission work disseminated by an organization with its headquarters residing in the Union or an individual residing in the Union.

¹³ Section 12 of the Copyright Law, 2019.

By looking at this 2019 Copyright Law of Myanmar expands the scope of copyright protection not only at the domestic level but also at the international cross-border level by protecting foreign works produced from member states. This is evidence of the new law's attempts to align with international copyright protection across cross-borders.

Protection of Economic Rights and Moral Rights

Under the Berne Convention, copyright provides both economic rights and moral rights. Economic rights resonate with the owners' rights to experience economic reward from the utilization of their work by others at the same time as moral rights supply the owners to authorship the rights of the work and to item to any attempts that will distort or regulate their work.

Authors and performers moral rights, however, included in perpetuity. Existing unexpired copyrights below the vintage Copyright Act of 1914 will continue to be legitimate, with the same term of copyright granted under the brand-new Copyright Law, 2019. Copyright owners can transfer all or part of their financial rights. Likewise, related rights owners can transfer their financial rights with the consent of all involved parties entitled to any related rights. Transfers of rights to registered literary and artistic works or related rights can be record with the IPD.¹⁴

Under section 82, anyone who infringes the copyright by using the work for commercial purposes without the authorization of the owner shall be sentenced to imprisonment up to 3 years or a compensation fine at least Ks. 1,000,000, or both. According to section 84, anyone who wrongfully issues or instructs to issue copyright or related rights registration certificate or who wrongfully records or instructs the copyright or related rights registration can be sentenced to up to 1-year imprisonment, a fine up to Ks. 2,000,000 or both. Repeated offences after being sentenced under section 82 can be punishable up to 3-10 years imprisonment with a fine up to 10,000,000.¹⁵

Remedies on Infringement of Copyright in Myanmar

The public performance or display of copyrighted works is without authorization. Remedies for copyrights infringement in Myanmar may involve legal actions, including seeking injunctive relief to stop the infringing activities, claiming damages, and pursuing parties. It's advisable to consult with a legal professional in Myanmar for specific guidance tailored to your situation.¹⁶

The Burma Copyright Act changed into promulgated in 1914 composing thirteen sections. Almost all of the provisions for the Burma Copyright Act had been subjected to the Copyright Act 1911 of the United Kingdom of Great Britain and Ireland whilst some sections had been changed. Thus, the work covered in the 1914 Burma Copyright Act inclusive of literary, dramatic, musical, and artistic works; sound recordings, films, broadcasts, and posted architectural work.

Section 43(a) of the Myanmar Copyright Law, 2019 likely addresses matters related to copyright and related rights management. This may include provisions for the management, enforcement and protection of copyright and related rights. It's recommended to review the specific language of the law or consult legal professionals for a detailed understanding of the provisions under Section 43(a) and how they apply to copyright and related rights management in Myanmar.

¹⁴ <https://www.tilleke.com/insights/myanmar-enacts-copyright-law>.

¹⁵ Section-82 of Copyright Law in Myanmar, 2019.

¹⁶ <https://www.tilleke.com/insights/myanmar-enacts-copyright-law>.

Section-43(b) of Myanmar Copyright Law, 2019, indicates that information covered by this section should not interfere with the actions of national authorities authorized by law for security. Regarding technology to prevent infringement (a) it emphasizes the necessity to maintain the effectiveness and integrity of such measure in the arrangement, preventing circumvention or destruction through robust technology, (b) Producing the contraptions, items, parts or services made for commercial enterprise taking note of evade, or to achieve success in evasion or to offer from the association stopping with the aid of effective technology, uploading, dispensing, promoting, leasing or advertising and marketing for rent, or preserving in hand shall now not be carried out.¹⁷

The Myanmar Copyright adopted on May 24, 2019, aligns with the TRIPs Agreement. The adjustments based on the prevailing currency suggest a flexible approach.

Section 82, sub-section (b) of the Myanmar Copyright Law appears to address the possession of mechanisms used to provide or reproduce copyrighted material, resulting in potential legal consequences.

Despite the existence of the copyright act, there were limited cases sued and charged under this law. A few case studies are included here. The very first reported case is called Maung Nyi Pu vs East End Films, AIR 1939 (Rangoon) 266. The photo of actress Ma Than Tin was published in the Burmese Cinema Journal in June 1937. The plaintiff, U Nyi Pu who is the sole proprietor of A1 Film Company, claimed that Ma Than Tin which was photographed was the copyright of the plaintiffs. He sued the East End Company for violating the copyright of the A1 Film Company by using the photograph of the actress Ma Than Tin. The plaintiff won the case under the court decision decided in February 1939, and the defendant, the East End Films had to compensate the plaintiff with the fee amount, Rs. 100.¹⁸

The second reported case, which also brought more public awareness towards the citizens' rights to the copyright, become the civil lawsuit case of U Hla Win and two others Vs. Daw Kyi Kyi @ Daw Yin Wai Lwin, Pyay1999, MLR(Civil) 208. This case involves a dispute between the author and the producer over the book "Hmine Wae Chit Tae Khet Thissa" written by the appellant, Daw Kyi Kyi and published in 1981. According to section 1(1) of the 1911 Copyright Act, Daw Kyi Kyi had copyright to the book. According to section 2(1) of the 1911 Copyright Act, one could be charged with a violation of the copyright if one used the work without the consent of the owner. In this specific case, Daw Khin Than bought the manuscript from Daw Kyi Kyi with the amount of Myanmar Kyats 1,000 for video production. Then, Daw Khin Than sold the manuscript to Phowa Video Production and Phowa Production mass-produced the video across the country. According to section 1(2) (c) and section 5(1) of the copyright law of Myanmar, the rights to copyright were transferrable under a written contract of transfer but were illegal if it was done without any written and signed contract. There was nothing such as the transfer of copyright while Daw Kyi Kyi sold the manuscript to Daw Khin Than. Although Daw Khin Than sold the manuscript to Phowa Video Production, the Phowa Video Production did not get any copyright from the original owner. In addition, the Phowa Video Production also made modifications to the work of the author including the contents and title of the manuscript, reproduced as a video, and broadcasted nationwide. Thus, the Phowa Video Production violated the copyright of the author, appellant Daw Kyi Kyi and was charged to compensate Myanmar Kyats 500,000 to the author according to the Division Court.¹⁹

¹⁷ Section-44 of Myanmar Copyright Law, 2019.

¹⁸ AIR 1939(Rangoon)pg-266

¹⁹ Myanmar Law Report (1999). Yangon- the Supreme Court of the Union of Myanmar, p-208

The third case is a special appeal case between the plaintiff, Daw Wa Dan Khaung Nin, and the defendants - Daw Kham Yin, Daw New Oo and U Min Nyo, ka U Htin Fu. In the case of Daw Wa Dan Khaung Nin Vs. Daw Kham Yin and two others, 2009 Special Appeal Case, No. 37, 38& 39, the defendants argued that the traditional clothing patterns were related to all nationalities and existed since the ancient past. Thus, it could not be given copyright. The plaintiff sued the defendants for imitating the Rawan ethnic female longyi design of the plaintiff's production and selling the longyi afterwards. The plaintiff requested a compensation amount of kyats 6,000,000 for her copyrights and related civil lawsuit processes. The court decided that the plaintiff had the right to copyright to her design and the right to the compensation. Thus, the defendants had to compensate the plaintiff with the amount of kyats 2,000,000 per defendant.

Although the 1914 Burma Copyright Act laid an essential ground for the protection of copyright in Myanmar, due to the inclusion of basic provisions, the 1914 Act did not cover the copyright issues relating to many audiovisual works and computer programs. In addition, the 1914 Act covered only domestic copyright issues. Thus, the new copyright law was ratified in Myanmar in 2019. This new law will be discussed and analyzed further in the next section.

The historical copyright infringement instances in Myanmar, with the majority resolved amicably. The reported cases at the Supreme Court level in 1919 and 1999 provide insights into the legal landscape.

Daw Dagon Khin Khin Lay's legal action against Moe Flim "Pone Pama" demonstrates the gravity of copyright infringement claims. The swift injunction granted against the movie's screening at proactive approach to protect her novel's rights.²⁰

In the event of a dispute between a user and an author, the involved parties could settle amicably by providing damages or compensations to the writer. This approach promotes resolution outside the court system, fostering a cooperative understanding between users and authors in Myanmar. However the resolution mechanism involving compensation aims to address any dispute that may arise, fostering a cooperative relationship between users and authors within the local context. To enhance the understanding of copyright in Myanmar, efforts should focus on widespread education about intellectual property rights, fair use, and the importance of obtaining permission from authors. Collaborating with education institutions, conducting workshops, and using accessible platforms can contribute to a broader awareness of copyright laws among both users and creators in Myanmar.

Conclusion

Intellectual Property, IP derives from the people's creative minds and thrives on the related culture and economic life for betterment. IP plays a vital role in the socio-economic life of different nations worldwide. Copyright, one of the important branches of the IP rights, is the right of the creator to its artistic and literary work that not only makes the society's culture and certainly, the proper protection of copyright under national law not only contributes to the socio-economic prosperity but also ensures both economic and moral benefits for the creators. Without rights safety, the incentive for individuals to create and innovate diminishes, potentially hindering cultural, artistic and technological progress. Copyright and related rights play a crucial in fostering a climate that encourages creativity and invention while providing a framework for fair compensation and acknowledgement for the creators.

Many international treaties and organizations have attempted to set up guidelines and cross-border protections such as outlined in the Berne Convention, the World Intellectual

²⁰ Journal of the Asia Research Centre, Yangon University, Vol-2, No-1, pp-121-122

Property Organization Copyright Treaty, the Beijing Treaty and the TRIPS agreements. However, actual protection of the creator's work derives from the establishment of effective and mandated law at the national level which guarantees the copyright of the owner by aligning with feasible and applicable rules and regulations from international instruments.

Copyright will automatically be protected without the need for compulsory registration. However, this new law introduces an alternative for rights holders to proactively file their copyrights in Myanmar. The new copyright law seeks to bring Myanmar's copyright regime in line with international standard of protection of literary and artistic works, computer programs as well as related performer, phonogram and broadcasting rights. The protection of moral and economic rights can be found in a well-planned punishment and compensation mechanism such as increased terms of imprisonment for more than one-time offenders. An increase in protection timeframe from the previous 30 years to the current 50 years after the death of the creator of literary and artistic work allows an enhanced right and economic benefit to the creator of the work. To sum up, current improvements in the 2019 Copyright Law of Myanmar will definitely bring both moral and economic benefits to the citizens of the country.

The adopted of the Copyright Law by the Republic of the Union of Myanmar on 24 May 2019, indicates a commitment to updating and revising the existing legal framework. The impending entry into force, upon the President's notification, suggests a shift in the copyright protection system. Addressing challenges and demands in the aftermath of repealing the Copyright Act, 2019, showcases the nation's efforts to establish an updated and effective copyright protection mechanism.

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THE PRACTICE OF *HIRĪ* AND *OTTAPPA* IN PĀḲI SCRIPTURES

Khin Phyu Phyu Soe¹, Aye Mehm², Thi Thi San³

Abstract

This paper examines *Hirī* and *Ottappa*, the fundamental principles of moral ethics of Buddhism. Anybody ashamed to do evil is *hirī* and dread or fear to do evil is *ottappa*. This paper will explore the different names for *Hirī* and *Ottappa*, the definition of *Hirī* and *Ottappa*, disadvantages of not having *Hirī* and *Ottappa* in *pāḲi* scriptures, and implications for personal growth. The paper also looks at the number of young people following *Hirī* and *Ottappa*, which are part of our national cultures. This is based on interviews with young people. The most important national cultures of our country are related to the practice of *Hirī* and *Ottappa*.

Keywords, *Hirī*, *Ottappa*, *jātaka*, national culture, *devadhamma*

Introduction

‘*Hirī*’ (Moral shame that is the shame which deters a man from sinning) and ‘*Ottappa*’ (Moral fear that is fear to sin) are two causes of *Sīla*.⁴ The two basic helpful foundations for moral life. These two causes are the proximate ones to get moral restraint or discipline in moral life. The Buddha points to two mental qualities as the underlying safeguards of morality, thus as the protectors of both the individual and society as a whole. These two qualities are called in *PāḲi* *Hirī* and *Ottappa*. There are Four Sublime Abodes or the natures of ‘*Hirī*’ (Moral shame that is the shame which deters a man from sinning) and ‘*Ottappa*’ (Moral fear that is fear to sin).⁵ They are *Mettā* (Loving-kindness), *Karuṇā* (Compassion), *Muditā* (Rejoicing on other’s good fortune), and *Upekkhā* (Equanimity). Moreover, the sevenfold dhamma⁶ was taught by the Buddha Himself; when the Buddha was staying at the Jetavana monastery near Sāvattthi. Then king Pasenadi asked Him about the wealth of Migāra, the grandson of Rohaṇa. Answering this question, the Buddha exhorted of pious ones that cannot be destroyed by any enemy. They are as follows;

- (1) *Saddhā* (Confidence),
- (2) *Sīla* (Morality),
- (3) *Cāga* (Liberality),
- (4) *Suta* (Knowledge),
- (5) *Paññā* (Wisdom or Insight wisdom),
- (6) *Hirī* (Moral shame) and
- (7) *Ottappa* (Moral fear).

Materials and Methods

This research is based on primary Buddhist sources and on interviews. The data has been collected from published sources such as *PāḲi* texts. This was complimented by interviews with 50 participants. Interviewees were between 19 to 25 years old. They were each asked ten questions about *hirī* and *ottappa*.

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⁴ It, A, 289,

⁵ It, A, 289,

⁶ A, ii, 398;.

Findings

There are three different names for *Hirī* and *Ottappa* in pāli scriptures. They are Lokapāla (Guardian of the world), Devadhamma and Sukkadhamma⁷

(a) Lokapāla (Guardian of the world)

The Pāḷi word *Lokapāla* is the combination of *Loka* and *Pāla*; *loka* means the world of living beings, *pāla* means guarding or protecting. So *Lokapāla* is protecting or guarding the world or is guardian of the world, “*Lokamariyādassa pālanato lokapāladhammonāma*.”⁸ It is *lokapāla* that protects the boundary of the world. *Lokapāla* guards society preventing chaos. It protects the boundary in relationships such as mother and son, brother and sister, and so on.⁹

(b) Devadhamma

The Pāḷi word *Devadhamma* is the combination of two words. They are *deva* and *dhamma*. *Deva* means divine, deity, and *dhamma* means doctrine. *Devadhamma* means divine virtue of *Sammuti deva*, *Upapatti deva* and *Visuddhi deva*. “*Hiri Ottappa Sampannā deva dhammāti vuccare*”¹⁰. They are also called ‘Devadhamma’¹¹.

Devadhamma preached by the Buddha

Once, the Bodhisatta was born as *Mahiṃsa*, son of the king of *Benaras*. His brother was *Canda* and his stepbrother *Sūriya*. *Sūriya*’s mother, having been granted a boon, claimed *Sūriya*’s mother, having been granted a boon, claimed the kingdom for him. *Mahiṃsa* and *Canda* thereupon went into exile, but they were accompanied by *Sūriya*. When they arrived in *Himavantā*, *Mahiṃsa* sent his two brothers to fetch water from a pool. There, first *Sūriya* and then *Canda*, were seized by a demon who had been allowed by *Vessavana* to eat anyone entering the pond who did not know the *Devadhamma*.¹² *Mahiṃsa* then went to the pond himself, and on being questioned by the demon, preached the *Devadhamma* to him - which is to shrink from sin. The demon was pleased and offered to release one of his victims. *Mahiṃsa* chose *Sūriya* and gave as reason that he was afraid of being blamed by others. Thereupon the demon gave up both his brothers and showed the Bodhisatta great honour. The Bodhisatta converted him and he gave up his evil ways.

The story relates to that of a rich man of *Sāvatti* who joined the Order after his wife’s death. But he continued to enjoy all kinds of luxuries until, arraigned before the Buddha, he pulled off his robes and stood only in his waist-cloth. The Buddha told him it was not the first time he had had to show him the error of his ways. He is identified with the water demon, *Ānanda* with *Sūriya*, and *Sāriputtarā* with *Canda*.¹³

(c) Sukkadhamma

The two words of Pāḷi *sukka* and *dhamma* are combined in *Sukkadhamma*. “*Sukka* is pure, virtue and *dhamma* is doctrine. They are also called ‘*Sukkadhamma*’¹⁴ as these two principles can make us free from defilements.¹⁵

The Buddha said,

“*Dve me bhikkhave sukkā dhammā lokam palenti.*

⁷ M, T, i, 91; AT, ii, 472; ADL, 82-83

⁸ M, T, ii, 213,

⁹ M, A, ii, 213

¹⁰ J, I, 2;

¹¹ J, i, 232; j, A, iv, 109; Dhp, A, ii, 47; J, A, i, 144, 149; MBW, 89

¹² J, A, ii, 144

¹³ J, A, i, 22

¹⁴ A, ii, 153; S, A, i, 121; A, A, ii, 96; M, iii, 400-409; MA, ii, 203; M A, ii, 232

¹⁵ M, i, 338; M, A, ii, 213; It, iv, 219; It, A, 150.

*Katame dve, Hirī ca ottappañca.*¹⁶

“O monks! These clean things (*dhammas*) protect the world.
What are they? They are moral shame and moral fear.”

They protect the world in the following ways.

1. They protect the relationships in society such as those between mother and son, brother and sister, etc. to ensure they are not chaotic.
2. They cleanse humanity to prevent it being dirty by committing immoral acts.
3. They protect the world as a good king (*Samuti Deva*) protects his people or as a Deva (*Upapatti Deva*)¹⁷ protects humanity or as an *Arahat* (*Visuddhi Deva*) protects all living beings.¹⁸

In these ways, they can protect the world and ensure calm, peace, and unity. So, they are called the protectors or guardians of the world. In the world, human beings deal with one another through adopting relevant customs and behavior. Moral shame and moral fear help human beings to refrain from doing evil deeds and to maintain a good society. That is why these two factors are very important for humans to be aware of and to follow.

Definition of of *Hirī* and *Ottappa*

The pāli word *hirī* (shame) is the same (*trī*)¹⁹ in Sanskrit. The pāli word *ottappa* is derived from ud √tap+nya.(afraid)²⁰ which is the same as the Sanskrit word *Apatrapya*²¹. Anybody ashamed to do evil is *hirī*²² and dread or fear to do evil is *ottappa*.²³ *Hirī* is evident in those who value their honour and dignity. *Ottappa* is evident in those who respect their parents, teachers, friends and relatives. According to the etymology "*Kayaduccaritādihi hiriyaṭṭi hiri*", *Hiri* means shame of unwholesome deeds like bodily action, etc. According to the definition "*Kayaduccaritādihi ottappatṭi ottappan*", *Ottappa* means fear of unwholesome deeds like bodily action, etc.

Disadvantage of without *Hirī* and *Ottappa*

Once, the Bodhisatta was a golden mallard, who was the king of birds in Nicca jāṭaka. He had a daughter. When his daughter became mature; he all birds to gather. His daughter chose the peacock as her husband. At that time the peacock was very happy and he spread his wings and began to dance, thus exposing himself. All the birds saw the shamelessness of the peacock. And then, the Bodhisatta shamed the peacock for his lack of decency and gave his daughter to a young mallard instead. In *Hirī Ottappa Hirī Ottappa Sutta* of *Aṅguttaranikāya* the Buddha illustrates that a tree devoid of branches and leaves cannot be endowed with its outer bark, bark, sapwood and core just as a monk who lacks *Hiri and Ottappa* cannot obtain the following, in order-restraint of the senses (*Indriya-samvara-sīla*), restraint with regard to the Disciplinary Code (*Patimokkha-samvara-sila*), right concentration (*Sammā-samādhi*), knowledge of seeing realistically (*Yathābhūta-ñānadassana*), knowledge of weariness (*Nibbida-ñāna*), and emancipated knowledge and insight (*Vimutti-ñāna-dassana*).²⁴ The Buddha expounded in *Itivuttaka* in this way those who have no *Hiri* and *Ottappa* are born and dead over and over again, those who hold the two have no more defilements and are free from rebirths. Those who

¹⁶ M, i, 338; M, A, ii, 213; MT, ii, 111; j, A, iii, 93

¹⁷ Thig, A, ii, 227; J, A, v, 120

¹⁸ Nd, i, 92, 225; M, A, i, 35; Khp, A, 103

¹⁹ HS, U, 1084

²⁰ HS, U, 265

²¹ SD, 15

²² V, iii, 69; HS, U, 1084

²³ HS, U, 265

²⁴ A, 472

forget *Hiri and Ottappa* are blameworthy; miserable planes are opened to them; they are like dogs, pigs, cattle, sheep and goats

Discussion

Fifty students aged between 19 to 25 were asked ten questions about *hirī* and *ottapa*.. To the question about wearing short skirts and trousers, 40 percent answered that they wear short skirts or short trousers when they go outside but 60 percent answered that wearing short skirts or short trousers is shameful. Twenty percent answered that wearing short skirts or short trousers is shameful but 80 percent answered that wearing short skirts or short trousers is up to date. To the question about going with your love in front of people, 20 percent answered that it's honorable to go out with their love in front of people. A hundred percent of students answered that they have never kissed in public. A hundred percent answered that doing evil must be feared and killing others is shameful. Four percent answered that they don't know about *Hirī* and *Ottapa*. Twelve percent answered that speaking out loud in front of people is brave but eighty-eight percent answered that speaking out loud in front of people is rude. A hundred percent of students answered that killing another is shameful. Two percent answered that wearing traditional dress when going to an event is not up to date but 98 percent answered that wearing traditional dress when going to an event shows pride. Two percent answered that they don't take care their relatives but 98 percent responded they take care of their relatives.

These results show that 16 percent of the students between the ages of 19 and 25 are missing *hirī* and *ottappa*. They indicate that many young people do not value Myanmar traditional dress. Traditional dress is part of the Myanmar culture and if these do not continue to be appreciated, national culture will be affected. In my opinion, the practice of *Hiri* and *Ottapa* is becoming less and less day by day. Today many people are void of moral shame and moral dread so they dress, eat, and behave indecently.

Table 1.

မေးခွန်းနံပါတ်	စာရင်းရှိ	အမှန်ရွေးသူ	ရာခိုင်နှုန်း	အမှားရွေးသူ	ရာခိုင်နှုန်း
၁	၅၀	၃၀	၆၀%	၂၀	၄၀%
၂	၅၀	၁၀	၂၀%	၄၀	၈၀%
၃	၅၀	၄၀	၈၀%	၁၀	၂၀%
၄	၅၀	၅၀	၁၀၀%	၀	၀%
၅	၅၀	၅၀	၁၀၀%	၀	၀%
၆	၅၀	၄၈	၉၆%	၂	၄%
၇	၅၀	၄၄	၈၈%	၆	၁၂%
၈	၅၀	၅၀	၁၀၀%	၀	၀%
၉	၅၀	၄၉	၉၈%	၁	၂%
၁၀	၅၀	၄၉	၉၈%	၁	၂%
စုစုပေါင်း		၄၂၀	၈၄၀%	၈၀	၁၆၀%

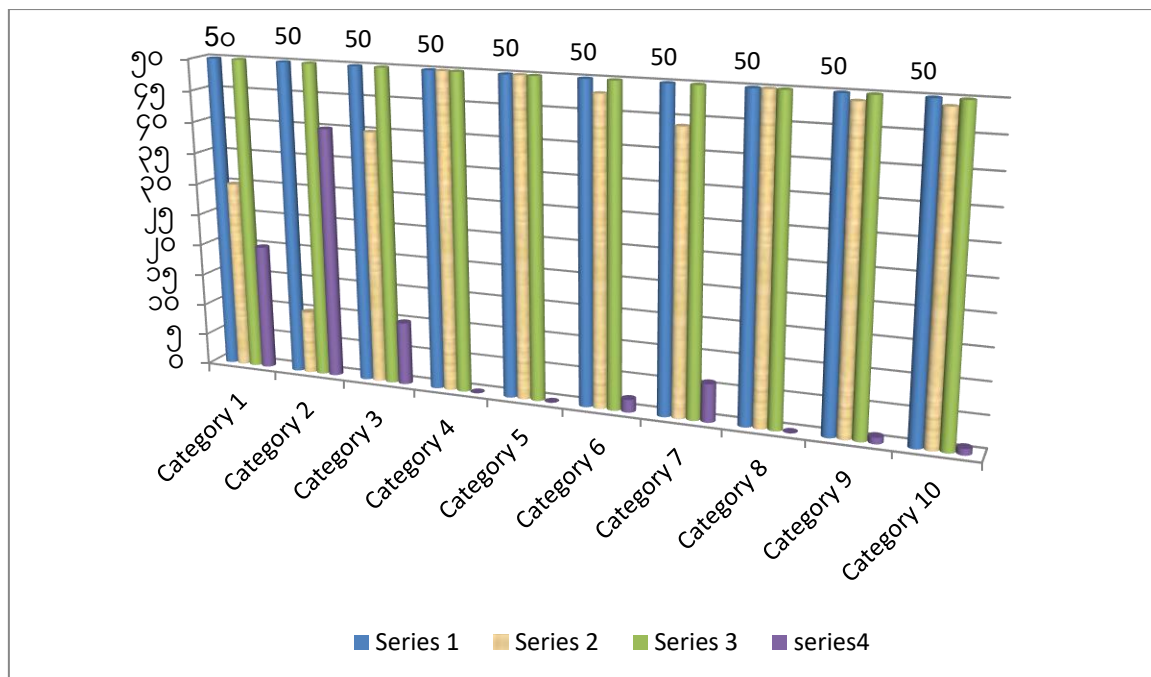


Figure 1.

Conclusion

In a nutshell, *Hirī and Ottappa* are the fundamental principles of moral ethics of Buddhism which are so important that human beings have a ‘moral sense’ and they need to have good morality. If people practice *Hirī and Ottappa* daily, they will not only observance of morality, but they will also enjoy peace of mind because they will not do bad things. If these two disappeared, the world would be destroyed like an unfastened bundle of bamboos or a bamboo floor without binders. The Buddha designated *Hirī and Ottappa* as which means principles protecting the world. If nobody, in the world, followed these two, the world would be destroyed; moreover, in society, there would be no differences between father and mother, mother and son, father and daughter, brother and sister, and uncle and aunt. Human world would be the same as animal world. Therefore, all people must keep *Hirī and Ottappa* for their whole lives

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Appendix

ကျား/မ -----

အသက်-----

- ၁။ ဘောင်းဘီ/စကတ်တို ဝတ်၍ အပြင်သို့သွားဖူး /မသွားဖူးပါ ။
- ၂။ ဘောင်းဘီ/စကတ်တို ဝတ်ခြင်းသည် ရှက်စရာ/ခေတ်မီခြင်း ဖြစ်သည်။
- ၃။ ရည်စားနှင့် လူအများရှေ့တွင် နမ်းဖူး/မနမ်းဖူးပါ။
- ၄။ ရည်စားနှင့်လူအများရှေ့သွားရခြင်းသည် ရှက်စရာ/ ဂုဏ်ယူစရာဖြစ်ပါသည်။
- ၅။ မကောင်းမှုကို ပြုလုပ်ရန် ကြောက်ရမည်/ ပျော်ရမည်။
- ၆။ ဟိရီ နှင့် ဩတ္တပ္ပတရား မှာလောကပါလ တရား ၂ ပါး/ ဒုက္ခ ဓမ္မ ၂ပါး ဖြစ်သည်။
- ၇။ လူအများရှေ့တွင် စကားကျယ်ကျယ်ပြောခြင်းသည် သတ္တိရှိခြင်း/ ရိုင်းစိုင်းခြင်းဖြစ်သည်။
- ၈။ သူတစ်ပါး အသတ်သတ်ဖြတ်ခြင်းသည် ရှက်စရာ/ ပျော်စရာဖြစ်ပါသည်။
- ၉။ မြန်မာ့ဝတ်စုံ ဝတ်ဆင်၍ ပွဲလမ်းသွားခြင်းသည် ခေတ်မီခြင်း/ဂုဏ်ယူစရာဖြစ်ခြင်း ပင်ဖြစ်သည်။
- ၁၀။ မိမိ ဆွေမျိုး၊ အဒေါ် ၊ ညီမ ဝမ်းကွဲများကို စောင့်ရှောက်/ လျစ်လျူ ရှုဖူးသည်။

STUDY ON IMPROVING HYDROPOWER PROJECTS IN MYANMAR (2010-2020)

Khaing Thazin Soe ¹

Abstract

Hydropower resource is the only renewable energy resource which is currently being exploited and which has future prospects for more exploitation and utilization in Myanmar. Hydropower development has attracted foreign direct investment and hydropower has been generated by utilizing water resources beneficially across the country. It is generally considered a clean renewable energy source, as no carbon dioxide or other green-house gas (GHG) emissions resulted from the generation of hydroelectricity. With the implementation of hydropower projects around the country, the people will have the opportunities to get electricity for the comprehensive development of the country. The development of hydropower projects may contribute to national development as well as people's socio-economic improvement of the country.

Keywords: renewable energy, hydropower, energy policy, socio-economic development

Introduction

Globally, the increasing depletion of the world energy resources as well as growing damage on the world environment caused by industrialization have made many countries to turn to renewable energy resources for their sustainable development. Renewable energy is one of the answers to solve the depleted fossil fuel and helping the economic development and the environmental protection of every country. Of renewable energy resources, hydropower resource is the most popular renewable energy resource in Myanmar. To achieve energy sustainability in Myanmar, it is needed to increase electricity generation from renewable energy resources especially in hydropower energy resources.

Materials and Methods

The purpose of this dissertation is to focus on the impacts of improving hydropower projects of Myanmar during the period of 2010 and 2020. It emphasizes how Myanmar cooperates with foreign countries to develop hydropower energy sector. It also highlights the hydropower energy sector of Myanmar as one of the important economic sectors supporting the development of the national economy. In doing the research, descriptive and comparative presentations are made by using both primary data and secondary data. Most of the data needed in this research are published and unpublished books, newspapers and online sources.

Results and Discussion

Myanmar's Hydropower Resources and its Potential

Hydropower resource is the most popular renewable resource and it is already a well-established resource which makes a substantial contribution to global energy. Since Myanmar has been a land of great river system that runs from the country's North to the South, the availability of water resource is said to be a more favorable renewable energy resource in Myanmar. Numerous streams, creeks and small rivers flow through the three main mountain

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ranges, namely the Rakhine Yoma, the Bago Yoma and the Shan Plateau and form four main rivers, namely the Ayeyawaddy, the Chindwin, the Thanlwin and the Sittaung rivers then flowing southward and enter into the Gulf of Mottama.

Before entering the sea, the Ayeyawaddy river splits into numerous tributaries to form a delta region. The drainage basin of the Ayeyawaddy and the Chindwin system includes about fifty-five percent of the area of the country. The Sittaung river originates from the confluence of Paunglaung, Nawin, Sinte and Ngalike streams. The upper Sittaung river is most commonly called Paunglaung river until it reaches Taungu. The Thanlwin river, which flows through the rugged mountainous terrain of the greater slop gradient, has high potential for hydroelectric power generation. With these favorable geographical and hydrological conditions, it provides abundant potential of hydropower resources. Exploited hydropower potential in States and Regions of Myanmar in 2010 can be seen in Table (1).

Table (1): Hydropower Locations and Potential in States and Regions

No.	Locations (State & Region)	Number of locations	Potential (MW)
1.	Kachin State	39	2061
2.	Kayah State	7	3909
3.	Kayin State	21	17021
4.	Chin State	22	1312
5.	Sagaing Region	21	2399
6.	Taninthayi Region	14	692
7.	Bago Region	12	483
8.	Magway Region	8	123
9.	Mandalay Region	17	3482
10.	Mon State	10	292
11.	Rakhine State	14	247
12.	Shan State	83	7699
Total		268	39720

Source: Department of Hydropower, Ministry of Electric Power No.(1), Nay Pyi Taw, 2010

According to Table (1), the number of locations for hydroelectric power projects was 268 sites with a total installed capacity of 39,720 megawatts (MW) in Myanmar. In building a developed nation, it is necessary to implement hydropower projects in all States and Regions of the country with the aim of generating hydropower through a lot of water resources. In December 2016, Ministry of Electricity and Energy (MOEE) reported that Myanmar had 302 hydropower energy potential sites with a total installed capacity of 46,330.55 MW around the country. It had made the greatest contribution to electricity generation. Myanmar government was harnessing the water resources of the country for its all-round development. The number of hydropower potential sites and its capacity is shown in Table (2).

Table (2): Hydropower Potential Sites and Capacity of Myanmar

No.	Capacity	Number of potential sites	Potential capacity (MW)
1.	Less than 10 MW	210	23.25
2.	Between 10 and 50 MW	32	806.30
3.	More than 50 MW	60	45,293.00
Total		302	46,330.55

Source: Department of Hydropower, Ministry of Electricity and Energy, Nay Pyi Taw, 2016

If Myanmar has implemented 302 hydropower sites with the capacity of 46,330.55 MW totally, it could meet domestic energy demand in a long term. The Ayeyarwaddy river basin has the greatest hydropower energy potential with (34) hydropower sites and the generating capacity of the hydropower plants has reached 21,821 MW. Hydropower potential in river basin areas can be seen in Table (3).

Table (3): Hydropower Potential in River Basin Areas

No.	River Basin	Number of Potential sites	Installed Capacity (MW)
1.	Ayeyarwaddy	34	21,821
2.	Chindwin	8	3,015
3.	Sittaung	11	1,128
4.	Thanlwin	21	17,641
5.	Mekong	4	720
6.	Others	14	1,776
Total		92	46,101

Source: Ministry of Electric Power No. (1), 2013.

According to Table (3), about 46,101 MW of potential capacity of hydroelectric power energy could be installed in river basin areas of the country. It could be explored and developed to boost existing capacity and to expand export potential to the neighbouring countries such as China and Thailand.

Myanmar's Energy Policy and it's Strategies

Energy is a basic requirement of economic development. Every sector of economy such as agriculture, industry, transport, and commercial needs inputs of energy. The national security, financial stability and standard of living of a nation are intertwined with its energy consumption. In order to meet the challenges of the energy demand growth in the twenty-first century, Myanmar's energy policy guidelines for energy sector are (1) to maintain the status of energy independence, (2) to promote wider use of new and renewable sources of energy, (3) to promote energy efficiency and conservation, and (4) to promote use the alternative fuel in household. In addition, five more policy objectives came to be included in 2006. They are-(1) to supply fuel oil, urea and fertilizer to industrial, agricultural and other sectors of the economy (2) to enhance foreign exchange earnings through exports of surplus oil, natural gas and petroleum products, (3) to promote regional cooperation, (4) to use modern methods and to promote human resource development of nationals in the energy sector, and (5) to stockpile fuel oil systematically for national security and economic stability.

The energy policy pursued by the government is important for survival of societies for national defense and for national economic development of the country. Energy policy is necessary for the national security, economic well beings and standard of living of the nation. In accordance with the guidance of the Myanmar's government, the main objective of the Myanmar's energy policy is to reduce energy imports, to utilize efficient amount of energy efficiently and to save non-renewable energy sources. It emphasized on the development of all available energy resources of the country to increase the level of production of existing energy sources and at the same time to update the applied technology.

In January 2013, the government established the National Energy Management Committee (NEMC) and the Energy Development Committee to improve resource planning and oversee investment in electricity sector development. The NEMC is a ministerial level energy policy

coordination body in Myanmar. It launched a National Energy Policy in 2014 that served as the main energy policy framework for the country.

According to 2014 National Energy Policy, it could be summarised in the following five points: (1) the provision of adequate energy at sustainable cost; (2) encourage citizens to contribute to electricity service to help the weak; (3) give priority to viable distributed generation from renewable energy sources; (4) encourage private development of renewable energy generation; and (5) ensure proper standards, attractive financing, and continuous capacity development. The policy, which has the objectives of ensuring energy security for sustainable economic development of the country, provides affordable and reliable energy supply to consumers, especially those without electricity. It was closely linked with the government's broader reform agenda, including the short-term Framework for Economic and Social Reforms of 2012-2015 that served as a bridge for the longer-term 2011-2031 National Comprehensive Development Plan.

In 2015, MOEE issued six objectives for electric power sector to meet the electricity demand of the country. They are:

- (a). In order to transmit the generated power, through national grid system to Regions and States by implementing the transmission lines and primary substations, and by carrying out the distribution plans for electricity supply to the industries and public.
- (b). To provide the technical know-how and policy support for using renewable energy such as bio-mass with co-operation and participation of the local people in rural areas, remotely located from the national grid.
- (c). To meet the electricity demand for the inaccessible areas to national grid, to be supplied by mini hydro and diesel generators.
- (d). In order to be reliable, the quality of national grid system for generation, transmission, distribution and consumption of electricity at the standard voltage level with the least of power interruption and losses, to be carried out by our skilled staffs and by getting technical know-how from abroad.
- (e). In order to fulfill the electricity demand of Myanmar, to encourage the power generation not only hydropower and also natural gas and coal, and to be widely and commercially operated by wind and solar power plants.
- (f). To generate more electricity from the renewable energy resources.

The Ministry not only issued the objectives for electric power sector but also laid down the following policies for power sector to get more and more improvement and to become efficient electricity utilities.

- (i). For sufficient electricity supply throughout the country to expand the national power grid for effective utilization of generated power from the available energy resources such as hydropower, wind, solar, thermal and other alternative ones.
- (ii) To conduct the electricity generation and distribution in accordance with the advanced technologies and to uplift and enhance the private participation in regional distribution activities.
- (iii). To conduct environmental and social impact assessments for power generation and transmission in order to minimize these impacts.
- (iv). To restructure the power sector with cooperation, boards, private companies and regional organizations for more participation of local and foreign investments and formation of competitive power utilities.
- (v). To formulate the electricity acts and regulations with the assistances of the local and international experts in order to align with the open economic era.

Subsequently, with technical assistance provided by the Japan Fund for Poverty Reduction, the NEMC launched an Energy Master Plan in 2015 to provide energy supply strategies through viable energy mix scenarios to secure long-term stable and reliable energy

supply for the country. The Master Plan includes a projection for 2030 electricity mix, which includes (57) percent for hydropower, (8) percent for natural gas, (5) percent for photovoltaic, and a significant increase in coal from (2) percent to (30) percent. Moreover, the policy draft also sets the potential contribution of renewable energy to the total energy mix of the country to reach 26.8 percent, or equal to 3,995 MW, by 2030. In the absence of a national renewable energy policy, existing Myanmar government's plans and initiatives led by the NEMC, and with the support from the Asian Development Bank (ADB), the government of Myanmar is in the process of developing a national renewable energy policy.

In the renewable energy development efforts, it is aimed at supporting electrification in rural areas of Myanmar. Hydropower serves as the main source of electricity generation, and the government planned the construction of more hydropower plants in the foreseeable future. The government also encouraged the participation of private sector in the development of hydropower, either as an independent power producer or through a joint venture initiative with local developers.

The Status of Hydropower Projects in Myanmar (2010-2020)

The energy sector including electricity plays an important role to drive for economic development of a nation. Myanmar is well known for its rich energy resources of both renewable and non-renewable resources. Of renewable energy resources that generate electricity, hydropower resource is the most popular renewable resource in Myanmar. Water resources blessed by nature are to be harnessed effectively by establishing hydropower projects across the country.

In Myanmar, the demand for electricity had dramatically increased in comparison with the consumption before 1988 as factories and industries had mushroomed across the country when investment from local people and abroad had flowed into the industrial sector as the country had practised the market-oriented economic system. In 2008, the electricity consumption had increased to 4,507.915 million units. In 2009, the electricity consumption had reached up to over 7,622 million units.

In 2010, public consumption of electricity in all states and regions were 700.19 MW. State-owned factories and industrial zones of the country consumed 299.48 MW and 171.8 MW each. For river pumping projects, electricity was needed about 35.48 MW. Private-owned factories and hospitals, schools and offices also demanded 106.99 MW and 241.93 MW. In Yangon Region, the total electricity consumption was 666.78 MW. The total electricity consumption of Mandalay Region was 141.64 MW. The total electricity consumption in States and Division was 1555.25 MW. To support factories, industries, private enterprises and foreign enterprises, electricity plays a vital role. It is one of the basic needs for development of the country. The total electricity consumption increases year after year in the country. Therefore, the government is implementing hydropower projects with all possible means to supply electricity to the generation of the people.

Myanmar's first commercial use of hydropower to generate electricity occurred in 1952, when Baluchaung hydropower plant was implemented. Before 1988, Myanmar has been delayed in the exploitation of hydropower reserves because of the requirement of high capital investment. After 1988, with the implementation of market-oriented economy, the government is taking systematic measures in order to effectively tap natural resources in all States and Regions. Hydropower plants under the Ministry of Electric Power No. (1) can be seen in Table (4).

As shown in Table (4), the generating capacity the hydropower plants under the Ministry of Electric Power No. (1) was totaled 1,441 MW in 2009. During the period of 1997 and 2007, Zawgyi (2) hydropower plant, Zaungtu hydropower plant, Thaphanseik hydropower plant, Mone hydropower plant, Paunglaung hydropower plant and Yenwe hydropower plant had been implemented. Yenwe multi-purpose project is one of the Sittaung basin development projects and it generates twenty-five MW and can irrigate 118,000 acres of farmland. In

Sittaung basin development projects, Paunglaung project was a major electric power project and Zaungtu and Yenwe were medium ones and inaugurated in 2000 and 2007. Hydropower plants under the Ministry of Electric Power No. (2) can be seen in Table (5).

Table (4): Hydropower Plants under the Ministry of Electric Power No. (1)

No	Hydropower plant	Megawatt	Year of completion
1.	Baluchaung (2)	168	1974
2.	Kinda	56	1985
3.	Hsedawgyi	25	1989
4.	Baluchaung (1)	28	1992
5.	Zawgyi (1)	18	1995
6.	Zawgyi (2)	12	1998
7.	Zaungtu	20	2000
8.	Thaphanseik	30	2002
9.	Mone	75	2004
10.	Paunglaung	280	2005
11.	Tikyit (coal-fired)	120	2005
12.	Yenwe	25	2007
13.	Khabaung	30	2008
14.	Kengtawng	54	2009
15.	Shweli (1)	500	2009
Total		1441	

Source: The New Light of Myanmar, 15 May 2009, p.7

As shown in Table (5), after 1988, the generating capacity of the hydropower plants under the Ministry of Electric Power No. (2) had reached 418.53 MW. Up to 2009, due to the Ministry of Electric Power No. (2)'s efforts the generating capacity of the hydropower plants had reached 723.82 MW and all the hydropower plants were gas-fired and steam ones. Although the generating capacity of electricity by the two Ministries were 2,164.82 MW in 2009, hydropower plants only could generate 556 MW. This was because decrease in the producing electricity from hydropower plants during summer season and decrease in generating capacity of some old power plants. So, the government was distributing electricity alternately to the public from the national power grid by setting groups in order to keep balance between supply and demand of electric power.

Since 2010, Myanmar had embarked on political reforms which were a series of political, economic and administrative reforms. As a transition to a Democratic Nation, many investments from local people and abroad had flowed into the industrial sector. Demand for electric power increased year after year while arrangement was being made to build more hydropower plants with the aim of producing electricity.

Between 2010 and 2015, the country tripled its installed capacity of hydropower plants, and total installed capacity was at least 3488 MW. All the water resources throughout the country are to be harnessed effectively by establishing hydropower projects for the distribution of more electricity to make considerable contribution towards the drive for boosting production of commodities and socio-economic development of the people.

In order to implement the electric power sector effectively and widely, major projects have been laid down and are being undertaken. Hydropower projects between the year of 2010 and 2015 can be seen in Table (6).

Table (5): Hydropower Plants under the Ministry of Electric Power No. (2)

No.	Hydropower plant	Megawatt	Year of completion
1.	Kyunchaung	54.50	1974
2.	Myanaung	34.70	1975
3.	Mann	36.90	1980
4.	Ywama	60.90	1980
5.	Mawlamyine	12.00	1980
6.	Shwedaung	55.35	1984
7.	Thaton	50.95	1985
8.	Thakayta	57.00	1990
9.	Hlawga	99.90	1995
10.	Ahlone	99.90	1995
11.	Thakayta (steam)	35.00	1997
12.	Kanma	8.72	1998
13.	Hlawga (steam)	54.30	1999
14.	Ahlone (steam)	54.30	1999
15.	Ywama (steam)	9.40	2004
Total		723.82	

Source: The New Light of Myanmar, 15 May 2009, p.7

Table (6): Hydropower Projects between 2010 and 2015

No	Name of Project	Locations	Generating capacity			Year of completion
			Electricity (MW)	Numbers of generators	Total (MW)	
1.	Shwegyin	Bago	18.75	4	75	2010
2.	Yeywa	Mandalay	197.50	4	790	2010
3.	An	Rakhine	5	2	10	2010
4.	Kyeeohn kyeewa	Magway	37	2	74	2010
5.	Pyu	Bago	20	2	40	2011
6.	Nancho	Mandalay	20	2	40	2011
7.	Tapein (1)	Kachin	60	4	240	2011
8.	Chiphwenge	Kachin	33	3	99	2011
9.	Kun	Bago	20	3	60	2011
10.	Upper-Paunglaung	Mandalay	70	2	140	2012
11.	Thaukyaykhat(2)	Bago	40	3	120	2012
12.	Beluchaung (3)	Kayah	24	2	48	2012
13.	Thahtay	Rakhine	37	3	121	2015
14.	Htamanthi	Sagaing	200	6	1200	2015
15.	Manipur	Sagaing	95	4	380	2015
16.	Upper Kengtawng	Shan	17	3	51	2015
Total					3488	

Source: The New Light of Myanmar, 2 January 2010, p.9

In accordance with the guidance of the Head of State, the Ministry of Electricity and Energy was implementing hydropower projects. On completion of all these projects according to Table (6), about 3,488 MW of electricity would be generated, but the large-scale hydropower plants of Htamanthi hydropower project was suspended in 2011. Therefore, only 2288 MW can be supplied to the people. Hydropower projects between 2016 and 2020 was shown in Table (7).

Table (7): Hydropower Projects between 2016 and 2020

No	Name of projects	Megawatt	Year of completion
1.	Mongwa	66	2016
2.	Myittha	40	2017
3.	Buywa	42	2018
4.	KengTawng (upper)	51	2020
5.	Baluchaung (upper)	30	2020

Source: Ministry of Electricity and Energy, 2020

During the period of 2016 and 2020, another five power plants were completed with total installed capacity of 229 MW namely; Mongwa hydropower project (66 MW), Myinttha hydropower project (40MW), Buywa (42 MW), Keng Tawng (upper) hydropower project (51 MW) and Baluchaung (upper) hydropower project (30 MW).

Among large-scale hydropower projects, Yeywa hydropower project is the third largest and the fifth highest irrigation facility in the world. Yeywa dam project is located on the Myintnge river, fifty-two kilometers southeast of Mandalay city, at Yeywa village in Kyaukse township of Mandalay Region. Yeywa hydropower project is being implemented by modern heavy machinery, applying advanced technologies. The hydropower project is the country's first roller-compacted concrete (RCC) dam. The hydropower project is the largest hydropower project in Myanmar. It is a heavy hydropower project to contribute much towards the progress of socio-economic sector of the State. From the hydropower projects about 3,550 gigawatt-hours of electricity per year can be supplied to the Mandalay Division regional power grid for public and private consumption.

With the completion of these hydropower projects, the people had the opportunities to get electricity for the development of the nation. In 2019, Myanmar electricity access was 68.31 percent and which is 2.21 percent increased from 2018. In 2020, Myanmar electricity access was 70.42 percent, a 2.1 percent increased from 2019. Myanmar electricity access for 2021 was 72.47 percent, a 2.05 percent increased from 2020. Ministry of Electricity and Energy adopted the strategy of the electrification rate milestones of 50 percent in 2020, 75 percent in 2025 and 100 percent in 2030.

The development of hydropower projects can be seen year after year due to the guidance of the Heads of State and the government put first priority in building mega structures of hydropower projects. Furthermore, feasible studies are being conducted to implement the large projects around the country. But some large hydropower projects such as Myitsone hydropower project and Htamanthi hydropower project had been controversial and so they were suspended in 2011.

Cooperation with Foreign Countries in Hydropower Projects

Myanmar is cooperating with foreign countries to develop hydropower projects around the country. Since 2004, Myanmar is cooperating with five neighbouring Asian countries such as China, Thailand, South Korea, India and Bangladesh, initiating major hydropower projects. China has been a particularly active investor in Myanmar's hydroelectricity generation industry. Since 2013, driven by the "Belt and Road" Initiative, China has become Myanmar's largest trading partner and major source of investment, and Myanmar is an important investment destination and project contracting market for China among ASEAN countries. China also considers Myanmar to be an important market overseas. Up to 2020 China still continues to participate in the strategic development needs of Myanmar and the investment of the development in energy infrastructure of the country and contributes to the bilateral mutually beneficial cooperation along the "Belt and Road" project.

During the period between 2010 and 2020, eight countries were involved in hydropower development in Myanmar. China was cooperating in (34) hydropower projects with the generating capacity of about 34,976 MW, (18) hydropower projects were being implemented by Chinese companies in Kachin State with the generating capacity of 21,403 MW and (11) hydropower projects in Shan State with the generating capacity of 12,303 MW. Besides China, Myanmar was also cooperating with its other Asian neighbours such as Thailand, South Korea, India and Bangladesh in the development of hydropower projects. In December 2005, Myanmar cooperated with the experts of the Electricity Generating Authority of Thailand (EGAT) to build the Hatgyi hydropower plant in Kayin State. The Hatgyi hydropower plant consists of a 600 MW turbine that can produce 3.82 billion KW hours yearly. Power generated from the project is expected to be partly exported to Thailand.

Myanmar and Thailand joint venture hydropower project is the 7,110 MW, Tarhsan hydropower project on Myanmar's Thanlwin river in eastern Shan State's Tachilek township. Myanmar agreed in July 2006 with Korean International Cooperation Agency (KOICA) and Korea Electric Power Corporation (KEPCO) to develop Myanmar's electric power network dealing with management and operation. Myanmar is also cooperating with India in Htamanthi 1,200 MW hydropower project, Manipur 500 MW hydropower project and Homalin 150 MW hydropower project.

On 16 September 2008, an agreement was signed between Myanmar's Hydroelectric Power Department and India's Hydroelectric Power Corporation Ltd to construct a 1,200 MW dam in Htamanthi and a 600 MW dam in Shwesayay in the Chin State, which borders India in the northwest of Myanmar. Myanmar and Bangladesh are enhancing cooperation in seeking to build hydropower plants in Myanmar for export of electricity to Bangladesh.

In 2009, Myanmar agreed with Bangladesh to implement 600 MW of Lemyo hydropower plant in the Rakhine State. Besides, Singapore invested in six hydropower projects with the generating capacity of 685 MW. France is cooperating in three hydropower projects totaling capacity of about 1,740 MW, Thailand is cooperating in 3 hydropower projects with the capacity of 4,780 MW. Austria is cooperating in one project with the capacity of 66 MW, and Norway is cooperating in one project with the generating capacity of 700 MW.

Hydropower development projects had attracted the most Foreign Direct Investment (FDI) in Myanmar. According to the government's National Investment Commission, the electric power sector dominated foreign investment in Myanmar with USD 6.311 billion in 2007. In 2008, FDI in hydropower projects by China, South Korea, Thailand, India, Singapore and Bangladesh, reportedly accounted for forty-three percent of foreign investment in Myanmar. In order to develop in renewable energy sector especially in hydropower sector, it is important for developing country, Myanmar to introduce modern technology and foreign investment in addition to MOEE own efforts.

Challenges and Opportunities of Hydropower Projects in Myanmar

According to the geographical conditions, Myanmar has rich water resources across the country for generating electricity. The greatest economic benefit of hydropower project is the fact that the hydropower project has abundant low-cost energy that contributes to electric power grids. The projects require a big amount of investments. In the long run, hydropower is inexpensive. After constructing the necessary infrastructure, there's usually less maintenance and upkeep than other forms of energy. It can save the rising fossil fuel prices and it does not need to rely on importing energy. Hydroelectric energy is a great resource because it creates greater energy independence for countries. A reduced demand for external fuel sources may lessen conflict and improve economic issues for countries that struggle to get fuel from international sources.

Other renewable sources of energy such as solar energy and wind power rely on the nature of the sun and wind, and just like any other energy storage system, there are windless day, and when it's night, the sun does not shine, which limits the production. Hydropower will provide electricity even when wind and solar cannot, making it more practical and economical as a source of electricity. According to survey that solar power is only a maximum of (30-36) percent efficient, wind power only (25-45) percent efficient, and coal power is only (33-40) percent efficient. Hydroelectric energy is up to 90 percent efficient at converting water into electricity. Hydroelectric power plants can supply a large amount of energy to the remote areas of the country and also it can create job opportunities in the country.

A majority of hydropower plants are the facilities that store large volumes of water in reservoirs, and they will mostly contain storage water to pull and generate the power. The reliance on stored water by hydropower plants means that this technology is reliable and can provide a stable source of energy. Hydropower facilities offer the benefit of a providing a source of irrigation for crops, flood control and clean water in the areas. Hydropower reservoirs can be used as reliable sources of fresh and clean water. There are some environmental considerations that come with large hydropower plants such as reservoirs or dams. However, after they become operational, they do not require to burn any fossil fuels to produce electricity.

Hydroelectric energy is one of the most environmentally friendly forms of energy production. In hydroelectric energy, there is no combustible fuel involved. Unlike the fossil fuel sources of energy, using hydropower to produce electricity does not release any pollutants in the air or water. Hydropower can provide clean and domestic power energy.

Hydropower is a renewable source of energy but there are usually environmental impacts associated with building the power plants. To build a dam, new roads and power lines must be installed that disrupt the environment. When dams are created, they limit the flow of water, which affects the oxygen levels in the water. Lower oxygen levels behind the dam can result in lower oxygen levels downstream as well. When there is not as much oxygen in the water, it is more difficult for some species of fish to survive, which affects river habitats. The increase in carbon dioxide and methane emissions from a hydroelectric plant can also harm all forms of aquatic plant life. The increased pollution of these greenhouse gases can cause plant life beneath the water to rot, which can severely impact the surrounding ecosystem. Dams also often form reservoirs that flood large areas and displace natural habitats. The pumped storage of hydropower which can affect the natural flow of the river system. Blocking the flow of water can also seriously impact fish migration, especially for species like salmon that rely on rivers to spawn. Dams can even impact biological triggers that make fish to migrate. Some dams have sought to solve this disadvantage of hydroelectric energy by creating fish ladders or fish elevators to help migratory fish make it to their spawning grounds. The effect can disrupt animal migration and bring up issues of water quality for wildlife and humanity.

Hydropower being a reliable energy source is ultimately controlled by prescriptive trends and the weather. However, most of the hydropower energy relies heavily on river water,

and this means that droughts will cause an impact on the overall electric production, which can impact the capacity of hydroelectricity. The amount of water available to produce hydroelectric will vary depending on the weather conditions, and therefore electric production is unreliable.

Reservoirs not only displace animals from their habitats, but they also displace people. This disadvantage of hydroelectric energy can have quite a large impact on communities. People who have lived in an area their whole lives may be forced to move, and although they are typically compensated for moving, it cannot make up for what they have lost. Cities, towns, and villages have been eliminated by dams, and local cultures displaced.

By studying the advantages and disadvantages of sustainable energy, there's no denying that it's an efficient mean of producing energy for a sustainable future. As Myanmar is water resource country, hydropower resource is the only renewable energy resource which is currently being exploited and which has future prospect for more exploitation and utilization in the country.

Hydropower plays an important role in electricity generation worldwide. Large-scale hydropower plants, more than 100 MW, are reliable, effective and can produce up to 100 years. China, Brazil, Venezuela are leading large-scale production in hydropower even though they can affect environment and society by damaging ecosystem, methane gas emissions, evaporation, siltation, and migration of people due to dam construction. They can even get risks due to dam failures. On the other hand, they can generate electricity in large scale to meet the national demands of their countries.

In Myanmar, it has enormous exploitable hydropower resources and the majority of them are ideal sites for mega-hydropower stations. However, hydropower was generated only 62.4 percent of total electricity generation in 2014. Furthermore, there are only (22) numbers of medium and small hydropower stations operational in Myanmar with the installed capacity of 31.712 MW. This situation is unmatched with the actual energy reserves in the country. Although the government of Myanmar endeavours to promote hydropower development, it is confronted with many obstacles.

In Myanmar, water resources are abundant in ethnic minority areas, especially in Karen, Shan and Kachin States. Conflicts and disputes between the government and armed ethnic groups lead to the suspension and cancellation of many hydropower plants, which scared off foreign country investment and impeded the utilization of hydropower stations in Myanmar. The implementation of large-scale hydropower plants of Myanmar has met many difficulties. Large scale hydropower projects such as Myitsone hydropower project is a controversial project. It was outlined in 2001 and the plan includes (64) hydropower plants and three coal power plants with combined installed capacity of more than 40,000 MW.

In December 2006, the government and the China Power Investment Corporation signed a memorandum of understanding (MoU) for a generation capacity of 6,000 MW of Myitsone hydropower project and a generation capacity of 3,400 MW project of Chibwe hydropower project. Myitsone hydropower project would have been the fifteenth largest hydroelectric power station in the world. The dam, planned to be 1,310 metres (4,300 ft) long and 139.6 metres (458 ft) high, was to be built by the Upstream Ayeyawaddy Confluence Basin Hydropower Company. The company is a joint venture between the China Power Investment Corporation (CPI), the Ministry of Electric Power, and the Asia World Company. The dam was planned to have a generation capacity of 6,000 MW and to produce electricity primarily for export to Yunnan province of China.

Myitsone hydropower project has been controversial in Myanmar due to its enormous flooding area, environmental impacts, location (60) miles from the Sagaing fault line, and uneven share of electricity output between the two countries. Myanmar public regarded the Ayeyarwady river as the birthplace of Myanmar civilization and some people thought that Myitsone hydropower project represented growing Chinese influence in Myanmar, which they

perceived as "exploitative" to the country hitherto isolated by western economic sanctions. On 30 September 2011, amid of democratic reforms in the country, the former President U Thein Sein announced that the Myitsone dam project was to be suspended during his tenure.

The implementation of large-scale hydropower plants of Myanmar has met many difficulties. Hydropower project alters the ecology more or less when it is built which involve the livelihood of millions of people along the four main rivers and their tributaries. The uneven distribution of benefits between the government and local people in Myanmar often triggers conflicts in the name of environmentalism. Actually, it is not merely an environmental issue but also a combat over territory. Large-scale hydroelectric dams are of minimal environmental and socio-economic damage and reduce the use of fossil fuels such as natural gas, oil and coal which release the polluting of carbon dioxide (CO₂) and other harmful gases and substances. Large hydropower stations can not only provide enough electricity for domestic supply, but also export surplus electric power to the neighbouring countries.

To resolve the large-scale hydropower projects issue, Myanmar government formed (20) members hydropower investigation commission in 2016. The main task for the commission is to assess the potential environmental and social effects of any proposed projects on the Ayeyawaddy river and weigh those against the benefits and potential losses to the wider economy.

Furthermore, the hydropower projects have to take into consideration that during the summer season, heavy reliance on hydropower could lead to shortages in power supply. The time of February, March, April and May is the summer of Myanmar, and power shortage is high during the summer. Therefore, some medium and small-scale hydropower stations are not capable of operating at the full capacity due to lack of water. Approximately, monthly deduction of electricity amounts up to about (20) percent during the summer season of the country.

In Myanmar, several large dams are planned to increase future hydropower utilization. Between 1990 and 2002, the country tripled its installed capacity of hydropower plants, increasing from 253 MW (339,000 hp) to 745 MW (999,000 hp). The total installed capacity in 2010 was at least 2,449 MW (3,284,000 hp) MW, and so it was six percent of potential. Most of Myanmar's electricity (74.7) percent is produced by hydroelectricity. The rest of (4.8) percent is from fossil fuels, with gas as the main fuel 20.5 percent followed by coal and oil. In 2017, Myanmar had an installed electricity generation capacity of about (5) GW. The country plans to achieve 100 percent electrification by 2030. The country is targeting twelve percent of all electricity to be generated from renewable sources by 2025.

In order to achieve the goal of 100 percent electrification of Myanmar in 2030, large-scale hydropower stations as well as responsible small-scale stations are advocated. In many rural areas of the country, there are no grid-lines with the national power supply and villagers have to try all kinds of means to self-electrification. Small-scale hydropower stations have the advantages of short construction period, easy maintenance and low-cost operation. It is one of the alternatives for those who live in remote areas of the country.

In order to meet the demand for electricity in domestic and foreign markets, Myanmar has promulgated an energy plan to increase its electricity generating capacity five-fold in 2030. It is difficult to accomplish this goal with its own capital investment and technical support. Currently, China and Thailand are the largest hydropower developers in Myanmar. As leading power in hydropower construction projects, Chinese state-owned enterprises and Myanmar government are needed to transparency and publicly involved in every large-scale hydropower projects around the country. In Myanmar, hydropower projects infrastructure and high investment risks hindered the construction of large-scale hydropower stations. The priority effort of government is to provide peace and stability of the country. The government should

make great efforts to implement national reconciliation so as to provide an environment that has the development of the hydropower sector across the country.

Conclusion

By utilizing water resources across the country, hydropower energy has been developed. In renewable energy sector, hydropower development has attracted foreign direct investment and China has been a particularly active investor in hydropower generation projects. In Myanmar, all these hydropower project sites are located near border areas and thus provide the cooperation opportunity for regional development. Additionally, cooperating with the Asian neighbours in developing the hydropower sector so far, Myanmar still needs much more foreign investments and cooperation to make greater achievement. It is concluded that Myanmar is abundant in hydropower resources, but the rate of utilization from hydropower project is extremely low. During the period of 2010 and 2020, the government is endeavouring to overcome energy deficit by implementing hydropower projects around the country.

It is suitable for Myanmar as a developing country, it should emphasize using hydropower more than oil and gas because of long term cost-effective, clean energy, and abundant of water resources around the country. To develop hydropower energy in the country, it is important to suite energy policy of Myanmar and it is necessary to set specific energy efficiency and conservation policy in future. It is needed to get national reconciliation and peace to speed up the process of hydropower projects and then a favourable environment will attract more foreign investments.

For further development, what the government should take into consideration is to do the construction of electricity national grid lines especially in rural areas of the country. With beneficial policy encouragement and sufficient financial and technology support, the hydropower of Myanmar will be greatly exploited. The development of hydropower projects provide many opportunities not only for economic development but also for accelerated natural resources extraction. With the development in hydropower projects, the country will not only enjoy its self-sufficiency of electricity but also export the surplus. Then it may contribute to the national development and also the improvement of socio-economy of the people.

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NAME AUTHORITY FILE IN CATALOGUING (ASEAN COUNTRIES EXCEPT MYANMAR)

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Abstract

This study investigates the compositional patterns of authors' names from ASEAN (Association of Southeast Asian Nations) countries, aiming to discern trends and variations in naming conventions within scholarly publications. The research analyzes diverse sets of data encompassing academic articles, journals, and conference papers authored by individuals from ASEAN nations. By employing data mining methods, the study delves into the structural components of authors' names, including given names, surnames, and potential cultural or regional nuances influencing naming conventions. The findings shed light on the diversity and uniqueness of author names across ASEAN countries, providing valuable insights for academic indexing, information retrieval systems, and cross-cultural communication within the scholarly community. Understanding these compositional patterns contributes to more effective and inclusive knowledge dissemination and collaboration within the ASEAN region and beyond. The study area is defined at first and collected data are analyzed to examine the extent how they comply with existing rules. After analyzing, suggested the headings for ASEAN personal authors and appropriate set of rules. The outcome of the studies is a table of personal authors' name according to similarity of their compositional pattern and Name authority file of ASEAN personal author with appropriate cross references. It is hoping this study is useful in cataloguing works written by the authors from ASEAN countries and produces a tiny part of authors' Name Authority list for cataloguing.

Keywords: Name Authority File, AACR2, ASEAN Countries

Introduction

Today is an information age and technology is rapidly advancing every sector all over the world. In line with the advancement of technology, most of the libraries have been trying to promote their operation system from manual to fully computerized system. Some libraries are nearly reaching the goal and can be called hybrid library. Some are still away from this trend due to many reasons. However, to retrieve an item from the library collection they both need well established catalogue with standard heading. To achieve well established catalogue, sufficient rules are necessary to record them. Recording items in accordance with existing rule is called cataloguing. Cataloguing is the process of organizing library materials and making them accessible to library users¹. The first step of cataloguing process is choice of access points such as Author, title, and subject...etc., because they are used to access the certain materials in a library collection by users. After getting access points, selecting main entry and making it as catalogue heading is an essential step in descriptive cataloguing.

Consistent heading for authors is very important in cataloguing process but sound and reliable authority list for authors is not appeared in Myanmar till now. Therefore, this research aims to produce authors' Name Authority list for cataloguing.

In AACR 2 rule 21.1A1 precisely defines the personal author as follow:

A personal author is the person chiefly responsible for certain intellectual or artistic content of a work. For example, writers of books and composers of music are the authors of the works they create; compilers of bibliographies; cartographers are the authors of their maps; and artists and photographers are the authors of the works they create. In addition, in certain cases performers are the authors of sound recordings, films, and video-recording.

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Therefore, it is assumed in general that an author is a main entry for the item because the author is chiefly responsible person of a work. As an author is main entry, it requires to correctly organizing the headings or entry element for author in accordance with the cataloguing rules. But nature of the naming system is differed from each other due to different tradition, custom and culture in ASEAN countries including Brunei Darussalam, Burma, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand and Vietnam

Name authority file controls to maintain consistency in assigning the naming system. This paper emphasizes on the naming system for ASEAN countries (except Myanmar) because the naming system of Myanmar are compiled as the PhD dissertation by Dr Tun Aung Kyaw.

Authority control has been an integral part of library catalogs since the inception of the modern library. Authority control is the establishment and maintenance of consistent forms of terms: names, subjects, and title, to be used as headings in the bibliographic records of the library catalogue. Heading must also be unique⁴. Authority control fulfills two important functions

1. It enables the disambiguation of items with similar or identical headings
2. It enables the collocation of materials the logically belong together, although they present themselves differently.

Objectives of the Study

The objectives of the study are as follows:

1. To organize a prototype of name authority control for ASEAN countries authors by selecting the most prominent one among various names and making it as a standard heading.
2. To propose the appropriate set of rules for ASEAN countries authors' name (except Myanmar)
3. To provide tiny parts of name authority file by adding authority list of authors from ASEAN countries.

Scope of the Study

Although the term of ASEAN countries authors' name is using in this paper, it is not included Myanmar personal author's name because it has already existed. Therefore, the remaining ASEAN countries such as Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand and Vietnam are included in this study. In this point, this study covered only personal authors name but corporate name and phrases used as pseudonym are not included.

Research Questions

The following questions can support the findings of the study.

1. What is a name authority file in cataloguing of a country?
2. How to catalog personal names?
3. What are the naming systems of ASEAN countries except Myanmar?
4. What are the benefits of adding an authority list of authors from ASEAN countries?

Methods of Study

Literature search method was mainly applied to collect raw data in the Department of Library and Information Studies library, the Yangon University Library, the Universities' Central library. After collecting the data, they are analyzed according to their compositional pattern in detail. Then, consultation is made with the existing rules (AACR 2 and Rules drawn by Myanmar Senior Librarian) and proper headings will be proposed. Interviewing methods are also applied for the authority persons of cataloguing for ASEAN countries' naming system. Finally, Authors' Name Authority List is produced.

Outcome of the Study

The outcome of this study is prototype of name authority list for authors from ASEAN countries. It can be used as one of the reference sources for consistent headings for the authors from ASEAN countries.

Literature Review

Name authority control represents a central activity of catalog professionals and is essential for the maintenance of library catalogs. It allows users to identify information resources and ensures the collocation of relevant search results. A literature review is a survey of scholarly sources that provides an overview of a particular topic. The following are reviews of relative literature for this research.

Authority Control of Arabic Personal Names: RDA and Beyond is a scholarly article entitled by Iman Daghera and Denise Soufib. It represents a foundation for authority control of Arabic personal names and to address some of the challenges that catalogers may encounter during this process; it will then conclude with an examination of future trends such as identity management and their effect on authority work in non-Latin script languages. This paper discusses the basics of creating name authority records for Arabic personal names in accordance with RDA instructions and PCC guidelines. The paper concludes with an examination of the possible benefits of identity management and other changes.

Tun Aung Kyaw submitted his doctoral dissertation titled "Headings for Myanmar Personal Authors" to Yangon University in 2017. This study is based upon name elements of Myanmar pennames to catalogue Myanmar books written by Myanmar authors. He presented most librarians use Anglo-American Cataloguing Rules Second Edition (AACR2) to catalogue library materials. This study aims to propose rules for Myanmar personal author names and to produce name authority file for Myanmar personal authors. He analyzed headings for Myanmar personal authors and an appropriate set of rules are proposed. By using consistent headings in every library user can search certain books in the library collection easily and quickly. The outcomes of the studies are a table of Myanmar personal author names according to similarity of their compositional pattern, a set of propc rules for Myanmar personal authors and name authority file of Myanmar personal authors v appropriate cross references.

Name Elements of Personal Author from ASEAN Countries

This study examines name authority file in cataloguing of ASEAN countries except Myanmar. These countries are Brunei, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, and Vietnam.

The Association of Southeast Asian Nations is a regional organization which was established to promote political and social stability amid rising tensions among the Asia-Pacific's post-colonial states. The motto of ASEAN is "One Vision, One Identity, One Community".



Figure 1. The Map, Flag, and People of ASEAN

Authors can use various names for his or her work. Cataloguer needs to choose a name as main entry to create catalogue heading for that person. It is import process in cataloguing library materials. Anglo-American Cataloguing Rules Second Edition (AACR 2) directed that “if the person is known by more than one name, choose the name by which the person is clearly most commonly known”. To harmonize with the rules from AACR 2, choose the most commonly known among names used by author. After choosing the most predominant name, analysis is made on

1. personal name or corporate name
2. any surname or family name are included or not
3. if there is a surname, it is first place or last place in the name
4. which part of name is pay attention to

This analysis enables the cataloguer to understand the compositional pattern of the name and to create the proper headings for that person. Based on their compositional pattern of name, appropriate catalogue heading will be created.

AACR 2 states if the name contains a surname enter under that surname. If the surname is in last position in name, transpose any elements, which included in front of the surname to the end of surname and place coma between them. If the surname is in first position in name, enter the name in direct order. Follow the surname by a comma. If the name does not contain a surname, enter it in direct order. This study obeys and practices the above rules.

The names of the authors discussed in this study are only the names that are currently in use. Old and less used names have been omitted. Therefore, conservative names will not be found in this study.

Compositional Pattern of Bruneian Name



Figure 2. The Map, Flag, and People of Brunei

In Brunei, the organization of names follows a unique cultural and linguistic pattern that reflects the country's rich heritage and Islamic influence. Typically, a Brunei person's name is structured in a way that emphasizes family and lineage. The naming convention often includes the individual's given name, followed by their father's name, and then the grandfather's name. This practice not only serves as a form of identification but also highlights the importance of familial ties and respect for ancestors.

Furthermore, Brunei's naming tradition is deeply rooted in Islamic principles, with many names having Arabic origins and meanings. Islamic names often carry significant cultural and religious symbolism, reflecting virtues, attributes, or historical figures from Islamic history. The inclusion of such names in the personal nomenclature of Brunei people reinforces the cultural and religious values that play a crucial role in shaping their identity.

Moreover, in addition to the individual's name, titles and honorifics may also be included, especially for those holding prominent positions or having a particular status in society. These titles, bestowed based on achievements, education, or social standing, contribute to the comprehensive organization of names in Brunei, offering insights into an individual's

background and role within the community. Overall, the structure and organization of names in Brunei serve as a cultural tapestry that weaves together elements of familial bonds, Islamic heritage, and societal roles.

Brunei names are generally following the Arabic patronymic naming system of given name + bin/binti or son of/daughter of (often abbreviated SO/DO) + father's name. Their compositional pattern is shown in following table. But this tradition is used only conservative people.

Table 1. Organization of Bruneian Names

Title*	Given name	Suffix*	Father's title*	Father name	Full name	Gender
Hajji	Abdul Hafiz	Bin	Hajji	Matsa'ad	Hajji Abdul Hafiz bin Hajji Matsa'ad	Male

Catalogue Heading for Bruneian Personal Authors

In this regard, Brunei names are entered in direct order as found in chief source of information because of lack of surname. For example:

Name = Aminah Hashim
 Heading = Hashim, Aminah

Table 2 Proposed Headings for Brunei Names

Names	Heading
Abdul Rahman	Rahman, Abdul
Ali Hassan	Hassan, Ali
Azizul Azmi	Azmi, Azizul

Compositional Pattern of Cambodia Name



Figure 3. The Map, Flag, and People of Cambodia

In Cambodia, the organization of names is deeply influenced by cultural, historical, and religious factors. Traditionally, a Cambodian person's name is composed of three parts: the given name, the father's name, and the grandfather's name. This three-part structure emphasizes the importance of lineage and ancestry, reflecting a respect for family heritage. It is not uncommon for individuals to be referred to by their full name in formal and traditional settings, underlining the significance of familial connections in Cambodian society.

Additionally, Cambodian names often have strong ties to Buddhism, the predominant religion in the country. Many names have Sanskrit origins and carry spiritual or symbolic meanings. Buddhist monks, who play a significant role in Cambodian culture, may also influence the naming process by providing guidance or suggesting names based on religious principles. This infusion of religious and cultural elements into personal names reflects the interconnectedness of individual identity with broader social and spiritual contexts.

Furthermore, titles and honorifics may be incorporated into Cambodian names, particularly for individuals holding positions of authority or respect within their communities. These titles can denote social status, educational achievements, or professional roles,

contributing to a nuanced and hierarchical organization of names. In modern Cambodia, individuals may adopt Western-style names for practical purposes, but the traditional naming conventions remain integral to the cultural fabric, reinforcing the significance of family, spirituality, and societal roles in the organization of Cambodian names. Married women retain their maiden name and do not add their husband's name to their own. Children can take either their father's surname or a personal name.

Catalogue Heading for Cambodian Personal Authors

Cambodian people use surname in last position in their name. The significant difference differ from western tradition is writing style of their name. The Cambodian name is always spoken and written in the order of last name then first name. Therefore, their names are started with surname and followed by the given name. There is no comma used to separate the last name from the first name.

For example: In the name of Soth Sopheap, Sopheap is given name and Soth is surname.

first name	-	Sopheap.	(given name)
last name	-	Soth	(surname)
full name	-	Soth Sopheap	(official style)
not		Sopheap Soth	

Because of the unique style of writing the name, it can be said that the catalog heading has already been created by itself. Therefore, to make catalogue heading, no need to do anything else and must be entered direct order. But comma is used to separate the surname and given name according to the rules directed in AACR 2. The heading should be

Name	=	Soth Sopheap
Heading	=	Soth, Sopheap

Table. 3 Proposed headings for Cambodian Names

Name	Heading
Chanmony Ngoun	Chanmony, Ngoun
Davith Chey	Davith, Chey
Rathana Sok	Rathana, Sok

Compositional Pattern of Indonesian Name



Figure 4. The Map, Flag, and People of Indonesia

Indonesia's naming system reflects its rich cultural diversity and historical influences. Typically, Indonesian names consist of one or more given names followed by a family name. The given names often have significant meanings, drawn from various linguistic traditions such as Javanese, Sundanese, Balinese, or other indigenous languages, as well as Arabic, Sanskrit, or European languages due to historical influences. For example, names like Putri (princess), Bayu (wind), or Budi (virtue) are common given names, each carrying its own cultural significance.

Family names in Indonesia often reflect the ethnic or regional background of the individual. For instance, names like Suryono, Kartini, or Gunawan might indicate Javanese ancestry, while names like Hasan, Salim, or Abdullah could signify Arabic heritage. However, it's important to note that not all Indonesians have family names, especially in rural areas or among certain ethnic groups where a single name or patronymic naming tradition might prevail.

In recent years, there has been a trend towards more creative and unique naming practices, with parents combining traditional names with modern influences or inventing entirely new names. Additionally, some Indonesians choose to adopt nicknames or use their father's name as a surname in informal settings. This blend of traditional, regional, and modern naming conventions reflects the dynamic nature of Indonesian society and its diverse cultural tapestry.

Catalogue Heading for Indonesian Personal Names

When Indonesian personal names are making as a heading, it can be categorized by two types. The first one is the name consisting of more than one element. It may be a compound given name, a given name followed by a surname, a given name followed by a father's name, or a given name followed by a clan name. Whatever the structure, when creating headings for Indonesian name consisting of more than one element, enter it under the last element of the name. E.g., The heading for the name “Mohammad Hatta” is “Hatta, Mohammad”

The second one is the names consisting of given name followed by an element denoting filial relationship, such as “bin”, “binti”, “ibni”, plus the father's name. In this point, enter under the first element of the name. Eg. The heading for the name Abdullah bin Nuh is “Abdullah bin Nuh”. In this point, the entry element is first element.

Table 4. Proposed Headings for Indonesian Names

Name	Heading
Aditya Putra	Putra, Aditya
Ahmad Bin Salim	Ahmad Bin Salim
Ali Bin Abdullah	Ali Bin Abdullah

In these examples, “Bin” is used for males, and “Binti” is used for females to indicate their relationship to their father.

Compositional Pattern of Laotian Name

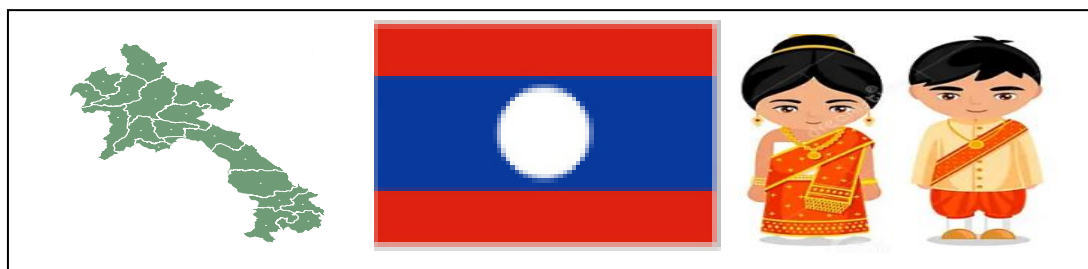


Figure 5. The Map, Flag, and People of Laos

The naming system of the Lao people, deeply rooted in tradition and culture, reflects a profound significance attributed to familial bonds and spiritual beliefs. Typically, Laotian names consist of two parts: the given name and the father's name. In Lao naming conventions, the typical format includes a given name followed by a patronymic (indicating the individual's relationship to their father), but there isn't necessarily a separate family name in the Western sense.

Beyond these structural components, Laotian names are rich with cultural nuances and symbolism. They often reflect the interconnectedness between nature, spirituality, and daily life. Certain prefixes or suffixes may denote gender or marital status, while others indicate respect or reverence. Additionally, Laotian names frequently incorporate elements from Buddhism, such as references to revered figures or religious concepts. This integration of spiritual elements underscores the profound influence of Buddhism on Lao society and underscores the importance of faith in shaping personal identity and values.

Furthermore, the naming process in Lao culture extends beyond mere convention, embodying a sense of familial pride and collective memory. Names are carefully passed down through generations, carrying with them the legacy of ancestors and the aspirations of descendants. Through this continuity, individuals are not only connected to their immediate family but also to a broader lineage spanning generations. Thus, the naming system of the Laotian people serves as a testament to the enduring traditions and values that bind communities together, fostering a sense of belonging and shared identity amidst the complexities of modern life.

Catalogue Heading for Laotian Personal Names

The compositional pattern of Laotian people's names typically consists of a given name followed by a patronymic, which indicates the individual's relationship to their father.

E.g.,	Name	-	Somphong Sisavat
	Given Name	-	Somphong
	Patronymic	-	Sisavat
	Heading	-	Sisavat, Somphong

Table 5. Proposed Headings for Laotian Names

Name	Heading
Bouasone Thammavong	Thammavong, Bouasone
Bounchanh Sisouphanthong	Sisouphanthong, Bounchanh
Bounleuth Sisombat	Sisombat, Bounleuth

Compositional Pattern of Malay Names

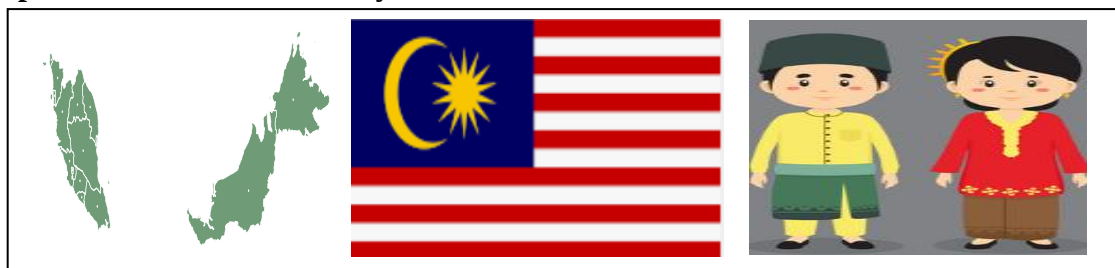


Figure 6. The Map, Flag, and People of Malaysia

In Malaysia, the organization of names reflects a diverse cultural landscape influenced by Malay, Chinese, Indian, and indigenous traditions. The naming convention for Malaysians typically consists of a given name, followed by the father's name. Surnames are not as common among Malays, and the organization of names often emphasizes the importance of family and paternal lineage. However, there can be variations in naming practices, especially among the Chinese and Indian communities in Malaysia, where surnames and additional given names may play a more prominent role.

The naming diversity in Malaysia is further enriched by the multicultural makeup of the population. Malaysian Chinese often follow the traditional Chinese naming convention,

including a family name followed by one or two given names. Similarly, Malaysian Indians may adhere to naming practices rooted in Hindu traditions, incorporating both personal names and familial elements. In this multicultural context, Malaysians may have names that reflect their ethnic background, religious affiliations, and cultural heritage, contributing to a rich and varied organizational structure of names that is reflective of the unity in diversity.

Naming system of Malaysia is similar to the Brunei Nationals' naming system. Malays do not have family names. They attach their father's name to their personal names. A Malay's name consists of a personal name, which is used to address them in all circumstances, almost always followed by a patronym. Thus, most Malays do not use family names or surnames. In general, the format of Malay names is "X BIN or BINTI Y", where 'BIN' means 'son of' and 'BINTI' means 'daughter of'. For men, the patronym consists of the title bin (meaning 'son of') followed by his father's personal name. Example: Razak bin Osman. In this case, Razak is the man's personal name while Osman is his father's name. It's important to note that Malay naming conventions can vary based on cultural and regional differences, and modern influences may lead to variations in naming patterns as well.

Catalogue Heading for Malay Personal Authors

Enter the Malay name under the first element of the name, if lack of surname.

E.g., Name - Shahnnon Ahmad
Heading - Shahnnon Ahmad

The Malay name consisting of surname is entered under the surname.

E.g., Name - Faridah Merican
Heading - Merican, Faridah (surname: Merican)

If the name contains the titles of honour, rank, or position, they are added after the name.

E.g., Name - Haji Abdul Majid bin Zainuddin
Heading - Abdul Majid bin Zainuddin, Haji

Table 6. Proposed Headings for Malay Names

Name	Heading
Aisha Ibrahim	Aisha Ibrahim
Amirah Abdullah	Amirah Abdullah
Azlan Chin	Azlan Chin

Compositional Pattern of Philippines Name



Figure 7. The Map, Flag, and People of Philippines

In the Philippines, most get their last names from their father too. But the parents don't get to choose the middle name, just the first name. The mother's maiden last name is automatically assigned as the middle name. The only name parents can choose is the first name, and the first name can be as long or as short or composed of several names, as long as it fits on the birth certificate. For people who like tracing their lineage, this system makes things easier.

For the most part, most Filipinos abide by the Spanish system of using both paternal and maternal surnames, the latter constituting the "middle name". An example would be Jose

Cuyegkeng y Mangahas becoming Jose Mangahas Cuyegkeng, where the particle y is used only for legal purposes and is otherwise dropped. The middle name in its natural sense would have been the second name if the person had one, but is never counted as an individual's given name.

Moreover, the naming process in the Philippines is not solely a matter of personal identity but also carries social and familial significance. Names are often passed down through generations, symbolizing continuity and familial legacy. They are a source of pride and belonging, connecting individuals to their roots and heritage. In Filipino society, names are revered and respected, with specific titles or honorifics denoting social status or authority. Overall, the naming system in the Philippines reflects the country's diverse cultural tapestry and the enduring importance of family, tradition, and identity in Filipino society.

Catalogue Heading for Philippine Personal Authors

The compositional pattern of Philippine people's names typically consists of a given name followed by a middle name (often denoting the mother's maiden surname) and finally the surname (family name).

E.g., Name - Maria Clara Dela Cruz
 Given name - Maria Clanar
 Middle - Dela
 Surname - Cruz
 Heading - Cruz, Maria Clara Dela

Table 7. Proposed Headings for Philippine Names

Name	Heading
Anna Garcia Del Rosario	Del Rosario, Anna Garcia
Antonio Garcia Reyes	Reyes, Antonio Garcis
Bienvenido L. Lumbera	Lumbera, Bienvenido L.

Compositional Pattern of Singaporean Name



Figure 8. The Map, Flag, and People of Singapore

The naming system in Singapore is a reflection of its diverse multicultural society, blending influences from various ethnic groups such as Chinese, Malay, Indian, and Eurasian communities. Singaporean names typically consist of a given name and a surname. A middle name is included in some cases but very rarely found. Given names are often chosen with significance, reflecting cultural or familial aspirations, religious beliefs, or simply personal preferences. It's not uncommon for individuals to have names that span multiple languages or traditions, showcasing Singapore's multiculturalism and linguistic diversity. Middle names, while less common, may sometimes be included to honor additional family members or cultural practices.

Surnames in Singapore can be indicative of the individual's ethnic background or familial lineage. Chinese Singaporeans often bear surnames derived from Chinese characters, reflecting the rich cultural heritage of the Chinese community. Similarly, Malay Singaporeans may have surnames with Malay or Arabic origins, while Indian Singaporeans may have

surnames rooted in Indian languages such as Tamil, Malayalam, or Hindi. Additionally, Eurasian Singaporeans, who trace their ancestry to European and Asian origins, may have surnames that reflect a mix of Western and Asian influences. The diversity of surnames in Singapore serves as a testament to the country's multiculturalism and the harmonious coexistence of different ethnic groups.

In Singaporean society, names are not only identifiers but also symbols of cultural pride and heritage. They serve as a link to one's roots and ancestry, connecting individuals to their familial lineage and community. Singaporeans often take great care in selecting names for their children, considering factors such as cultural significance, auspicious meanings, and the desire to preserve familial traditions. Moreover, names may carry social implications, with certain titles or honorifics signifying respect or authority. Overall, the naming system in Singapore reflects the country's multicultural ethos and underscores the importance of diversity, unity, and mutual respect in its society.

Catalogue Heading for Singaporean Personal Authors

Most Singaporean citizen of Chinese descent usually has an English or Christian name, so the format is [Christian Name] [Last Name] [First Name], and those without Christian names are written as [Last Name] [First Name]. Those of Indian and Malay descent will have their names in the standard [First Name] [Last Name]. The name order promoted by the Singapore government is Surname plus Chinese given name plus English given name. It is found that the compositional patterns of Singaporeans are of three types. The first one format is Christian name come first, Surname is in middle position and given name is last position. Catalogue heading is

E.g., Name - Rachel Tan Mei Ling
 Heading - Tan Mei Ling, Rachel

The second one is Surname comes first and followed by a given name. For this name, it is entered under surname. Catalogue heading is

E.g., Name - Tan Ah Kow
 Heading - Tan, Ah Kow

The last one is given name comes first and followed by a surname. Catalogue heading is

E.g., Name - Rajesh Patel
 Heading - Patel, Rajesh

Table. 8 Proposed headings for Singaporean

Name	Heading
Chia K. G. Robert	Robert, Chia K. G.
Kernal Singh Sandhu	Sandhu, Kernal Singh
Lee Wei Jie	Lee, Wei Jie

Compositional Pattern of Thai Names



Figure 9. The Map, Flag, and People of Thailand

Thai naming conventions arrange names as follows: [given name] [FAMILY NAME]. For example, Somchai THEERAVIT (male) and Parfun VAIYASINGHA (female). The given name (or ‘personal name’) is chosen at birth as the individual’s personal identifier. It is generally considered the most important aspect of a person’s name. The ‘family name’ (or ‘surname’) is inherited from one’s parents and shared with other members of the individual’s immediate family. Thai names are traditionally patrilineal, whereby children inherit their father’s family name at birth. Most women will take their husband’s surname upon marriage. For example, if Parfun VAIYASINGHA married Somchai THEERAVIT, she may be known as Parfun THEERAVIT.

Children are not always named immediately after birth in Thai culture. It is common for children to be given a nickname (see below) before their official name is decided. It is common for parents to consult with a monk, fortune teller, or other respected person in society in order to choose the most appropriate or auspicious name for their child. Thai given names generally have a positive connotation in their meaning and may signify an aspiration for the child. Most Thai given names and nicknames are derived from one or multiple of the following languages: Thai, Chinese, Malay, Sanskrit, Pali, English and Japanese. Surnames only became officially introduced to Thailand in the early 20th century. Therefore, many Thai family names are newly created and only two or three generations old. Thai law prevents people from creating a surname that duplicates that of another family. Therefore, Thai citizens have been made to adopt surnames that are longer and more complex in order to keep them unique (e.g. SONJOHNKOKSOONG).

However, it is expected that people use their official name in formal and legal settings. Thai people generally address others using the title ‘Khun’ followed by their personal name, e.g. ‘Khun Somchai’. This is a non-gender specific honorific (equivalent to Mr/Mrs/Miss) used in most formal or professional settings or when addressing strangers.

People may also address close friends and relatives using honorifics based on their gender, status and relationship to one another. For example, someone may refer to a younger male friend as ‘noongchaai’ (younger brother) and an older female friend as ‘piisaa’ (older sister). Such terms often indicate closeness and endearment. Thai people always refer to and identify others by their personal name. It is incorrect to address someone by their title and surname (as is Western practice).

Thai names are constituted with given name, family name, and honorific terms.

Given Name - the personal name given to an individual by their parents.

1. Given Name- the personal name given to an individual by their parents.

Example: Surachai, Wanchai, Suwat

2. Family Name - the surname, passed down through generations.

Example: Prayadkao, Inchai, Sukkhi

3. Honorific Terms – may be Prefix or Suffix

Male: Nai, Nang, Nangsao (honorific prefix)

Female: Nang, Nangsao (honorific prefix)

Khun (honorific suffix)

Catalogue Heading for Thai Personal Authors

Thai names typically consist of a given name followed by a surname. In Thai naming conventions, the surname typically comes after the given name.

E.g.,	Name	-	Pimchanok Srisawat
	Heading	-	Srisawat, Pimchanok

Table 9. Proposed Headings for Thai Personal Author Name

Name	Heading
Chayanon Kamnan	Kamnan, Chayanon
Naree Phormbutr	Phormbutr, Naree
Natthawut Charoenwong	Charoenwong, Natthawut

Compositional Pattern of Vietnamese Name**Figure 10. The Map, Flag, and People of Vietnam**

Vietnamese names are generally arranged as follows: [FAMILY NAME] [middle name] [given name]. For example, NGUYEN Van Nam (male) or LE Thi Lam (female). However, in practice, many Vietnamese individuals use only two parts - the family name followed by the given name. The family name, which is passed down from generation to generation, holds significant importance as it signifies the family lineage and heritage. In Vietnamese culture, family names are relatively few in number compared to given names and are shared by a large number of people.

Given names in Vietnam are chosen with great care and often have poetic or symbolic meanings. Parents may select names based on desirable characteristics, virtues, or aspirations for their child. Additionally, names may be influenced by historical figures, literary works, or religious beliefs. Vietnamese given names are often monosyllabic and may include diacritical marks to denote tones, adding depth and nuance to pronunciation. Despite the diversity of names, certain naming conventions are followed to maintain harmony and respect within families and society.

The middle name, if present, is less common in Vietnamese names but may be used to further differentiate individuals within the family or to honor a specific ancestor. It may also serve as a marker of generational affiliation. While the Vietnamese naming system has evolved over time, reflecting historical and societal changes, the emphasis on family lineage, respect for ancestors, and the significance of personal identity remains deeply ingrained in Vietnamese culture. Overall, Vietnamese names are a reflection of the country's rich history, cultural values, and enduring traditions.

Catalogue Heading for Vietnamese Personal Authors

The compositional pattern of Vietnamese names typically follows a structured format consisting of three elements: family name, middle name (if present), and given name. But most used pattern is Family Name plus Given Name.

E.g., Family Name - Ho
 Middle Name - Dem
 Given Name - Ten

Table 10. Proposed Headings for Vietnamese Names

Name	Heading
Do Thi Thu Ha	Do, Thi Thu Ha
Hoang Van Khanh	Hoang, Van Khanh
Le Thi Kim Ngan	Le, Thi Kim Ngan

Conclusion

In conclusion, the naming systems of people from ASEAN (Association of Southeast Asian Nations) countries exhibit diversity and reflect the rich cultural, historical, and linguistic backgrounds of each nation. While there are variations in naming conventions among ASEAN countries, some common patterns emerge, given names are chosen by parents and hold individual significance. They often reflect cultural, religious, or auspicious meanings and are an essential aspect of personal identity. Family names may or may not be present in ASEAN naming systems. In countries where family names are used, they are typically passed down through generations and denote familial ties. However, in some countries, such as Indonesia and parts of Malaysia, family names are less common. Middle names are present in some ASEAN countries, such as the Philippines, where they often include maternal surnames or the mother's maiden name. However, middle names are not universal across all ASEAN nations. ASEAN naming systems are influenced by various cultural, religious, and historical factors. These influences can include indigenous traditions, colonial legacies (such as Spanish, Portuguese, or Dutch), and neighboring cultural exchanges. ASEAN countries are home to diverse ethnic groups, each with its own naming customs and practices. This diversity adds richness and complexity to the region's naming systems, with variations observed based on ethnicity, language, and regional customs.

Overall, while there are differences in naming conventions across ASEAN countries, there are also shared elements that emphasize the importance of family ties, individual identity, and cultural heritage. The naming systems of ASEAN nations serve as a reflection of the region's vibrant cultural tapestry and its history of multicultural interactions.

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HEADING FOR MYANMAR PERSONAL AUTHORS NAME WITH REGION NAME

Ni Ni Aung*

Abstract

Every library owns certain amount of collection and each librarian has a responsibility to record these collections. Most librarians used Anglo-American Cataloguing Rules Second Edition (AACR2) to catalogue library materials, Dewey Decimal Classification Scheme to assign classification number and Sear List of Subject Heading to assign subject heading. Although AACR2 is used to catalogue, actually it is not covered rules for collection of Myanmar books and it is not convenient for Myanmar Librarians. Therefore, this paper aims to propose the consistent heading for Myanmar personal authors with region names are one of the essential factors in the process of cataloguing Myanmar books. Firstly, collect the various names of Myanmar authors. After collecting those names, they are analyzed by their compositional pattern consulting with the rules from Anglo-American Cataloguing Rules Second Edition and drawn by Myanmar senior librarians. Then propose proper heading for Myanmar personal authors with region name. Through the research, literature survey method is used. This paper can produce consistent heading for Myanmar personal authors with region name as an output. This paper can provide the catalogue of heaving responsibility for cataloguing Myanmar books. It can also beneficial for the person who is interesting and wants to study the Myanmar personal authors with region name. Moreover, this paper can be served as part of name authority file for Myanmar personal authors.

Keywords: Myanmar personal authors, Region name, Proposed heading, Name authority file

Introduction

This paper describes and analyzes the nature and composition of Myanmar personal author name with region names.

Myanmar authors can freely assume any pseudonym for their creation. Some authors intentionally used pseudonyms or pen names by the reason of keeping themselves secrets. It is found that some male authors have assumed the name customarily used by a female, and vice versa. Sometimes, the same pseudonyms have been used by different authors can be found.¹

Myanmar cataloguers face challenges due to insufficient implementation rules in Anglo-American Cataloguing Rules Second Edition (AACR2) for Myanmar authors. Therefore, Myanmar senior librarians drew additional rule for Myanmar authors. But, there are still many issues in cataloguing Myanmar books.

Aim and Objectives of the Study

The aim of this paper is to provide consistent heading for Myanmar personal author name with region name. There are many objectives of compilation of this paper. Among them some objectives are described the following.

- To explain the concept of personal author names in cataloguing rules
- To help Myanmar librarians for cataloguing
- To reduce confusing problems of Myanmar personal author names.
- To find Myanmar books easily and quickly

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1. U Thein Shwe, “*Mran'mā cāre*”su ámaññ ‘myā’ á tvak’ kat’talok’ sūu” kho”cañ’ chuiñ’rā cññ’ “myañ’ ”myā” áā” le’lākhrāi” (မြန်မာစာရေးသူအမည်များအတွက် ကတ်တလောက်သုံး ခေါင်းစဉ်ဆိုင်ရာ စည်းမျဉ်းများအား လေ့လာခြင်း) (paper presented at the 80th Anniversary of Yangon University, Yangon University, 2000). (hereafter cited as Thein Shwe)

- To know composition of Myanmar personal names
- To study Myanmar personal author name with region name

Scope of the Study

The study includes Myanmar personal names, Myanmar personal author names, composition of Myanmar personal author names and Name authority file. This paper mainly focuses on proposed Myanmar personal author name with region name in 20th century.

Research Questions

- What are the main features of Myanmar personal names?
- What are the challenges in cataloguing Myanmar personal author names?
- How to compose the Myanmar personal author names?
- What is the name structure of Myanmar personal authors with region names?
- What will the cataloguers do Myanmar personal author names according to AACR 2?

Method of the Study

Literature search method is used for this paper. At first required data is collected from libraries and Department of Library and Information Studies. The data is analyzed by compositional pattern. And then, proposed headings are consulted with Anglo-American cataloguing Rule Second Edition and drawn by Myanmar senior librarians.

Outcome of the Study

Outcome of this paper is consistent heading for Myanmar personal author name with region name for cataloguers. Readers will be able to understand more about the compositional pattern of Myanmar personal author names. Besides, it supports as part of name authority file for Myanmar personal authors with region name.

Findings

1. Myanmar Personal Names

Myanmar has a custom of giving names to a child after a month of he or she was born. The name element is chosen in accordance with the day on which the child was born. Myanmar has no tradition of using the family name (Phay Myint : Real name is Maung Phay Myint and Son of U Aung Nyein and Daw Khin Thein) ဖေ့မြင့်/အမည်ရင်း မောင်ဖေမြင့်၊ မိဘနှစ်ပါးမှာဦးအောင်ငြိမ်းနှင့်ဒေါ်ခင်သိန်း။ And, there is no discrimination in giving the name element against sex. Therefore, the name of a man may sometimes be similar to the name of a woman (U Kyi, Daw Kyi: ဦးကြည်၊ ဒေါ်ကြည်/ U Kyi Nyunt, Daw Kyi Nyunt: ဦးကြည်ညွန့်၊ ဒေါ်ကြည်ညွန့်/ U Khin, Daw Khin: ဦးခင်၊ ဒေါ်ခင်/ Maung Tin Shwe, Ma Tin Shwe : မောင်တင်ရွှေ၊ မတင်ရွှေ/ Maung Tin Aung, Ma Tin Aung: မောင်တင်အောင်၊ မတင်အောင်။ Maung Yin Kyae, Ma Yin Kyae: မောင်ယဉ်ကျေး၊ မယဉ်ကျေး). Myanmar has various honorific prefixes to differentiate among age, sex, rank and status U, Ko Maung, Daw, Ma, Sayar, Thakhin, Thakhin Ma, Yebaw, Bomu, Doctor, Professor (ဦး၊ ကို၊ မောင် ဒေါ်၊ မ၊ ဆရာ၊ သခင်၊ သခင်မ၊ ရဲဘော်၊ ဗိုလ်မှူး၊ ဒေါက်တာ၊ ပါမောက္ခ). The numbers of name elements generally found in Myanmar personal name is up to seven elements Zin Min Myo Ma Ma Kyu Htwe (ဇင်မင်းမျိုးမမကြူထွေး)².

2. Myanmar Personal Author Names

At the present time, there were many personal authors who had created intellectual or artistic works. The name may be an original name, or religious name, or a royal lineage name,

². Thein Shwe.

or a personal author name. In this paper describes and analyzes the nature of Myanmar personal authors with region name.

Some authors intentionally used pseudonyms or pen-names by the reason of keeping themselves secrets. These pseudonyms did not present the real life of authors. Authors had assumed them just conceal-themselves. At present, it might be said that a choosing of pseudonym is the first task for an author before he or she prepares to create a work.

Myanmar authors can freely assume any pseudonym. Male authors have assumed the name customarily used by a female, and vice versa. Mya Watt Ye/ မြဝတီရည် was used by Min Thu Won/မင်းသုဝဏ်၊ May May Hlaing/ မေမေလှိုင် was used by Mya Than Tint/ မြသန်းတင့်၊ Ko Ko Lay/ကိုကိုလေး was used by Dagon Khin Khin Lay/ဒဂုံခင်ခင်လေး. There is no restriction to the number of pseudonym Alingarkyawzwar Saw Mya Aye Kyi/ အလင်္ကာကျော်စွာစောမြေကြည် and the combination of foreign alphabets with Myanmar words K.L (ကုမ္ပဏီ). Also, the same pseudonym has been used by different author Khin, Chit, Nyi Nyi, Nyo, Nyunt, Nu, Maung, Maung Maung Kyaw, Maung Maung Myint, Maung Maung Thein (ခင်၊ ချစ်၊ ညီညီ၊ ညို၊ ညွန့်၊ နု၊ မောင်၊ မောင်မောင်ကျော်၊ မောင်မောင်မြင့်၊ မောင်မောင်သိန်း). Some pseudonyms are fanciful and quite awkward. These are the cause of problems to the cataloguers in creation of Catalogue Heading in accordance with the present existing cataloguing rules.

Composition of Myanmar Personal Author Names

Myanmar personal author names may be composed of any letter, any word without limitation in numbers.

e.g., မကြန်
မောင်ခက်ပန်
ရဲဘော်ချမ်းအေး
ဒေါက်တာညီညီ
ရွှေမန်းဒေါ်တင်လှ
ကျောက်ဘီလူးတင်မောင်ဆွေ
မန်းတက္ကသိုလ်မောင်ပေါက်စည်
အမျိုးသားစာကြည့်တိုက်မြင့်ကြိုင်
အလင်္ကာကျော်စွာစောမြေကြည်
မြန်မာသမိုင်းအဖွဲ့ဝင်ဒေါ်အုန်းကြည်

When Myanmar personal author names are analyzed, it is found that there are three elements. They are.

- (1) Name Element (NE)
- (2) Honorific Prefix (HP), and
- (3) Other Appellation (OA).³

Name Element (NE)

Name Element (NE) is the one assumed under which he or she is known in the social surrounding by others. It generally reveals who the person is, by adding an appropriate

³. IFLA, *Names of Persons: National Usage for Entry in Catalogues*. 3rd ed. London: IFLA, 1977). 20.

honorific prefix (HP) before the Name Element (NE), it specifically points out the personal status of the bearer's sex, race, rank, age and a religious person or not, etc.

Honorific Prefix (HP)

Myanmar nationalities such as Bamar and other ethnic groups customarily have different honorific prefix (HP). They are used to differentiate each other on the basics of race, sex, rank, and age, etc. The common characteristic of honorific prefix (HP) is that it always exists in front of name element (NE).

Other Appellation (OA)

Other appellations (OA) are any word which obviously or likely extends the meaning of the name element (NE). It works as the same as the adjective does in the language. The place of other appellation (OA) in Myanmar author names may be before or after of the name element (NE).

3. Myanmar Personal Authors Name with Region Name

This paper describes and analyzes the compositional pattern of Myanmar personal author names that region name is added to the name as other appellation. When studying Myanmar personal author name with region name, it can be categorized by three groups. The first one is the name including region full name. The second one is the name including part(s) of region name. And the last one is the name including metaphorical terms of region name.

- (1) Names with region's full name
- (2) Names with region's partial name
- (3) Names with metaphorical term of region name

(1) Names with region's full name

After analyzing the compositional pattern of the name, four types of compositional patterns are found in this type. The first type is including name elements and region's full name and started with name element. The second one includes the name elements and region's full name but region name comes first. The third one is the names consisting of honorific prefix, name elements and region's full name. The last one is started region's full name and followed by honorific prefix and name elements.

- (a) Name elements (NE) and region's full name (RN)
- (b) Region's full name (RN) and name element (NE)
- (c) Honorific prefix (HP), name elements (NE) and region's full name (RN)
- (d) Region's full name (RN), honorific prefix (HP) and name elements (NE)

Name elements (NE) and region's full name (RN)

In this type name elements are placed at the first position and region's full name is included after name elements. They may be used / not used in parenthesis.

e.g.,	NE	+	RN	=	Name
	ခင်မြင့်	+	(ဆကာကြီး)	=	ခင်မြင့်(ဆကာကြီး)
	Khin Myint	+	(Zakargyi)	=	Khin Myint (Zakargyi)
	မြင့်ရည်	+	တမာမြေ	=	မြင့်ရည်-တမာမြေ
	Myint Yee	+	Tamarmyay	=	Myint Yee – Tamarmyay

(a) Region's full name (RN) and name element (NE)

The name is started with the region's full name and followed by name elements.

e.g.,	RN	+	NE	=	Name
	ကန့်ဘလူ	+	ခင်မောင်ဆွေ	=	ကန့်ဘလူခင်မောင်ဆွေ
	Kantbalu	+	Khin Maung Swe	=	Kantbalu Khin Maung Swe

(b) Honorific prefix (HP) , name elements (NE) and region's full name (RN)

In this type, the name is formed with three elements. They are honorific prefix, name elements and region's full name. They may be used / not used in parenthesis.

e.g.,	HP	+	NE	+	RN	=	Name
	ကို	+	ပညာ	+	(အမရပူရ)	=	ကိုပညာ(အမရပူရ)
	Ko	+	Pyinnya	+	(Amarapura)	=	Ko Pyinna (Amarapura)
	မောင်	+	ရင့်ကျူး	+	မြောင်းမြ	=	မောင်ရင့်ကျူး-မြောင်းမြ
	Maung	+	Yint Kyue	+	Myaunnmya	=	Maung Yint Kyue- Myaunnmya

(c) Region's full name(RN), honorific prefix(HP) and name elements(NE)

The name is started with region's full name and after it honorific prefix and name elements are included.

e.g.,	RN	+	HP	+	NE	=	Name
	နာဂတောင်တန်း	+	မောင်	+	ကြည်ဇင်	=	နာဂတောင်တန်းမောင်ကြည်ဇင်
	Narga-Taungtan	+	Maung	+	Kyi Zin	=	Narga-Taungtan Maung Kyi Zin
	ဘိုကလေး	+	မ	+	တင်လှိုင်	=	ဘိုကလေးမတင်လှိုင်
	Bogalay	+	Ma	+	Tin Hlaing	=	Bogalay Ma Tin Hlaing

(2) Names with region's partial name

In this type, parts of region name are taken from region's name and added to the name either after or before the name elements. Sometimes it is enclosed within parenthesis when it included in the last position in name. There are of two types in this category. They are

(a) Name elements (NE) with parts of region name (RN)

Parts of region name (RN) and name elements (NE)

(a) Name elements (NE) with parts of region name(RN)

The name is organized with name elements and parts of region name. Name elements come first. Region name may be used / not used in parenthesis.

e.g.,	NE	+	RN	=	Name
	မြ	+	ကေတု	=	မြကေတု
	Mya	+	Kaytu	=	Mya Kaytu
	ညိုမြင့်	+	(သလ္လာ)	=	ညိုမြင့်(သလ္လာ)
	Nyo Myint	+	(Thallar)	=	Nyo Myint (Tharllar)

(b) Parts of region name (RN) and name elements (NE)

The name is formed with name elements and parts of region name but parts of region name come first in this type.

e.g.,	RN	+	NE	=	Name
	ဝတီ	+	ရွှေမင်း	=	ဝတီရွှေမင်း
	Wati	+	Shwe Min	=	Wati Shwe Min
	နာဂ	+	တင်ဦး	=	နာဂတင်ဦး
	Narga	+	Tin Oo	=	Narga Tin Oo

(3) Names with metaphorical term of region name

Sometimes the names consisting of metaphorical terms of region name. When analyzing this category, it can be divided into three types. The first one includes two elements

such as name elements and metaphorical term of region name. The second one also includes two elements as in first type. But the positions of elements are differed from each other. Although the first type of name is started with name elements, the second type of name is started with metaphorical term of region. The third one is organized by three elements such as metaphorical term of region name, honorific prefix and name elements.

- (a) Name elements (NE) with metaphorical term of region name (RN)
- (b) Metaphorical term of region name (RN) and name element (NE)
- (c) Metaphorical term of region name(RN), honorific prefix (HP) and name element (NE)

(a) Name elements (NE) with metaphorical term of region name(RN)

e.g.,	NE	+	RN	=	Name
	ခိုင်လင်း	+	(မေဃဝတီ)	=	ခိုင်လင်း(မေဃဝတီ)
	Khine Lin	+	(Maygawati)	=	Khin Lin (Maygawati)
	မြန်မာပြည်သား	+	(ဆရာစံမြေ)	=	မြန်မာပြည်သား(ဆရာစံမြေ)
	Myanmar Pyi Thar	+	(Sayar San Myay)	=	Myanmar Pyi Thar (Sayar San Myay)

(b) Metaphorical term of region name(RN) and name element (NE)

e.g.,	RN	+	NE	=	Name
	ကျွန်းစဉ်မြေ	+	စောခက်	=	ကျွန်းစဉ်မြေစောခက်
	Kyunsinmyay	+	Saw Khet	=	Kyunsinmyay Saw Khet

(c) Metaphorical term of region name(RN), honorific prefix (HP) and name element (NE)

e.g.,	RN	+	HP	+	NE	=	Name
	မြေလတ်	+	မောင်	+	မြင့်သူ	=	မြေလတ်မောင်မြင့်သူ
	Myaylet	+	Maung	+	Myint Thu	=	Myaylet Nan Myint Thu
	ကမ္ဘောဇ	+	မောင်	+	ပြီးရည်	=	ကမ္ဘောဇ မောင် ပြီးရည်
	Kanbawza	+	Maung	+	Pyone Yee	=	Kanbawza Maung Pyone Yee

According to the number and kind of elements, when compositional patterns are analyzed to constitute the Myanmar personal author names and regardless of their position in name, two main patterns are found. One consists of two kinds of elements such as name elements and region name. The next one consists of three kinds of element such as honorific prefix, name elements and region name. In this point region name means full region's name, parts of region name and metaphorical term of region name.

4. Proposed Headings for Myanmar Personal Author Name with Region Name

According to the rules of AACR 2 and drawn by Myanmar senior librarians, entry element for Myanmar personal author name must be name element. Therefore, the honorific prefix or/and region name (including full region's name, parts of region name and metaphorical term of region name) which included in front of name element is transposed to the end of name elements so that name elements are first element in catalogue heading. If region name is included after the name element it is entered in direct order of name.

They are four pattern of proposed heading of the below.

- (i) Name Element (NE) with Region Name (RN)
- (ii) Region Name (RN) with Name Element (NE)
- (iii) Honorific Prefix (HP) , Name Element (NE) with Region Name (RN)

(iv) Region Name (RN) , Honorific Prefix (HP) with Name Element (NE)

Name Element (NE) with Region Name (RN)

In this pattern, the other appellation (OA)/ region name may be full name or partial name or metaphor name. Any region name may include after the name element (NE). They may be used/ not used in parenthesis, enter it straight.

e.g., -

NE	+	RN	=	Proposed Heading
ကြော့	+	ဝက်လက်	=	ကြော့ဝက်လက်
Kyawt	+	Wet Let	=	Kyawt Wet Let
လင်းလက်	+	(လခြမ်းမြို့)	=	လင်းလက်(လခြမ်းမြို့)
Lin Let	+	(La Channmye)	=	Lin Let (La Channmye)

(i) **Region Name (RN) with Name Element (NE)**

In this pattern, the other appellation (OA)/ region name may be full name or partial name or metaphor name. Any region name may precede the name element (NE). Transpose to the end and underline it (for type written) or type bold phase it (for computer), and add the dash (-) after it. Place comma (ပုဒ်ကလေး) between them.

e.g.,	RN	+	NE	=	Proposed Heading
	ချောင်းဆုံ	+	အုန်းသွင်	=	အုန်းသွင်၊ ချောင်းဆုံ-
	Chaunn Son	+	Ohnn Thwin	=	Ohnn Thwin, Chaunn Son-
	မန်း	+	ခင်ခင်	=	ခင်ခင်၊ မန်း-
	Mann	+	Khin Khin	=	Khin Khin, Mann-
	ခေတ္တရာ	+	ညွန့်	=	ညွန့်၊ ခေတ္တရာ-
	Khittayar	+	Nyunt	=	Nyunt, Khittayar -

(ii) **Honorific Prefix (HP), Name Element (NE) with Region Name (RN)**

In this pattern, the other appellation (OA)/ region name may be only full name. This region name may be included after the honorific prefix (HP) and the name element (NE). Transpose the honorific prefix (HP) to the end and underline it (for type writer) or type bold phase it (for computer).

e.g.,	HP	+	NE	+	RN	=	Proposed Heading
	ဒေါ်	+	ခင်ခင်	+	(ပြည်)	=	ခင်ခင်၊ <u>ဒေါ်</u> (ပြည်)
	Daw	+	Khin Khin	+	(Pyi)	=	Khin Khin, Daw (Pyi)
	ဒေါက်တာ	+	မြင့်သန်း	+	(ညောင်လေးပင်)	=	မြင့်သန်း၊ ဒေါက်တာ (ညောင်လေးပင်)
	Dr.	+	Myint Than	+	(Nyaung Lay Pin)	=	Myint Than, Dr. (Nyaung Lay Pin)

(iii) **Region Name (RN), Honorific Prefix (HP) with Name Element (NE)**

In this pattern, the other appellation (OA)/ region name may be full name or metaphor name. Any region name may precede the honorific prefix (HP) and the name element (NE). Transpose the region name (full name or metaphor name) and honorific prefix (HP) to the end and underline it (for type written) or type bold phase it (for computer), and add the dash (-) after it. Place comma (ပုဒ်ကလေး) between them.

e.g.,	RN	+	HP	+	RN	=	Proposed Heading
	မြေလတ်	+	မောင်	+	မြင့်သူ	=	မြင့်သူ၊ <u>မောင်</u> ၊ မြေလတ်-
	Myay Latt	+	Maung	+	Myint Thu	=	Myint Thu, Maung, Myay Latt-

ပုသိမ်	+	ဒေါ်	+	တင်တင်	= တင်တင်၊ ဒေါ် ပုသိမ်-
Pathein	+	Ma	+	Tin Tin	= Tin Tin, Daw, Pathein-

Discussion

Myanmar people are practicing tradition of using the terms in front of name element which pay respect to each other by age, by gender respectively in social communication. It is brought into the field of authorship when they assumed the name for their writing. Due to complicated nature and custom of naming system, and various ways of assuming pseudonym, issues are arisen in making proper heading for Myanmar personal author names, by organizing their similarities, it is found that there are so many types of pattern for religious person, and royal family. Due to complicated nature and custom of naming system and various ways of assuming pseudonym, issues are arisen in making proper heading for Myanmar personal author name. There are various Myanmar personal author names, by organizing their similarities. It is found that there are many types of pattern for religious person, royal family and their servant, and ordinary person. Based on this finding set of rules are proposed complying with the rules from AACR2 and drawn by Myanmar senior librarians as possible. There are different names for many ethnic groups in Myanmar. So, Myanmar librarians should produce set of rules based on AACR 2 for Myanmar personal author names. Cataloguers need to know definitely the name elements, honorific prefix, and other appellation of Myanmar Personal Authors.

Conclusion

The nature of Myanmar naming system is different from other citizen. Myanmar people are practicing tradition of using the terms in front of name element which pay respect to each other by age, by gender respectively in social community. It is bought into the field of authorship when they assumed the name for their writing. Due to complicated nature and custom of naming system and various ways of assuming pseudonym, issue are arisen in making proper heading for Myanmar personal authors.

Therefore, it is necessary to product set of rules for Myanmar personal authors. This paper is a brief study on Myanmar personal author names with other appellation (OA)/ region name (full name, partial name, metaphorical term of region name). It can produce consistent headings for Myanmar personal author names with region name [Full Name (FN), Parts Name (PN), and Metaphorical Name (MN) as an output]. Headings of person are important for library field and trying continually to produce the set of rules for consistent headings of Myanmar personal author names are more important. Cataloguers need to have consistency in choosing the most predominant name among other different names of Myanmar personal author. If the cataloguer chooses the wrong headings, reader cannot find the sources easily. By using consistent heading in every library, users will be able to quickly and easily find certain books in these libraries. So, consistent headings are very important for users. So, this paper may be helpful cataloguers and users for Myanmar personal author names. This paper will support as part of name authority file of Myanmar personal author names.

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Appendix**Name Authority List of Myanmar Personal Authors with region name.****Pseudonym / Penname****Heading****(က)**

မောင်ကိုကို(လမ်းမတော်)
 တောင်တွင်းကိုကိုကြီး
 မောင်ကောက်စံ (ရခိုင်ပြည်)
 ကောင်းခန့်လင်း (မုံရွာ)
 မောင်ကောင်းမွန်(ရင်းငြိမ်း)
 ကျော်စိုး (ကော့သောင်း)
 ကိုကျော်စွာ(ကျိုက်ပိ)
 ထားဝယ်ကျော်မင်း
 နတ်တလင်းကျော်ဦး
 ကိုကြည်(ပြင်ဦးလွင်)
 နာဂတောင်တန်းမောင်ကြည်ဇင်
 မှော်ဝန်းကြည်မြတ်

ကိုကို၊ မောင်(လမ်းမတော်)
 ကိုကိုကြီး၊ တောင်တွင်း -
 ကောက်စံ၊ မောင်(ရခိုင်ပြည်)
 ကောင်းခန့်လင်း (မုံရွာ)
 ကောင်းမွန်၊မောင်(ရင်းငြိမ်း)
 ကျော်စိုး (ကော့သောင်း)
 ကျော်စွာ၊ ကို_(ကျိုက်ပိ)
 ကျော်မင်း၊ ထားဝယ် -
 ကျော်ဦး၊ နတ်တလင်း -
 ကြည်၊ ကို(ပြင်ဦးလွင်)
 ကြည်ဇင်၊ မောင်၊ နာဂတောင်တန်း -
 ကြည်မြတ်၊ မှော်ဝန်း -

(ခ)

ကိုခါး(ကွမ်းခြံကုန်း)
 ခင်ခင်(ပြည်)
 မန်းခင်ခင်
 ပျော်ဘွယ်ခင်မေသိန်း
 ရွှေဘိုသူမခင်ဂျမ်းစိန်
 မှော်ဝန်းသားဦးခင်ညွန့်
 မောင်ခင်မင်(ဓနုဖြူ)
 မန္တလေးမောင်ခင်မောင်
 ကန့်ဘလူခင်မောင်ဆွေ
 ရွှေဆယ်မြေခင်မောင်မြင့်
 ရေနံသာခင်လေး
 ကမ္ဘောဇခင်လှိုင်
 ခင်သန့်စင်(ရေးမြို့)
 မခိုင်(လွိုင်ကော်)
 လေးဝတီခိုင်ကျော်
 မောင်ခိုင်မာ(အထက်မင်းလှ)
 ခိုင်မျိုးအေး(ပုဏ္ဏားကျွန်း)
 အဝကျွန်းချစ်မောင်
 ဘုတလင်ချစ်လေး

ခါး၊ ကို (ကွမ်းခြံကုန်း)
 ခင်ခင်(ပြည်)
 ခင်ခင်၊ မန်း-
 ခင်မေသိန်း၊ ပျော်ဘွယ် -
 ခင်ဂျမ်းစိန်၊ မ၊ ရွှေဘိုသူ -
 ခင်ညွန့်၊ ဦး၊ မှော်ဝန်းသား-
 ခင်မင်၊ မောင် (ဓနုဖြူ)
 ခင်မောင်၊ မောင်၊ မန္တလေး -
 ခင်မောင်ဆွေ၊ ကန့်ဘလူ -
 ခင်မောင်မြင့်၊ ရွှေဆယ်မြေ-
 ခင်လေး၊ ရေနံသာ -
 ခင်လှိုင်၊ ကမ္ဘောဇ -
 ခင်သန့်စင်(ရေးမြို့)
 ခိုင်၊ မ (လွိုင်ကော်)
 ခိုင်ကျော်၊ လေးဝတီ-
 ခိုင်မာ၊ မောင် (အထက်မင်းလှ)
 ခိုင်မျိုးအေး(ပုဏ္ဏားကျွန်း)
 ချစ်မောင်၊ အဝကျွန်း-
 ချစ်လေး၊ ဘုတလင်-

ချင်းတွင်းချစ်သွေး
မောင်ခွန်နွယ်(အင်းလေး)

(ဂ)

ဂုဏ်သိမ်(ကော့သောင်း)
ဂျက်ကွမ်းခြံကုန်း

(စ)

လယ်တွင်းသားစောချစ်
ဂေါယာမြေစောဝင်း
မောင်စိုးထိုက်(သုံးဆယ်)
ခရမ်းစိုးမြင့်
စည်တော်မောင်(ကျိန်းအနောက်)
ရွှေတွင်းစိန်
မောင်စိန်ဝင်း(ပုတီးကုန်း)
ခေတ္တရာစိမ်းဝါ

(ဇ)

အထက်မင်းလှဇေယျာမင်း
ဇင်မင်း(သမိန်တော)
ဇင်မင်းထိုက်(ထန်းတပင်)

(ည)

မောင်ညီညာ(မကွေး)
ဗန်းမော်ညိုနွဲ့
ညိုမြင့်(သလ္လာ)
သန်လျင်မောင်ညိုမှိုင်း
ညိုသန်း(လေးဝတီ)
ညွန့်ဟံ(ကြူတော)
မောင်ညွန့်(တောင်ငူ)
မင်းလှညွန့်ကြူး
မြေလတ်နန်းညွန့်ဝေ

(တ)

ပေါက်ကွဲမောင်တင်
နာဂတင်ဦး
တင်စိုး(ပဲခူး)
ပုသိမ်ဒေါ်တင်တင်
တင်မြင့်(နတ်တလင်း)
တင်ဇ(ရှမ်းပြည်)
ဦးတင်ဦး(မြောင်)

ချစ်သွေး၊ ချင်းတွင်း-
ခွန်နွယ်၊ မောင်(အင်းလေး)

ဂုဏ်သိမ်(ကော့သောင်း)
ဂျက်ကွမ်းခြံကုန်း

စောချစ်၊ လယ်တွင်းသား -
စောဝင်း၊ ဂေါယာမြေ-
စိုးထိုက်၊ မောင်(သုံးဆယ်)
စိုးမြင့်၊ ခရမ်း-
စည်တော်မောင်(ကျိန်းအနောက်)
စိန်၊ ရွှေတွင်း-
စိန်ဝင်း၊ မောင်(ပုတီးကုန်း)
စိမ်းဝါ၊ ခေတ္တရာ-

ဇေယျာမင်း၊ အထက်မင်းလှ -
ဇင်မင်း(သမိန်တော)
ဇင်မင်းထိုက်(ထန်းတပင်)

ညီညာ၊ မောင် (မကွေး)
ညိုနွဲ့၊ ဗန်းမော် -
ညိုမြင့်(သလ္လာ)
ညိုမှိုင်း၊ မောင်၊ သန်လျင်-
ညိုသန်း(လေးဝတီ)
ညွန့်ဟံ(ကြူတော)
ညွန့်၊ မောင်(တောင်ငူ)
ညွန့်ကြူး၊ မင်းလှ-
ညွန့်ဝေ၊ နန်း၊ မြေလတ်-

တင်၊ မောင်၊ ပေါက်ကွဲ -
တင်ဦး၊ နာဂ-
တင်စိုး(ပဲခူး)
တင်တင်၊ ဒေါ်၊ ပုသိမ်-
တင်မြင့်(နတ်တလင်း)
တင်ဇ(ရှမ်းပြည်)
တင်ဦး၊ ဦး(မြောင်)

ဗန်းမော်တင်အောင်
လှည်းတန်းလမ်းကိုတင့်

(ထ)

တန်ခိုးဆရာထွန်း
လင်းခေးဦးထွန်းမြင့်
ပြည်ထွန်းရွှေ
ဆကာကြီးထိပ်တင်

(ဒ)

အိမ်မဲဒေါင်းပြာ

(န)

ပျဉ်းမနားမောင်နီသင်း
နုရည်(အင်းဝ)
မြင်းမူမောင်နိုင်မိုး
နွေးနွေးအောင်ကြွယ်(ဟိုင်းကြီးကျွန်း)

(ပ)

ကိုပညာ(အမရပူရ)
ညောင်တုန်းမောင်ပညာ
မာန်အောင်ပီယ
စလေဦးပုည
မောင်ပန်(လယ်ဝေး)
ကမ္ဘာမောင်ပြုံးရည်
ရွှေမြိုင်ပြုံးလဲ့မော်

(ဖ)

သန်လျင်ဖေသွင်
ဖိုးထောင်-တောင်သာ
ပခုက္ကူ ဖုန်းမြိုင်
ဖြိုးဝေအောင်(ငါးသရောက်)

(ဗ)

ဗဂျီးကျော်(စစ်တွေ)

(ဘ)

ရန်ကုန်ဘဆွေ
ထိလာဘရီ
စစ်ကိုင်းဦးဘိုးသင်း
ပေါင်းတည်ဘုန်းကြည်

တင်အောင်၊ ဗန်းမော်-
တင့်၊ ကို၊ လှည်းတန်းလမ်း-

ထွန်း၊ ဆရာ၊ တန်ခိုး-
ထွန်မြင့်၊ ဦး၊ လင်းခေး-
ထွန်းရွှေ၊ ပြည်-
ထိပ်တင်၊ ဆကာကြီး-

ဒေါင်းပြာ၊ အိမ်မဲ-

နီသင်း၊ မောင်၊ ပျဉ်းမနား-
နုရည်(အင်းဝ)
နိုင်မိုး၊ မောင်၊ မြင်းမူ-
နွေးနွေးအောင်ကြွယ်(ဟိုင်းကြီးကျွန်း)

ပညာ၊ ကို(အမရပူရ)
ပညာ၊ မောင်၊ ညောင်တုန်း-
ပီယ၊ မာန်အောင်-
ပုည၊ ဦး၊ စလေ-
ပန်၊ မောင်(လယ်ဝေး)
ပြုံးရည်၊ မောင်၊ ကမ္ဘာမောင်-
ပြုံးလဲ့မော်၊ ရွှေမြိုင်-

ဖေသွင်၊ သန်လျင်-
ဖိုးထောင်-တောင်သာ
ဖုန်းမြိုင် ၊ ပခုက္ကူ-
ဖြိုးဝေအောင်(ငါးသရောက်)

ဗဂျီးကျော်(စစ်တွေ)

ဘဆွေ၊ ရန်ကုန်-
ဘရီ၊ ထိလာ-
ဘိုးသင်း၊ ဦး၊ စစ်ကိုင်း-
ဘုန်းကြည်၊ ပေါင်းတည် -

(မ)

ဘိုးကလေး မတင်လှိုင်
သုံးဆယ်သူမမိ
ရွှေဘိုမိမိကြီး
မောင်မိုးသစ်အောင်လံ
မန္တလာမောင်
ရန်အောင်မောင်မောင်
ရေနံမြေမောင်မောင်ကြည်
မောင်မောင်ထိန်(ကျောက်ပန်းတောင်း)
သန်လျင်မောင်မောင်ဦး
မောင်မေတ္တာ(ရန်ကင်း)
ကြူရတနာမောင်မြကြိုင်
မြင့်စိုး(မြိတ်)
မော်ကျွန်းမြင့်ဆွေ
မြေလတ်မောင်မြင့်သူ
ဒေါက်တာမြင့်သန်း(ညောင်လေးပင်)
တောင်ကြီးမြင့်ဦး
ပဲခူးသိန်းသိန်း
မွန်ဆောင်းအို(မြိတ်)
မောင်မွန်မြတ်(ကျေးလက်-မကွေး)

(ရ)

ရဲရင့်သက်ဝေ(ကျိုက္ကော်)
ရဲသွေးနီ(ဟဲဟိုး)
ရိုးလှသန္တာ(ကျိန်းရိပ်မြီ)
မောင်ရင့်ကျူး(မြောင်းမြ)
ရောင်နီဝင်း(ဆင်ဖြူကျွန်း)
ဝတီရွှေမင်း

(လ)

လူအောင်(ကသာ)
မောင်လင်းယုန်(ရှမ်းပြည်)
လင်းလတ်(လခြမ်းမြီ)
ရွှေတောင်မောင်လွန်း
ကော့သောင်းလှမြင့်
လှိုင်ဘွား(ဗန်းမောက်)

မမလေး၊ ဂျာနယ်ကျော် - ကြည့်
မိ၊ မ၊ သုံးဆယ်သူ-
မိမိကြီး၊ ရွှေဘို -
မိုးသစ်၊ မောင်၊ အောင်လံ -
မောင်၊ မန္တလာ -
မောင်မောင်၊ ရန်အောင်-
မောင်မောင်ကြည်၊ ရေနံမြေ -
မောင်မောင်ထိန်(ကျောက်ပန်းတောင်း)
မောင်မောင်ဦး၊ သန်လျင်-
မေတ္တာ၊ မောင်(ရန်ကင်း)
မြကြိုင်၊ မောင်၊ ကြူရတနာ -
မြင့်စိုး(မြိတ်)
မြင့်ဆွေ၊ မော်ကျွန်း -
မြင့်သူ၊ မောင်၊ မြေလတ်-
မြင့်သန်း၊ ဒေါက်တာ(ညောင်လေးပင်)
မြင့်ဦး၊ တောင်ကြီး-
မြတ်လေး၊ မ - ကြည့်
မွန်ဆောင်းအို(မြိတ်)
မွန်မြတ်၊ မောင်(ကျေးလက်-မကွေး)

ရဲရင့်သက်ဝေ(ကျိုက္ကော်)
ရဲသွေးနီ(ဟဲဟိုး)
ရိုးလှသန္တာ(ကျိန်းရိပ်မြီ)
ရင့်ကျူး၊ မောင်(မြောင်းမြ)
ရောင်နီဝင်း(ဆင်ဖြူကျွန်း)
ရွှေမင်း၊ ဝတီ-

လူအောင်(ကသာ)
လင်းယုန်၊ မောင်(ရှမ်းပြည်)
လင်းလတ်(လခြမ်းမြီ)
လွန်း၊ မောင်၊ ရွှေတောင် -
လှမြင့်၊ ကော့သောင်း -
လှိုင်ဘွား(ဗန်းမောက်)

(ဝ)

ရန်ကုန်သိန်းဖေ
ဝေလင်း(ပြည်)
မုံရွာဝင်းဖေ
ဝင်းဗိုလ် (မြန်အောင်)
ပန်းတနော်ဝင်းသိန်း

ဝ၊ မောင်၊ သိပ္ပံ - ကြည့်
ဝေလင်း(ပြည်)
ဝင်းဖေ၊ မုံရွာ -
ဝင်းဗိုလ် (မြန်အောင်)
ဝင်းသိန်း၊ ပန်းတနော် -

(သ)

မသဇင်(မောင်းတော)
တောင်တွင်းကြီးသတိုးစိန်
ရေကြည်ဦးသာတင်
မန်းသင့်နောင်(ကော့ကရိတ်)
ရွှေပိန်သောင်း
သောင်း(ကေတု)
ကိုသန်း(ကြည့်မြင်တိုင်)
မောင်သန်းဆွေ(ထားဝယ်)
ဦးသန်းထွန်း(ရွှေဘို)
ပျဉ်းမနားဦးသန်းမောင်
သန်းလွင်(မကွေး)
မှော်ပီဆရာသိန်း
ဝိန်းဇလုပ်သိန်းညွန့်
သိန်းမြင့်ကျော်(မိတ္ထီလာ)

သဇင်၊ မ (မောင်းတော)
သတိုးစိန်၊ တောင်တွင်းကြီး-
သာတင်၊ ဦး၊ ရေကြည် -
သင့်နောင်၊ မန်း(ကော့ကရိတ်)
သောင်း၊ ရွှေပိန်-
သောင်း(ကေတု)
သန်း၊ ကို(ကြည့်မြင်တိုင်)
သန်းဆွေ၊ မောင်(ထားဝယ်)
သန်းထွန်း၊ ဦး(ရွှေဘို)
သန်းမောင်၊ ဦး၊ ပျဉ်းမနား -
သန်းလွင်(မကွေး)
သိန်း၊ ဆရာ၊ မှော်ပီ -
သိန်းညွန့်၊ ဝိန်းဇလုပ်-
သိန်းမြင့်ကျော်(မိတ္ထီလာ)

(အ)

စစ်ကိုင်းအေးလွင်
ဥဿာဆရာအို
ပုသိမ်အောင်သန်းဦး
ဆင်ဖြူကျွန်းအောင်သိန်း
အောင်ဟိန်း(ကျိုက်ကော်)
မကွေးမြို့အုန်းဖေ
ပခုက္ကူဦးအုန်းဖေ
ပေါင်းတည်အုန်းမောင်
သံတွဲအုန်းလွင်
ချောင်းဆုံအုန်းသွင်

အေးလွင်၊ စစ်ကိုင်း -
အို၊ ဆရာ၊ ဥဿ-
အောင်သန်းဦး၊ ပုသိမ် -
အောင်သိန်း၊ ဆင်ဖြူကျွန်း -
အောင်ဟိန်း(ကျိုက်ကော်)
အုန်းဖေ၊ မကွေးမြို့-
အုန်းဖေ၊ ဦး၊ ပခုက္ကူ-
အုန်းမောင်၊ ပေါင်းတည် -
အုန်းလွင်၊ သံတွဲ -
အုန်းသွင်၊ ချောင်းဆုံ-

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EXTRACTION AND INVESTIGATION OF THE PRELIMINARY PHYTOCHEMICAL CONSTITUENTS, ELEMENTAL CONSTITUENTS, ANTIOXIDANT PROPERTIES AND ANTIMICROBIAL ACTIVITIES OF JUICE FROM THE FRUIT OF *MORINDA CITRIFOLIA* LINN. (YE YO)

Kyu Kyu Khaine¹, Moe Lwin², May Thu Hnin Zaw³

Abstract

Noni juice extracted from the fruit of *Morinda citrifolia* Linn has the highest value of the medicinal purpose. In this research work, *Morinda citrifolia* Linn known as noni (Myanmar name – Ye yo) was chosen to extract juice and for the investigation of preliminary phytochemical and elemental constituents, some nutrients and biological activities such as antioxidant and antimicrobial activities. The fruits of *Morinda citrifolia* Linn. were collected from West Yangon University Campus, Htantapin Township, Yangon Region, Myanmar on July, 2023. The noni juice was extracted by fermentation in air tight bottle. Preliminary phytochemical screening was performed using test tube method and the elemental constituents by EDXRF technique. Protein and fat were determined by AOAC method. Vitamin-C content was estimated by iodometric titration method. The antioxidant properties of noni juice were determined by DPPH assay method and the antimicrobial activities by agar-well diffusion method on six selected micro-organisms: *Bacillus subtilis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Bacillus pumilus*, *Candida albicans* and *Escherichia coli*. Preliminary phytochemical tests revealed that the juice contains alkaloids, α -amino acids, carbohydrates, flavonoids, glycosides, organic acids, phenolic compounds, reducing sugars, saponin, starch, steroids, tannins and terpenoid. Potassium, sulphur, rubidium, copper and iron besides water were found in noni juice. The pH of the extracted juice is 3.22 and found to contain protein (1.4%), fat (0.38%) and vitamin-c (39.6 mg). The antioxidant properties of noni juice is more scavenging than the standard ascorbic acid. In the antimicrobial activity tests all antimicrobial activities of noni juice are nearly the same as in standard chloramphenicol. Therefore the noni juice from this research work may be used as juice for health benefits.

Keywords: *Morinda citrifolia* Linn., Phytochemical, EDXRF, Antioxidant, Antimicrobial

Introduction

Plant is an important medicinal source and plays a key role in world health (Oladeji, 2016). The primary benefits of using medicinal plant are relatively safer than their synthetic drugs (Madhavan, 2016). Plants are used for medicinally in various countries and they are sources of many potent and powerful drugs. Moreover, medicinal plants are sources of great economic value all over the world. They contain large varieties of chemical substances possessing important therapeutic properties used in the treatment of human diseases (Jesy, 2017).

Morinda citrifolia Linn., known as Noni, grows widely throughout the Pacific and uses as medicine in the majority of the ASEAN countries. This small evergreen tree or shrub is native from Southeastern Asia to Australia, and now has a pan tropical distribution. Active molecules such as xeronine are present in the noni fruit (Oladeji, 2016). Antioxidants play an important role in inhibiting and scavenging free radicals for providing protection to human against infections and degenerative diseases. Current research is now focused towards natural antioxidants originated from plants due to safe therapeutics (Vennila, 2014).

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Noni juice is especially known for its medicinal properties: antibacterial, analgesic, anti-congestive, antioxidant, anti-inflammatory, astringent, laxative, sedative and hypo tensor. The noni juice concentrate contains a third more polysaccharides than aloe vera and known as one of the highest polysaccharides-rich superfoods in the plant world. The polysaccharides in noni juice are believed to enhance white blood cell efficiency and boost immune system functions. In addition, high quality commercial noni juice, homemade fermented juice are naturally detoxifying to the body and are healing and softening to the skin tissue and hair follicles when consumed internally or used topically (Thawartha, 2005).

Noni juice has become a popular health supplement. In the first dozen years of its commercial marketing, more than 106 million liters of Tahitian Noni Juice were consumed in more than 80 nations. Noni juice was one of the first whole foods approved under the European Union's 1997 novel food regulations. The Chinese government has approved not only one source of noni juice as a safe resource but also as a functional food that can enhance immunity (Brett, *et al.*, 2018).

Also in Myanmar, medicinal plants are abundant. Most people use the traditional medicinal plants for the treatment of diseases and to relieve pain. The study of traditional indigenous medicinal plant and their usage in therapy play a very important role. Therefore, this research has been made on the interesting upgrade level of the Myanmar traditional indigenous medicinal plant, and have been studied chemically: investigation of phytochemical constituents, elemental constituents, physicochemical properties, vitamin-C, protein and fat contents, antioxidant properties and antimicrobial activities of noni juice. These were performed to know how an invaluable source of new chemical products, which may be important for their biological properties, and their potential use in medicine.

Materials and Methods

Sample Collection

The fruits of *Morinda citrifolia* Linn. were collected from West Yangon University Campus, Htantapin Township, Yangon Region, Myanmar on July, 2023.

Botanical Description

The botanical description of Noni (Ye yo) is mentioned as follows and shown in Figure 1.

Botanical name	- <i>Morinda citrifolia</i> Linn.
Family name	- Rubiaceae
Genus	- <i>Morinda</i>
Species	- <i>citrifolia</i>
Myanmar name	- Ye yo
Common name	- Noni
Part utilized	- Fruit
Medicinal Uses	- Anti-bacterial, Analgesic, Anti-congestive, Anti-oxidant



Figure 1 The plant of *Morinda citrifolia* Linn.(Noni)

Noni Juice Extraction

The fresh and ripen noni fruits (500 g) were collected and washed with tap water and filtered the sieve for 10 minutes to evaporate the water content on the fruits in Figure 2(a). Then the fruits were added into the bottle and closed tightly for fermentation in Figure 2(b). After 30 days the fermented juice were collected from the bottle. The collected juice was first filtered by nylon mesh to avoid the debris and seeds. The second filtration was done by Wathman No.1 filter paper and stored in air tight bottle shown in Figure 2(c) to investigate the phytochemical constituents, elemental constituents, physicochemical properties, some nutrients, antioxidant properties and antimicrobial activities.

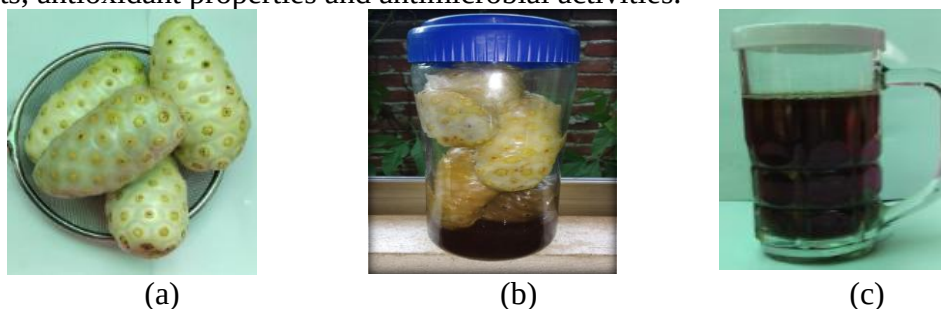


Figure 2 Cleaned fruits and the juice of *Morinda citrifolia* Linn.(Noni)

Preliminary Phytochemical Investigation of Noni Juice

The plant may be considered as biosynthetic laboratory for multitude of compounds like alkaloids, glycosides, tannins, saponins, steroids and flavonoids etc. These compounds are termed as secondary metabolites and are responsible for therapeutic effects. The presence or absence of primary and secondary metabolites in the noni juice of *Morinda citrifolia* Linn. were investigated by following standard chemical tests ie. test tube method (Harborne, J.B. 2009, M-Tin Wa. 1972).

Investigation of Elemental Constituents of Noni Juice

In order to determine the heavy toxic metals and micronutrient elements in noni juice sample, elemental contents were determined by EDXRF method at Universities' Research Center, Monywa University, Myanmar. The major advantage of X-ray spectrometry is that it offers a satisfactory compromise among economy, speed and ease of operation (Ertel, 1991).

Determination of Physicochemical Properties of Noni Juice

To know the physicochemical properties of the noni juice, pH, moisture and ash were measured at Laboratory of Chemistry Department, West Yangon University, Myanmar.

Determination of Some Nutrients of Noni Juice

For the determination of contents of some macro-nutrients such as vitamin-C, protein and fat, the noni juice was determined by iodometric titration and AOAC methods at Laboratory of Chemistry Department, West Yangon University, Myanmar.

Investigation of Antioxidant properties of noni juice

Antioxidant properties of the noni juice were investigated by free radical scavenging effect on DPPH radical in Department of Chemistry, West Yangon University, Myanmar. In this experiment, each noni juice (3 mL) with five different concentrations (3.125, 6.25, 12.50, 25, 50, 100 mg/mL) were mixed with 1 mL of 0.1 mM ethanolic solution of DPPH. The absorbance was measured by a spectrophotometer at 517 nm at 30 min intervals against a blank (pure ethanol). The percentage of radical scavenging activity was calculated using the formula: Radical scavenging (%) = $[(A_0 - A_1)/A_0] \times 100$ where A_0 is the absorbance of the control and A_1 is the absorbance of the sample extracts. Lower absorbance values show higher free radical scavenging activity. Ascorbic acid was used as a reference standard. The 50% inhibitory concentration value (IC_{50}) is indicated as the effective concentration of the sample that is required to scavenge 50% of the DPPH free radicals (Rezaeizadeh, *et al.*, 2011). Among the most concentrations of IC_{50} values were calculated by Linear regressive analysis.

Investigation of Antimicrobial Activity of Noni Juice by Agar-well Diffusion Method

Antimicrobial activity of the noni juice was screened *in vitro* by Agar-well diffusion method compared with antibiotic properties of standard chloramphenicol (Perez *et al.*,1990). Bacterial cultures used in the research involved three strains of gram positive bacteria (*Bacillus subtilis*, *Staphylococcus aureus* and *Bacillus pumilus*), two strains of gram negative bacteria (*Pseudomonas aeruginosa* and *Escherichia coli*) and one strain of fungi (*Candida albicans*). This experiment was carried out at Department of Chemistry, Hinthada University, Myanmar.

Results and Discussion

Phytochemical Constituents of Noni Juice

The results of the phytochemical screening of the noni juice of *Morinda citrifolia* Linn.by standard methods were shown in Figure 3 and Table 1.



Figure 3
Table 1 **Phytochemical screening of the noni juice**
Phytochemical Constituents of the Noni Juice

No.	Test	Extract	Reagent	Observation	Result
1	Alkaloids	1% HCl	(i) Dragendorff's reagent (ii) Mayer's reagent (iii)Wagner's reagent	Orange ppt. Orange ppt. Orange ppt.	+
2	α -Amino acids	H ₂ O	Ninhydrin reagent	Purple color spot	+
3	Carbohydrates	H ₂ O	10% α -naphthol & H ₂ SO ₄ (conc.)	Red ring	+
4	Flavonoids	EtOH	Conc: HCl & Mg ribbon	Pale green solution	+
5	Glycosides	H ₂ O	10 % Lead acetate	White ppt.	+
6	Organic acids	H ₂ O	Bromocresol green indicator	Greensh yellow solution	+
7	Phenolic compounds	H ₂ O	10% FeCl ₃	Dark green solution	+
8	Reducing Sugars	H ₂ O	Benedict's solution	Brick red ppt.	+
9	Saponin	H ₂ O	Distilled water	Froth	+
10	Starch	H ₂ O	I ₂ solution	Brown solution	+
11	Steroids	PE	Acetic anhydride & H ₂ SO ₄ (conc.)	Green solution	+
12	Tannins	H ₂ O	FeSO ₄ soluton	Yellow solution	+
13	Terpenoids	CHCl ₃	Acetic anhydride & H ₂ SO ₄ (conc.)	Dark blue solution	+
(+) = present			(-) = absent	ppt. = precipitate	

According to Table 2, the noni juice of *Morinda citrifolia* Linn. consists of alkaloids, α -amino acids, carbohydrates, flavonoids, glycosides, organic acids, phenolic compounds, reducing sugars, saponin, starch, steroids, tannins and terpenoids. Therefore, the noni juice of *Morinda citrifolia* Linn. contains valuable phytochemical constituents which have health benefits to humans.

Elemental Constituents of Noni Juice

Elemental constituents in the noni juice of *Morinda citrifolia* Linn. are depicted in Table 2 and Figure 4.

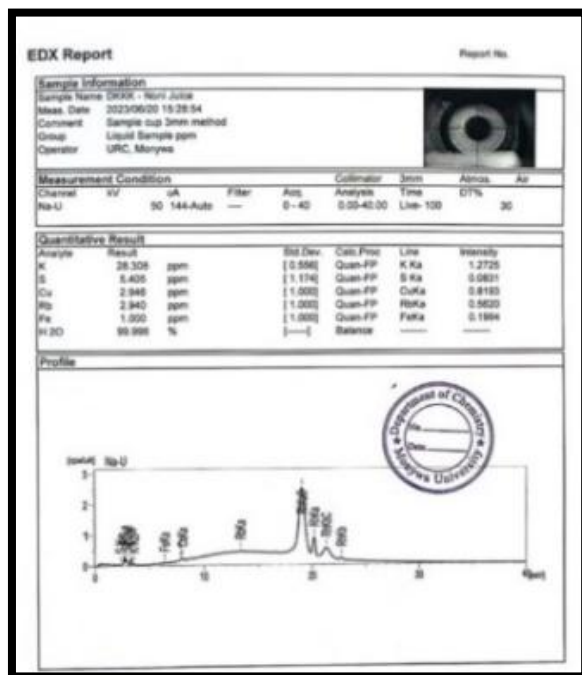


Figure 4 EDXRF spectrum of elements present in noni juice

Table 2 Relative Abundance of Elements Present in Noni Juice

No.	Element	Symbol	Relative Abundance
1	Potassium	K	28.308 ppm
2	Sulphur	S	5.405 ppm
3	Rubidium	Rb	2.946 ppm
4	Copper	Cu	2.940 ppm
5	Iron	Fe	1.0 ppm

From the results of EDXRF, the noni juice consists of micronutrients such as potassium, sulphur, rubidium, copper and iron. Among them, potassium is present as the highest value in this sample. Potassium (K) is one of the essential functions which controls the high blood pressure and maintain kidney health and help in prevention cancer of kidney.

Physicochemical Properties of Noni Juice

The physicochemical properties of the noni juice such as pH, moisture and ash were shown in Table 3. From this result the noni juice should be drunk by dilution with water or bee juice because of its pH 3.36 in acidic character.

Table 3 Physicochemical Properties of the Noni Juice

No.	Parameter	Amount
1	pH	3.35
2	Moisture (%)	93.56
3	Ash (%)	6.44

Some Nutrients of Noni Juice

The contents of some macro-nutrients such as vitamin-C, protein and fat of the noni juice were shown in Table 4. According to these results the noni juice should be used as food additive for health benefits.

Table 4 Some Nutrients Present in Noni Juice

No.	Nutrients	Content
1	Vitamin-C (mg)	39.6
2	Protein (%)	1.40
3	Fat (%)	0.89

Antioxidant Properties of Noni Juice

Antioxidant properties of the noni juice were tested with DPPH radical with the reference standard ascorbic acid. The results are calculated by calibration curves, prepared with ascorbic acid (Vitamin C) rendered in account the dilution factor shown in Table 5 & 6, and Figure 5 & 6.

Table 5 Percent Inhibition of Standard Ascorbic Acid and Noni Juice

No.	Concentration ($\mu\text{g/mL}$)	% RSA	
		Ascorbic acid	Noni juice
1	3.125	32.09	39.81
2	6.25	48.60	48.68
3	12.5	49.06	51.51
4	25	55.81	71.51
5	50	61.63	75.09
6	100	65.35	81.13

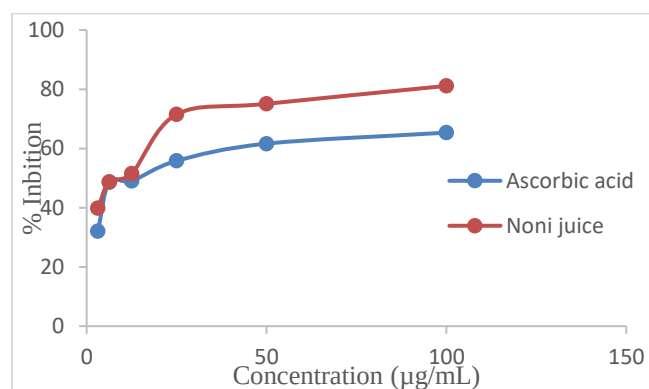


Figure 5 Antioxidant activities of standard ascorbic acid and noni juice

*Absorbance of DPPH (Control) = 0.430

$$\% \text{ Inhibition} = \frac{\text{Abs}_{\text{DPPH}} - [\text{Abs}_{\text{sample}} - \text{Abs}_{\text{blank}}]}{\text{Abs}_{\text{DPPH}}} \times 100$$

Table 6 The Regression Equations and Inhibitory Concentrations 50 (IC_{50}) Analysis Results Obtained from Standard Ascorbic Acid and Noni Juice

No.	Test Solution	Regression Equations	IC_{50} ($\mu\text{g/mL}$)
1	Ascorbic acid	$y = 0.2582x + 43.618$	14.24
2	Noni juice	$y = 0.3874x + 48.576$	9.17

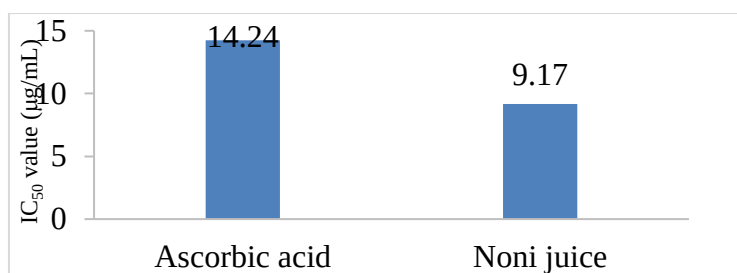


Figure 6 IC₅₀ values of standard ascorbic acid and noni juice

According to the results shown in Table 6, the IC₅₀ values in noni juice was less than that in ascorbic acid and so the noni juice had better scavenging activity than the standard ascorbic acid. In this study the free radical scavenging activity of noni juice is a dose dependent relationship in the DPPH assay. The activity increased as the concentration increased for all noni juice tests.

Antimicrobial Activities of Noni Juice

Antimicrobial activities of the only noni juice extract without other solvents were tested with one fungal and five bacterial micro-organisms by Agar-well Diffusion method. The products of noni juice evaluation and are highly effective for rapidly growing microorganisms and the activities of the test extracts are expressed by measuring the zones (mm) of inhibition. Generally, the more susceptible the organism, the bigger is the zone of inhibition. Among the many antibiotic drugs, antimicrobial activity of noni juice was measured not only by control but also by standard antibiotic drug as chloramphenicol. The observed data of the noni juice of *Morinda citrifolia* Linn. compared with the antibiotic properties of standard chloramphenicol were shown in Table 7 and Figure 7.

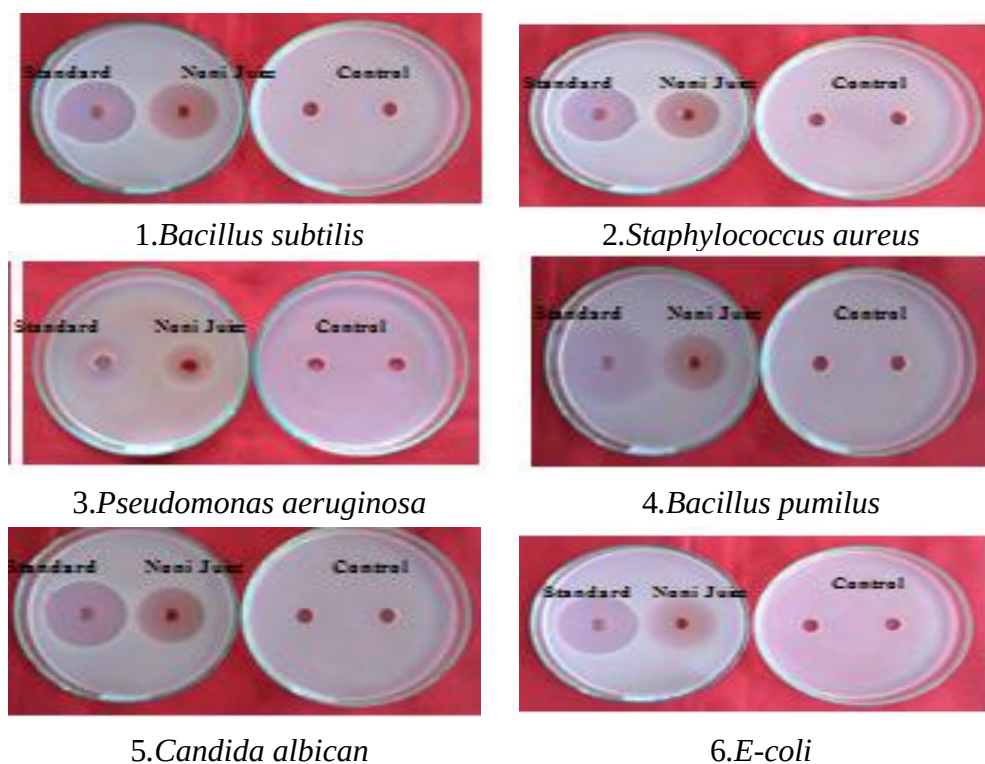


Figure 7 Photos for the results of antimicrobial activities of the noni juice

Table 7 Antimicrobial Activities of the Noni Juice in Absolute Ethanol

Micro-organism	Inhibition Zone	
	Chloraphenicol	Noni Juice
<i>Bacillus subtilis</i>	33.86 mm (+++)	30.61 mm (+++)
<i>Staphylococcus aureus</i>	31.61 mm (+++)	28.46 mm (+++)
<i>Pseudomonas aeruginosa</i>	27.08 mm (+++)	22.43 mm (+++)
<i>Bacillus pumilus</i>	34.89 mm (+++)	28.36 mm (+++)
<i>Candida albican</i>	33.61 mm (+++)	28.00 mm (+++)
<i>E-coli</i>	34.57 mm (+++)	29.64 mm (+++)

Agar well-8 mm 10 mm-14 mm = (+) = low activity
 15mm-19 mm = (++) = medium activity 20 mm-above = (+++) = high activity

According to the results shown in Table 7, the antimicrobial activities of noni juice were almost equally to the antimicrobial activities of standard chloramphenicol. Among them, noni juice has the higher activities to inhibit *Bacillus pumilus* and *E-coli* than other micro-organisms. In addition, it has lowest activities to inhibit *Pseudomonas aeruginosa*. Therefore, noni juice is should be used due to these antimicrobial activities.

Conclusion

From this research work, the phytochemical investigation in the juice of *Morinda citrifolia* Linn. (Ye yo) revealed the presence of alkaloids, α - amino acids, carbohydrates, flavonoids, glycosides, organic acids, phenolic compounds, reducing sugars, saponin, starch, steroids, tannins and terpenoids. In elemental analysis potassium has the highest relative abundance. The juice contains valuable nutrients such as vitamin-C, protein and fat. In the antioxidant activity, the noni juice has better scavenging activity than the standard ascorbic acid. In the antimicrobial study, the noni juice has the high activities on the five bacterial micro-organisms: *Bacillus subtilis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Bacillus pumilus* and *E-coli* and one fungal micro-organism, *Candida albican*. The result of this research revealed that the juice of *Morinda citrifolia* Linn. (Ye yo) can be used as antibacterial and antioxidant agents and a natural source of chemical constituents to prevent the progression of many diseases.

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SEASONAL VARIATIONS OF AIR POLLUTANTS IN DIFFERENT ROOMS AT NAYPYITAW STATE ACADEMY: A COMPARATIVE STUDY BETWEEN DECEMBER AND MAY

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Abstract

Poor indoor air quality can have adverse health effects on humans, especially in susceptible populations; however, few studies have measured multiple indoor air pollutants simultaneously. This study evaluated the concentrations of major indoor air pollutants such as formaldehyde (HCHO), total volatile organic compounds (TVOCs), carbon dioxide (CO₂), carbon monoxide (CO), fine particulate matter (PM_{2.5}), nitrogen dioxide (NO₂), ozone (O₃), air quality index (AQI), and temperature and humidity in the nine different rooms at Naypyitaw State Academy campus. Using a portable air quality detector (Bosean Electronic Co. Ltd., Zhengzhou City, PRC), the major indoor air pollutants in these sites were measured from 8:00 a.m. to 4:00 p.m. (8 hours duration) for one week 20th to 26th, in December, 2022, and May 2023. As a result, high concentrations of HCHO, TVOCs, CO₂, CO, and PM_{2.5} were observed in the Engineer & Store Room, which polluted a little over the good condition of the WHO guideline value due to the polluted resources; the office supplies, furniture, copy machines, and human activity. In classroom, laboratory, library, academic, engineer & store, and finance & administration room, the Air Quality Index (AQI) was found to be over 50, indicating poor air qualities in the December but there is no very serious risk to human health. In May it was observed that the AQI value of all the areas no exceed the standard WHO guideline value.

Keywords: Indoor air pollutants, Portable Air Quality Index, TVOC, WHO guideline

Introduction

With the rapid development of the economy and booming population growth, an enormous amount of resources (e.g., energy, water, and food) is required in our society to sustain our activities. According to the results, various kinds of pollution have been produced. Among the various pollution problems, air pollution has caused major concern around the world due to its widespread nature, damage to our environment, and potential health risks to humans. The indoor air quality index has become an important area of concern in the twenty-first century. Indoor air quality is affected by many factors, including the type and running conditions of indoor pollution sources, ventilation conditions, and indoor activities. Air pollution seriously damages the ecological condition and affects the health of humans, animals, and plants. Levels of indoor air pollutants are increasing; therefore, concerns over indoor air quality and its potential health effects have increased within the scientific community in the field of environmental health sciences. In order to reduce, prevent, and control air pollution, air quality monitoring has been proposed to accurately monitor the concentration of chemical pollutants and abnormal conditions in a region, which can purify the air. A number of studies have shown that indoor levels of various types of air pollutants, such as total volatile organic compounds (TVOCs), formaldehyde (HCHO), carbon monoxide (CO), carbon dioxide (CO₂), ozone (O₃), nitrogen dioxide (NO₂), Air Quality Index (AQI), temperature, and humidity (H) and fine particulate matter (PM_{2.5}), in modern residential buildings are significantly higher than their outdoor levels for several reasons. These reasons include the existence of indoor emission sources (e.g., paint and associated supplies, household furnishings, consumer products, combustion appliances, etc.), low ventilation rates, environmental tobacco smoking, internal fuel combustion for cooking, seasonal variations in temperature and relative humidity, and other environmental conditions (Hoskins *et.al.*, 2003 and Zhang *et.al.*, 2003). Sources of indoor

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air pollutants may be brought about by contaminated outdoor air, air conditioning or office equipment, human activity, building components and furnishings, and other accidental events (USEPA, 1991; and McNamara *et al.*, 2011). This study was aimed at discovering common indoor air pollutants, examining the characteristics and sources of indoor pollutants based on an AQI investigation of different rooms, and assessing the risks posed by pollutants to the inhabitants of all staff from the Naypyitaw State Academy Campus.

Materials and Methods

Air samples were collected from staff room, classroom, laboratory room, academic affairs room, sport room, engineer and store room, and finance and administration room in Naypyitaw State Academy Campus for the measurement of Formaldehyde (HCHO), Total Volatile Organic Compounds (TVOC), Carbon dioxide (CO₂), Carbon monoxide (CO), Particulate matter (PM_{2.5}), Nitrogen dioxide (NO₂), Ozone (O₃), Air Quality Index (AQI), Temperature, and Humidity (H). A BOSEAN sensor was used to measure for TVOC, CO, CO₂, HCHO, and PM_{2.5}, NO₂, O₃, AQI, T and H for eight hours a day (from 8:00 am to 4:00 pm from December 20th to 26th, 2022 and May 20th to 26th 2024).

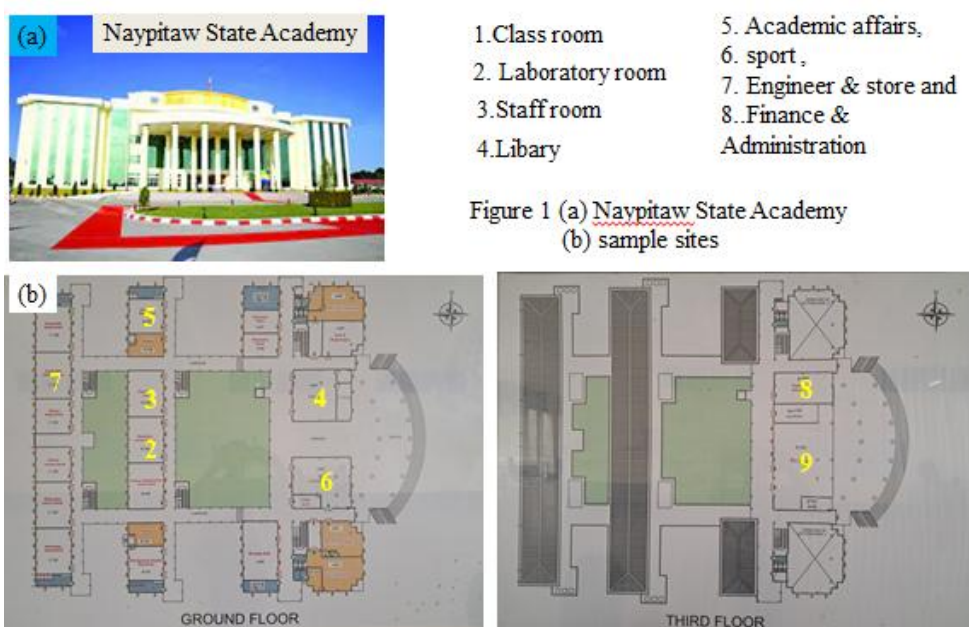


Figure 1 (a) Naypyitaw State Academy (b) sample sites in the Napyitaw State Academy

Results and Discussion

The minimum, maximum, and mean of HCHO, TVOCs, CO₂, CO, PM_{2.5}, NO₂, and O₃ concentrations, of eight different sites were shown in Table 1 and Table 2. In December: High levels of mean concentrations of HCHO and TVOCs (0.092 and 0.805 mg/m³) were observed in the engineer & store room followed by the second highest concentration (mean 0.077 and 0.597 mg/m³) found in the academic affairs room and (mean 0.068 and 0.424 mg/m³) in the library room and apartment room, as shown in the figure 2. The lowest concentrations (mean 0.023 and 0.130 mg/m³) of HCHO and TVOCs were observed in the laboratory and staff room. In May: Highest levels of mean concentrations of HCHO (0.844 mg/m³) was observed in the sport room, the second highest concentration (0.735 mg/m³) found in the Finance & Administration room and the third one (0.434 mg/m³) in the Academic & Affairs department as shown in the figure 2. The lowest concentration (mean 0.103 mg/m³) of HCHO was observed in the Apartment. The highest concentration (mean 0.958) of TVOC was found in the staff room (department of chemistry), second highest concentration (mean 0.871 mg/m³) in the staff

apartment and the lowest concentration (mean 0.166 mg/m³) was detected in the sport room. The HCHO and TVOCs pollutant comes from sources such as the adhesive in wall paints, the polish in the wooden furniture, the carpet on floors, cooking and fuel burning, and other outdoor (motor engine, mobile shop, restaurants, and many human activities) pollutants entering the indoors. Formaldehyde is a toxic substance with a strong, pungent odor. When the indoor formaldehyde concentration exceeds 1.249 mg/m³, it will harm the health of the human body. Formaldehyde has been listed as a "possible carcinogen" by international organizations. HCHO and TVOCs such as toluene and xylenes are among the commonly used indoor air pollutants (Tunga *et.al.*, 2010 and Hengyi *et.al.*, 2016), HCHO is classified as a Group 1 human carcinogen by the International Agency for Research on Cancer, and it can cause irritation of the eyes and upper respiratory tract (Tunga *et.al.*, 2010) TVOCs may deteriorate indoor air quality in terms of odor annoyance, eye and airway irritation (Weschler *et.al.*, 2006 and Wolkof *et.al.*, 2006) Some other studies in China and the United States found the HCHO and TVOCs to be highly toxic and a source of carcinogens that can cause respiratory illness (Ashford *et.al.*, 2001 and Bu *et.al.*, 2016)

Table 1. Concentrations of Pollutants Indoors in December

Rooms	HCHO (mg/m ³)	TOVC (mg/m ³)	CO ₂ (ppm)	CO (ppm)	PM _{2.5} (μg/m ³)	NO ₂ (ppm)	O ₃ (ppm)
	Mean ±STD	Mean ±STD	Mean ±STD	Mean ±STD	Mean ±STD	Mean ±STD	Mean ±STD
	Min~Max	Min~Max	Min~Max	Min~Max	Min~Max	Min~Max	Min~Max
Staff	0.029 ±0.02	0.130 ±0.13	437 ±4	1.48 ± 1.05	29 ± 6	ND	ND
	0.01~0.13	0.02~0.79	405~632	1.00~6.00	22.00~43.00	ND	ND
Class	0.029 ±0.01	0.341±0.26	503±8	3.07±1.87	41±18.51	ND	ND
	0.01~0.07	0.00~1.81	398~933	1.00~13.00	21~94	ND	ND
Laboratory	0.023 ±0.01	0.249±0.20	476±5	2.40±1.52	39±7	ND	ND
	0.02~0.09	0.00~1.18	398~749	1.00~9.00	19~87	ND	ND
Library	0.068 ±0.03	0.407±0.23	519±7	3.49±2	43±7	ND	ND
	0.032~0.157	0.043~1.209	348~767	1~10	16~96	ND	ND
Academic affairs	0.077 ±0.03	0.597±0.24	579±7	4.39±1.8	39±7	ND	ND
	0.03~0.26	0.02~1.30	350~785	2~10	18~85	ND	ND
Sport	0.06 ±0.06	0.308±0.29	496±8	3.00±2.00	28±1	ND	ND
	0.033~0.498	0.260~1.970	0.26~1.970	474~982	2~15	ND	ND
Engineer & Store	0.093 ±0.06	0.805±0.3	636±8	6.30±2	44±1	ND	ND
	0.033~0.498	0.260~1.970	474~982	2~15	22~125	ND	ND
Finance & Administration	0.058 ±0.025	0.389±0.097	512±3	3.34±1	47.15±1	ND	ND
	0.023~0.187	0.22~0.67	327~599	2~5	24~132	ND	ND

Figure 2 showed the variation of indoor CO₂ concentration in different sampling rooms. In December: the variation of indoor CO₂ and CO concentrations in different sampling rooms. The (mean 636 ppm and mean 6 mg/m³) highest concentration of CO₂ and CO was found in the engineer & store room. The second highest concentration (mean 579 ppm and 5mg/m³) and third highest concentration (mean 524 ppm and 4 mg/m³) were found in the Academic affairs and apartment room. In May: the highest concentration of CO₂ (mean 684 ppm) was found in the staff room (department of chemistry). The second highest concentration (mean 660 ppm) and the third highest concentration (mean 602 ppm) were found in the staff room, staff apartment, and class room. The highest concentration of CO was observed (mean 9 ppm), the second highest (mean 7 ppm) was in the staff room (department of chemistry), and the third (mean 5 ppm) was found in the class and laboratory. According to the Ambient Air Quality Index 2012, CO₂ concentrations ≤1000 ppm represent good or excellent indoor air quality

(AQI), 1000–1500 ppm represent acceptable or moderate AQI, and concentrations >1500 ppm represent poor AQI. Indoors, CO₂ is mainly produced through the respiration (breathing) of occupants but can also come from cigarette smoking, furniture, and other office instruments (printers, computers, fans, air conditioning, etc.). Additionally, doors and windows are closed resulting in the accumulation of indoor CO₂. In this study, CO₂ and CO have no harmful effects since the pollutant results do not exceed 1000 ppm and 10 mg/m³ of the WHO guideline value, respectively, as shown in Figure 3.

Table 1. Concentrations of Pollutants Indoors in May

Rooms	HCHO(mg/m ³)	TOVC(mg/m ³)	CO ₂ (ppm)	CO (ppm)	PM _{2.5} (µg/m ³)	NO ₂ (ppm)	O ₃ (ppm)
	Mean ±STD	Mean ±STD	Mean ±STD	Mean ±STD	Mean ±STD	Mean ±STD	Mean ±STD
	Min~Max	Min~Max	Min~Max	Min~Max	Min~Max	Min~Max	Min~Max
Staff	0.287 ±0.04 0.006~1.999	0.958 ±0.6 0.00~2.462	683 ± 166 398~1144	7.44 ± 4 1.00~19.00	20 ± 4 15~33	ND ND	ND ND
Class	0.138 ±0.00 0.078~0.308	0.69±0.20 0.34~1.18	602±53 499~753	5±1 3~9	18±2 14~31	ND ND	ND ND
Laboratory	0.122 ±0.08 0.012~0.468	0.613±0.05 0.00~2.441	582±15 398~1128	5.2 ±1.5 1.00~18.00	22 ± 5 15~33	ND ND	ND ND
Library	0.434 ±0.07 0.010~1.999	0.285 ±0.12 0.004~0.743	480±49 398~624	2.50±1 1~6	17±2 13~27	ND ND	ND ND
Academic affairs	0.397 ±0.03 0.03~1.999	0.361±0.25 0.000~0.859	486±77 398~654	3±1.1 1~7	20±4 13~31	ND ND	ND ND
Sport	0.844 ±0.2 0.000~1.999	0.166±0.1 0.00~0.897	447±4 398~667	2.00±1.00 1~7	14±2 11~23	ND ND	ND ND
Engineer & Store	0.135 ±0.059 0.065~0.412	0.516±0.2 0.00~2.456	553±16 398~1294	4.3±1.3 1~22	14±3 11~27	ND ND	ND ND
Finance & Administration	0.735±0.08 0.01~0.111	0.207±0.106 0.0~0.598	460±32 398~577	2.00±1 1~5	15±4 11~30	ND ND	ND ND

In December, engineer & store rooms had the highest PM_{2.5} concentrations 47 µg/m³, followed by the library, which had the second highest at 43µg/m³ and the third highest 41 µg/m³ found in the class room. The mean PM_{2.5} concentrations were found to exceed the Ambient Air Quality Index guideline value (mean 35 µg/m³, 24 hr) in the engineer & store, library and class, Finance & Administration, Lab and Academic affairs rooms, as shown in Figure. In contrast, staff room, and sport room were below the Ambient Air Quality Index guideline value. In May, the highest PM_{2.5} concentrations 22 µg/m³ was observed in laboratory, the second highest 20µg/m³ in the staff room (department of chemistry) and the third highest 18 µg/m³ in the class room. The lowest PM_{2.5} concentration (mean 14µg/m³) was found in the sport and engineer & store room. The mean PM_{2.5} concentrations did not exceed the Ambient Air Quality Index guideline value (mean 35 µg/m³, 24 hr: 2012) in all rooms. In terms of PM_{2.5}, a few exceeded the WHO guideline value (mean 15 µg/m³, 24 hr: 2021) in the staff apartment, staff (department of chemistry), class room, laboratory room, library, and academic affairs department; other rooms were below the WHO (2021) guideline value. PM_{2.5} pollutants also come from natural sources such as anthropogenic sources and human activity sources. According to the previous reported the inhaling air pollutants could lead to the formation of atherosclerotic plaque, the activation of platelets and binding to each other, vessel wall damage, and thrombosis, and there by trigger cardiopulmonary diseases (Brook *et al.*, 2010; Münzel *et al.*, 2018). Previous studies results have also suggested that short-term exposure to high ambient air pollution was associated with increased airway inflammation and respiratory symptoms (Cortez-Lugo *et al.*, 2015; Wu *et al.*, 2016). Human activities (machine and

cleaning) contribute to the pollutant in the rooms. The results found that there was no significant relationship between temperature and AQI values and humidity and AQI values in all sites. In Figure 4, the AQI highest range mean values (65, 62, and 58) were observed in the engineer & store room and finance & administration and library, in December. The highest AQI mean values (31, 30 and 28) were observed in the laboratory, staff and academic affair rooms, in May. According to the Ambient Air Quality Index 2012, AQI ranges between 0–50 represent good or excellent indoor air quality (AQI), 51–150 represent acceptable or slight moderate AQI, and concentrations 150–300 ppm represent moderate serious AQI. In this study, all rooms were found to have a good air quality index.

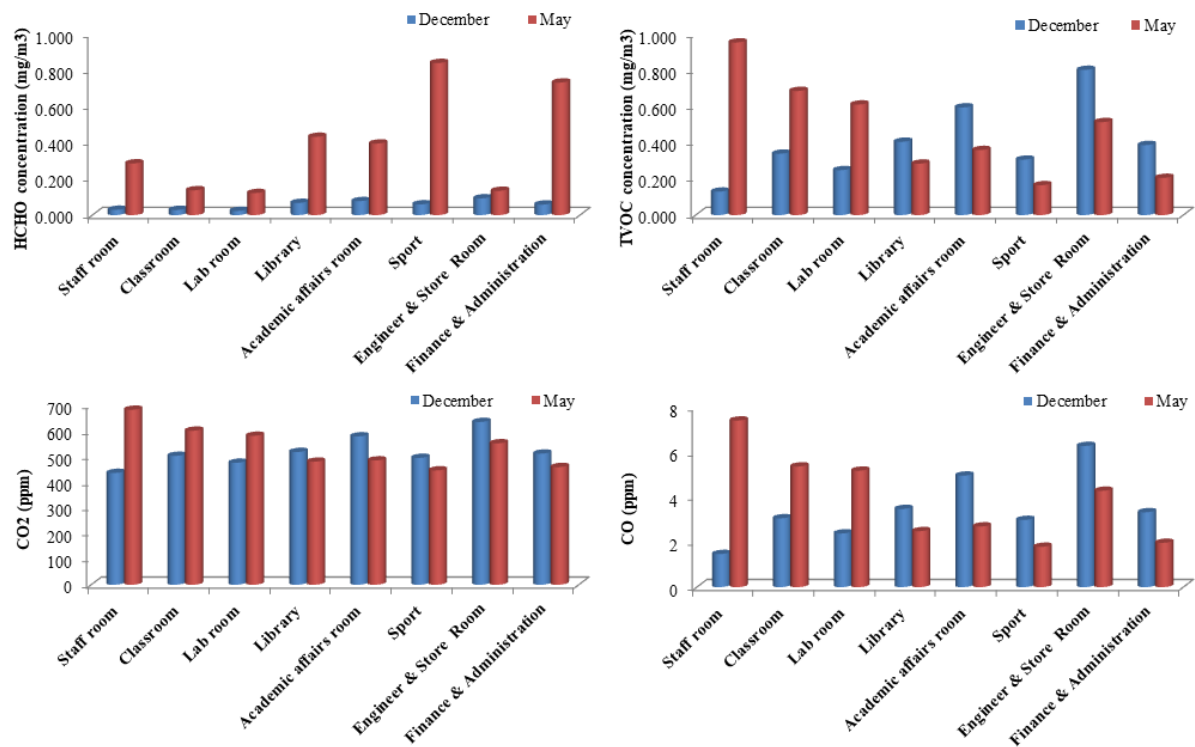
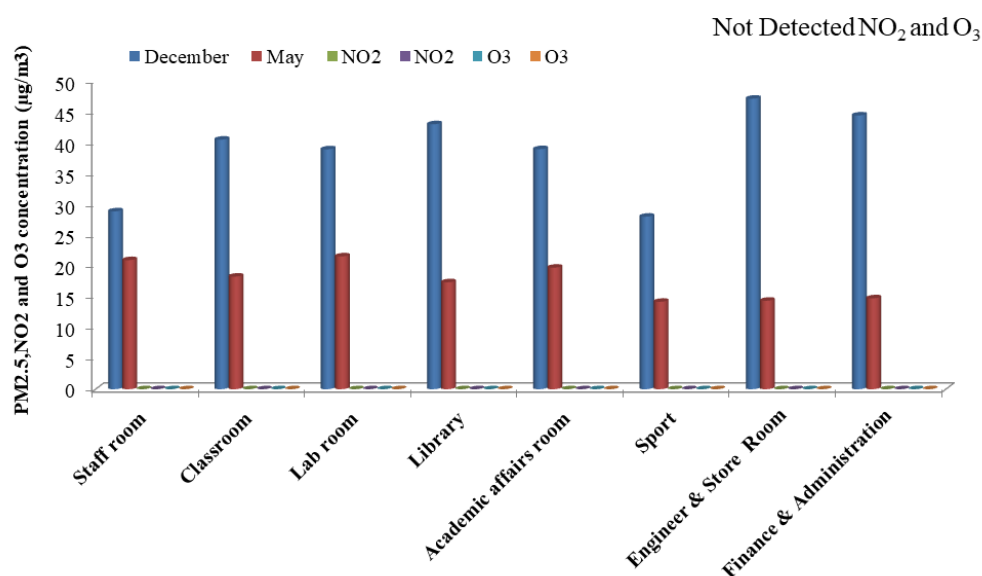
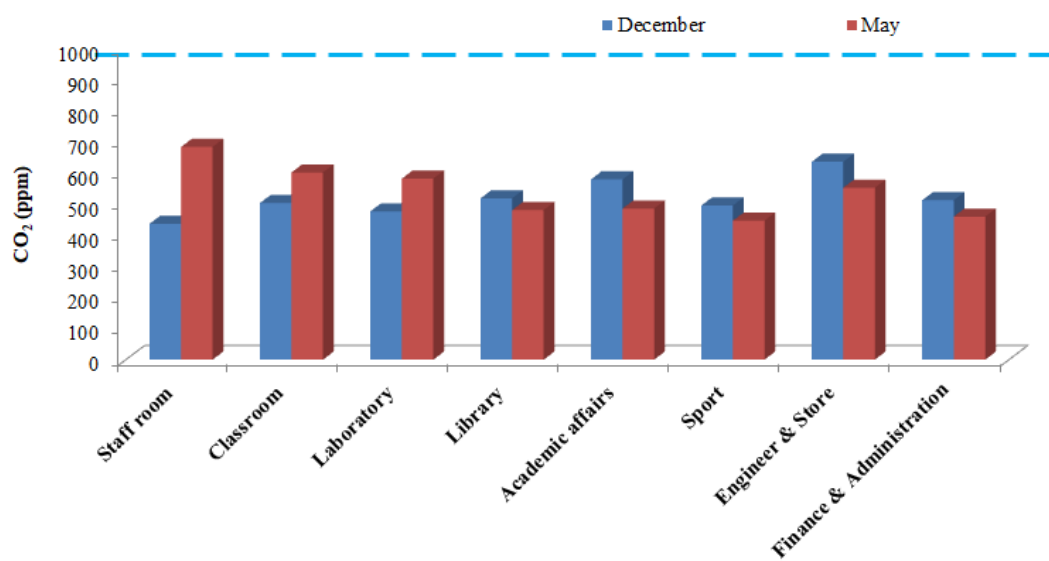
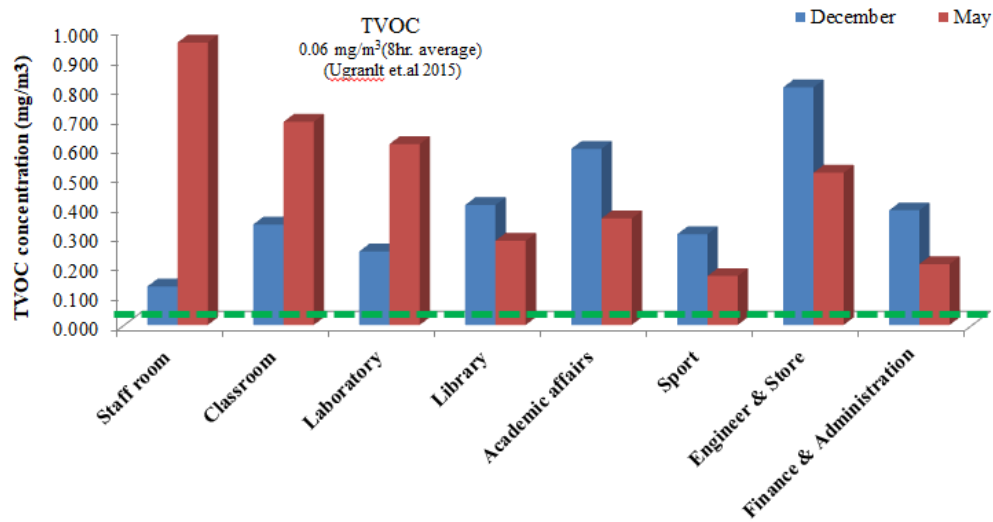
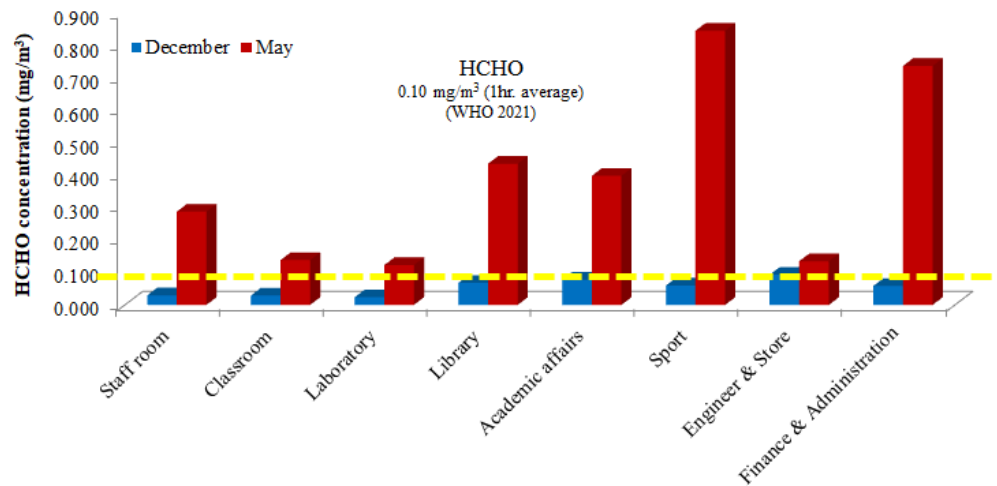


Figure 2. Concentrations of the HCHO, TVOCs, CO₂, CO, NO₂, O₃ and PM_{2.5} in Naypyitaw State Academy Campus





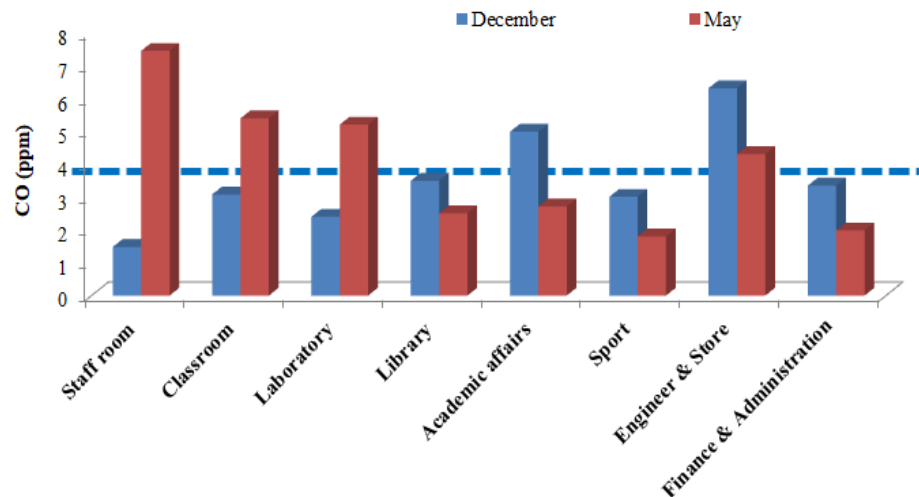


Figure 3. Comparison of pollutants concentration of different rooms of the Naypyitaw State Academy Campus with its WHO guideline

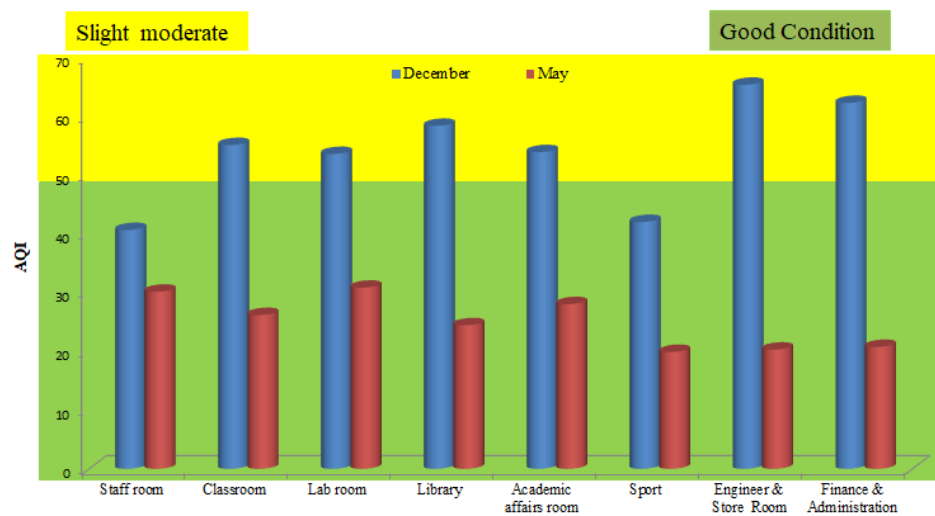
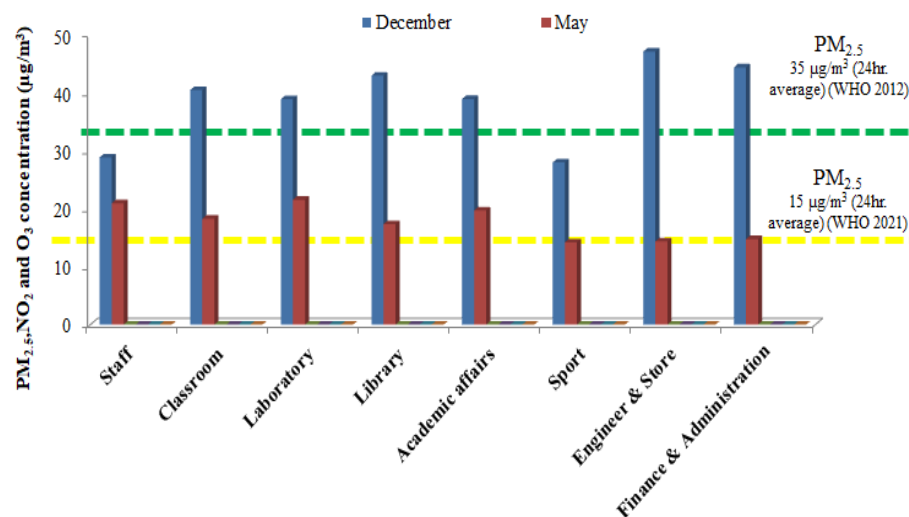


Figure 4. Comparison of air quality index concentrations of different rooms with its WHO guideline values

Conclusion

In this study, different concentrations of pollutants were detected in all rooms. The values of formaldehyde Total volatile organic compounds were above the WHO guideline values in all rooms. Whereas the concentrations of other pollutants, such as carbon dioxide, particulate matter, nitrogen dioxide, and ozone, were below the WHO guideline value. There is no significant relationship between temperature and AQI and humidity and AQI. Air Quality Index (AQI) concentrations did not exceed the WHO guideline value. Therefore, the air quality in the respective areas is good. In this study, air pollutants come from furniture, copy machines, office supplies, and human activity. In addition to the strength of sources, the impact of indoor emissions on air quality depends directly on ventilation and air mixing in the space. In the future, we plan to reduce indoor air pollution and improve the air quality index by raising awareness among the public regarding lifestyle in microenvironments.

Acknowledgements

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STUDY ON THE REMOVAL OF LEAD ION FROM AQUEOUS SOLUTION BY USING FROND CHAR OF *COCOS NUCIFERA* L. (COCONUT)

Thin Yu Wai*

Abstract

In this study, coconut frond (CF) was used to prepare charred sample for the removal of Pb^{2+} ion from aqueous solution. Fallen coconut Leaves are agricultural wastes. The characteristic properties of coconut frond powder (raw) and prepared charred samples before and after adsorption were determined by conventional methods and modern techniques. The removal percent of lead ion before and after adsorption were determined according to adsorption parameters such as adsorbent dosage, initial concentration, contact time and pH by using UV-visible spectrophotometric method. The investigated variable included adsorbent dosage (0.1-0.5 g/L), initial concentration (1-5 mg/L) and contact time (15-120 min) and pH (3-8). The optimum condition was (0.5 g/L) adsorbent dosage, initial lead concentration (1 mg/L), initial solution pH (7), and agitation time (60 min), respectively. Under optimal conditions, high removal efficiency for Pb^{2+} ion was observed as 59.06 % and equilibrium adsorption isotherm was investigated. The Langmuir and Freundlich models of adsorption were used to analyze the experimental data. This study indicates that frond char could be employed as a low cost adsorbent for the removal of Pb^{2+} ion from aqueous solution.

Keywords: coconut frond (CF), charred sample, Langmuir, Freundlich, adsorption, frond char

Introduction

The pollution of wastewater by heavy metals is presently attracting global attention because of the harmful effects it has on the environment and especially on human health (Yasser, *et al.*, 2016).

Coconut fronds are the few components, which are the frond base, cushion, keel, petiole, pinnae and rachis. The rachis part of a coconut frond is the component used in this study for adsorbent preparation. Charcoal is created by burning organic, carbon-containing materials, such as bone, wood or other plant matter (Mohamad., Aziz, *et al.*, 2018).

Heavy metal pollution is a global issue, although severity and levels of pollution differs from place to place. Lead is particularly among the common heavy metal that has been identified in polluted water. The release of these metals without proper treatment poses a significant threat to public health because of their persistence, biomagnifications and accumulation in food chain. Severe effects include reduced growth and development, cancer, organ damage (Rosmawani., *et.al.*, 2017).

Lead, Pb is a metal with atomic number 82 and molar mass 207.2 with its ions exist in Pb^{2+} . Lead is not required by human body and it is highly toxic in long term exposure or intake. Lead is widely used in industrial area and daily life such as lead acid battery, plastic stabilizers, ammunition, paint, and etc. Lead is carcinogenic metal and very poisonous, it was recognized that it has caused several health issues such as kidney damage, loss of memory, hallucinations, lung cancer, stomach cancer, and reproductive problems (Wikipedia, 2019).

Adsorption is the adhesion of atoms, ions or molecules from a gas, liquid or dissolved solid to a surface. This process creates a film of the adsorbate on the surface of the adsorbent. This process differs from absorption, in which a fluid (the absorbate) is dissolved by or permeates a liquid or solid (the absorbent), respectively. Adsorption is a surface phenomenon, while absorption involves the whole volume of the material. The term sorption encompasses

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both processes, while desorption is the reverse of it. Similar to surface tension, adsorption is a consequence of surface energy. Adsorption is present in many natural, physical, biological and chemical systems and is widely used in industrial applications such as heterogeneous catalysts, activated charcoal, capturing and using waste heat to provide cold water for air conditioning and other process requirements (adsorption chillers), synthetic resins, increasing storage capacity of carbide- derived carbons and water purification (Mondal, 2008).

Botanical Aspect of Coconut Plam

Family	: Arecaceae
Genou	: Cocos
Species	: <i>C. nucifera</i>
Botanical name	: <i>Cocos nucifera</i> L .
English name	: Coconut Palm
Myanmar name	: Ohn
Part used	: Coconut fronds

Materials and methods

Sample Collection and Preparation

Coconut fronds (CFs) were collected from Gyaung Wine Gyi village, Twantay Township, Yangon Region. The samples were collected from the fallen CF, which were found under the coconut trees in the plantation. Then, the fronds were cut into smaller pieces. The CF was then dried in a conventional oven at 105°C until the moisture content was below 10% wt to avoid the growth of fungi or mould. The CF was ground to pass a 200µm sieve and then stored in an airtight container prior to analysis.

Determination of Physicochemical Properties of Coconut Fronds Powder and Charred Sample

Physicochemical properties of coconut fronds power and charred sample were determined moisture content, ash content, bulk density and pH. The results are shown in Table 1.

Fourier Transform Infrared (FT IR) analysis

The FT IR spectra of the samples were recorded on 1% KBr pellet using Fourier Transform Infrared spectrometer. The FT IR spectra were shown in Figures 1. a, b and c. The assignments of FTIR spectra were shown in Table 2.

Scanning Electron Microscopic (SEM) analysis

Coconut fronds powder (raw) and prepared charred samples were examined by Scanning Electron Microscope (SEM) for a visual inspection of external porosity and micro-texture. The SEM micrographs were shown in Figures 2. a, b and c.

Adsorbate Preparation and Batch Adsorption Studies

The stock solutions (10 mL) were taken into separately 100 mL of volumetric flask. The volume mark was filled up with distilled water to produce a concentration of 50 mg/ L.

Determination of Adsorption Capacity

Effect of pH

Five beakers were filled with 1 mg/L Pb (II) solution and (0.5 g) of sample was added to each beaker. 5mL of 1:2 ammonia solutions were added into each conical flask. Then 2 drops of potassium cyanide and 3 drops of sodium sulphide solution were added. The pH of Pb (II)

solution was adjusted from (3.0, 4.0, 5.0, 6.0, 7.0 and 8.0) respectively with appropriated volumes of NaOH (0.1 M) and HCL (0.1 M) solution using pH meter. Then there were shaken by using mechanical shaker for 60 minutes. After shaking, the solutions were filtered immediately. The concentrations remaining were determined for Pb (II) solution at 410 nm by UV-240 spectrometer.

Effect of initial concentration

Accurately weighed constant sample (0.5 g) into each conical flasks and varying concentration (1, 2, 3, 4 and 5 mg/L) of Pb (II) solution were added. Then there were shaken by using mechanical shaker for 60 minutes. After shaking, 5 mL of 1:2 ammonia solutions were added into such conical flask. Then, 2 drops of potassium cyanide and 3 drops of sodium sulphide solution were added. The solutions were determined for Pb (II) solution at 410 nm by UV-240 spectrometer.

Effect of contact time

To a fixed of sample (0.5 g/100 mL) was thoroughly mixed with 1 mg/L Pb (II) solution and it was shaken by using mechanical shakes for 60 minutes. After shaking it was allowed to stand for (15, 30, 60, 90 and 120 min) and the solutions were filtered immediately. 5 mL of 1:2 ammonia solutions were added into each conical flask. Then 2 drops of potassium cyanide and 3 drops of sodium sulphide solution were added. The equilibrium concentrations were determined for Pb (II) solution at 410 nm by UV-240 spectrometer.

Effect of dosage of adsorbent

Accurately weighed samples varying from (0.1, 0.2, 0.3, 0.4 and 0.5 g) into the conical flasks and 1 mg/L of Pb (II) solution was added into each conical flask. There were shaken by using mechanical shaker for 60 minutes. After shaking, the solutions were filtered immediately. 5 mL of 1:2 ammonia solutions were added into each conical flask. Then 2 drops of potassium cyanide and 3 drops of sodium sulphide solution were added. The concentrations were determined for Pb (II) solution at 410 nm by UV-240 spectrometer.

Results and discussion

Characteristic Parameters of Coconut Frond (Raw) and Prepared Charred Sample

Table 1 shows the result of proximate analysis of the coconut frond (raw) and prepared frond char (charcoal) samples. Coconut frond (raw) contains 1.15 % of moisture content, 6.52 % of ash content, 0.49 g/mL of bulk density and 6.0 of pH. Prepared charred sample contains 1.12 % of moisture content, 7.94 % of ash content, 0.95 g/mL of bulk density, 6.6 of pH, and 30 % of fixed carbon.

Table 1 Characteristic Parameters of Coconut Frond (Raw) and Prepared Charred Sample

Sample	Moisture content %	Ash content %	Bulk density g/ml	pH	Yield %
Coconut fronds powder (Raw)	1.15	6.52	0.49	6.0	100
Char	1.12	7.94	0.95	6.6	30

Fourier Transform-Infrared (FT IR) Spectrometric Analysis

Surface functional group containing oxygen have a major role in coconut frond (raw) and the prepared charcoal properties such as surface behavior and reaction, hydrophobicity, surface charges, electron density of graphene layer and may be further used for surface modification. Different functional group present in coconut frond (raw) and the prepared charcoal sample were carboxylic, carbonyl, phenol and lactones etc. The functional groups present were as shown in the table (2). The range 3500-3200 cm^{-1} indicates the presence of O-H stretch bonded, alcohol, phenol functional group. At 3300-2500 cm^{-1} shows the presence of O-H stretch and carboxylic group. At 1320-1000 cm^{-1} (strong) frequency shows C-O stretch and functional group presents are alcohol, carboxylic acid, esters and ethers. A band at 1400 cm^{-1} was only can be attributed to the plane N-H bending vibration. A band at 1100 cm^{-1} is attributed to C-O stretching vibration in hydroxyl and phenol groups. Combination of bands at 1750 and 1100 cm^{-1} suggested that it is predominantly carboxylic groups. The frequency ranges 1470-1450 cm^{-1} show the presence of alkanes (C-H bond). Figures 1(a) and (b) shows the number of distinct absorption bands of coconut frond (raw) and the prepared charcoal before and after Pb(II) adsorption. A number of absorption peaks were observed, indicating the complex nature of the prepared biomass. The results revealed sorbent heterogeneity, evidenced by the different characteristic peaks. The main functional groups that contributed to adsorption were -OH, C=O, C-O, C-H, and -COOH. the number of distinct adsorption bands of prepared charred sample before and after Pb (II) ion adsorption. A number of absorption peaks were observed, indicating the complex nature of the prepared biomass. The results revealed sorbent heterogeneity, evidenced by the different characteristic peaks. The main functional groups that contributed to adsorption were -OH, C=C, C-O, C-H, and -COOH. FTIR spectra of Pb(II) sorbed in Figure 1(c) showed that the peaks expected at 3120, 2338, 1557, 1101 and 1,057 cm^{-1} had shifted to 3421, 2920, 2312, 1581, 1427, and 1107 cm^{-1} , respectively, attributed to Pb (II) ion adsorption. These groups may function as proton donors; hence, deprotonated hydroxyl and carbonyl groups may be involved in coordination with metal ions.

Table 2 FT IR Spectral Characteristics of Coconut Frond (Raw) and Charred Sample

Observed Frequency (cm^{-1})			Frequency range (cm^{-1})	Assignment
Raw	Char	Lead sorbed		
3331	3120	3421	3600-3000	OH-stretching
2917	-	2920	3000-2800	C-H stretching
-	2338	2312	2500-2300	O-H carboxylic acid
1730	-	-	1740-1680	C=O carbonyl group
1599	1557	1581	1580-1570	C=C (stretching)
1237	-	1427	1450-1200	C-O stretching
1028	1101	1107	1200-1000	C-OH stretching

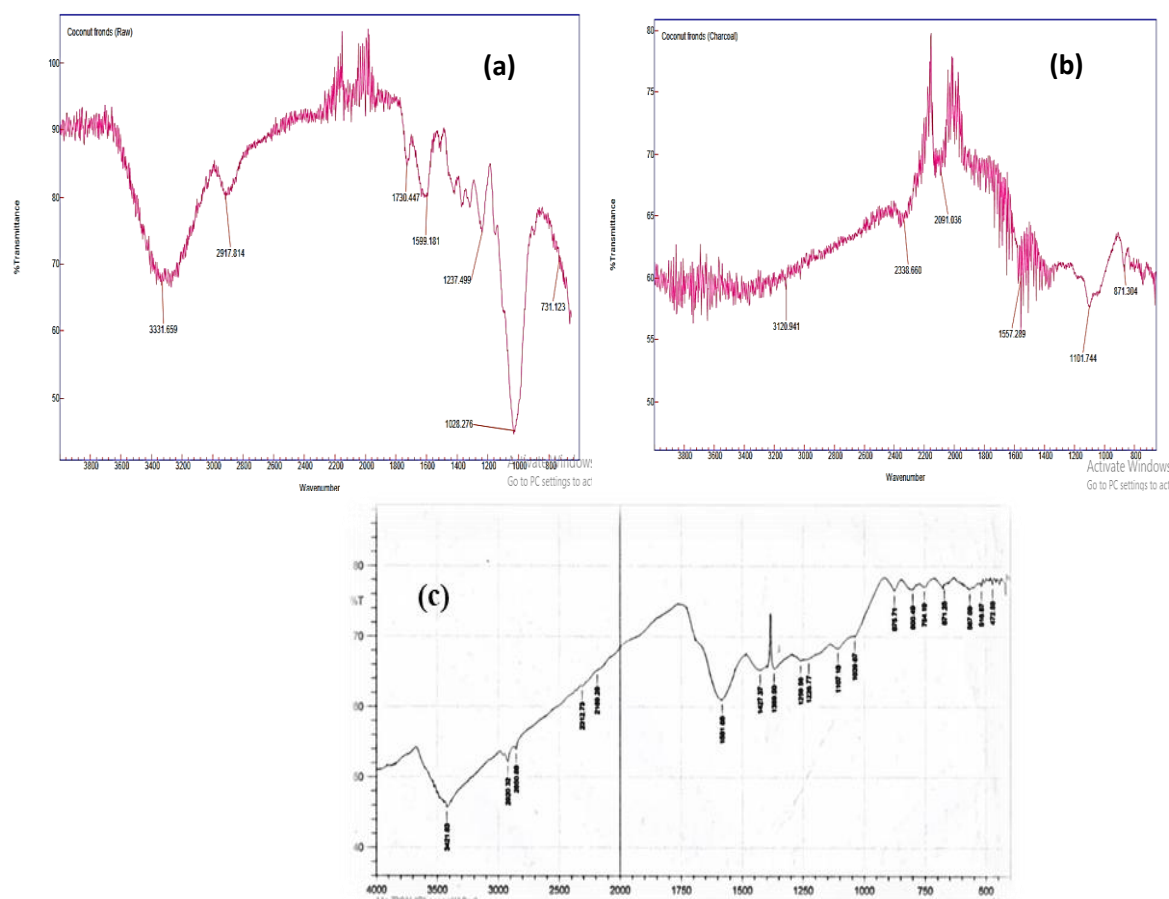


Figure 1. FT IR spectrum of (a) coconut frond (raw), (b) charred sample and (c) lead sorbed

Scanning Electron Microscopic (SEM) analysis

SEM photographs showed that the surface morphology of coconut frond (raw), prepared charred powder before and after Pb (II) ion adsorption at different magnifications. The coconut frond (raw) and prepared char exhibited a rough surface and a porous structure. Different pores were observed in the coconut frond (raw) and prepared charred sample. Due to carbonization, volatiles are removed producing a fixed carbon mass with widening of pore networks that are present in prepared charred sample. Before Pb (II) ion adsorption, prepared char displayed an irregular, porous, and compact structure as shown in Figure 2 (a) and (b). After Pb (II) ion adsorption, the surface of Pb (II) ion loaded prepared char composed of a great porous with honeycomb shaped because of the adsorbed Pb (II) ions. The amount of Pb (II) ion on the surface (analogous to release of volatiles), and there are many uniformly pore structure and becoming honeycomb shape as shown in Figure 2 (c).

Bath Adsorption Studies

Effect of solution pH

pH is an important parameter for adsorption of metal ions because it affects the solubility of the metal ions, concentration of the counter ions on the functional groups of the adsorbent and the degree of ionization of the adsorbate during reaction. The removal of metal ions from wastewater sample by adsorption is related to the pH of the sample, as the latter affects the surface charge of adsorbents, the degree of ionization, and the species of adsorbate. The pH of the aqueous solution is an important controlling parameter in the adsorption process and thus the role of H^+ concentration was examined from samples at different pH covering a range of 3-8 (Figure 4).

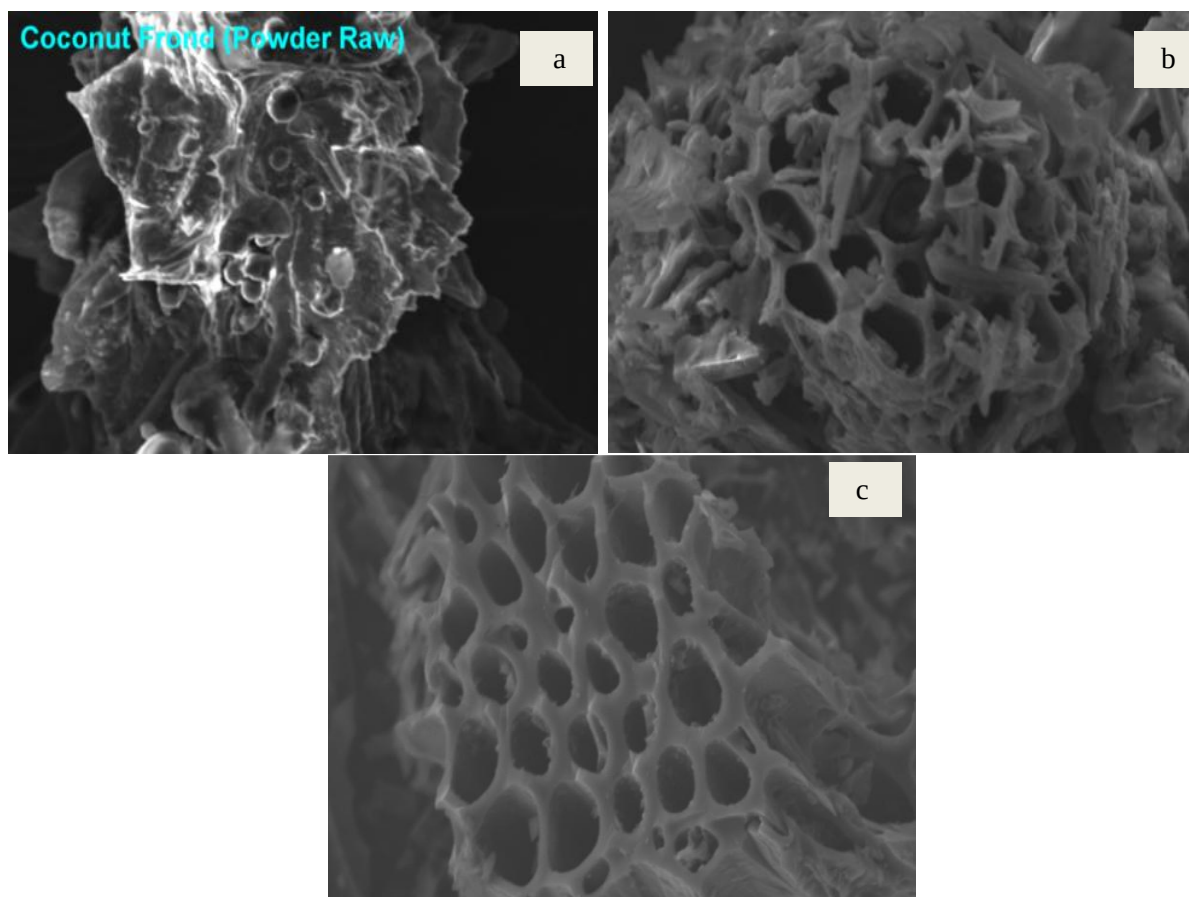


Figure 2. SEM microphotographs of (a)coconut fronds (raw) ,(b) charred sample and (c)lead sorbed

Preparation of different concentration of Pb (II) nitrat solution by using UV- visible Spectrophotometer

Table 3 Calibration for Pb (II) Nitrate Solution by Using UV-visible Spectrophotometer at $\lambda_{\max} = 410 \text{ nm}$

Concentration (mg/L)	Absorbance
1.0	0.0282
2.0	0.0571
3.0	0.1112
4.0	0.1392
5.0	0.1863

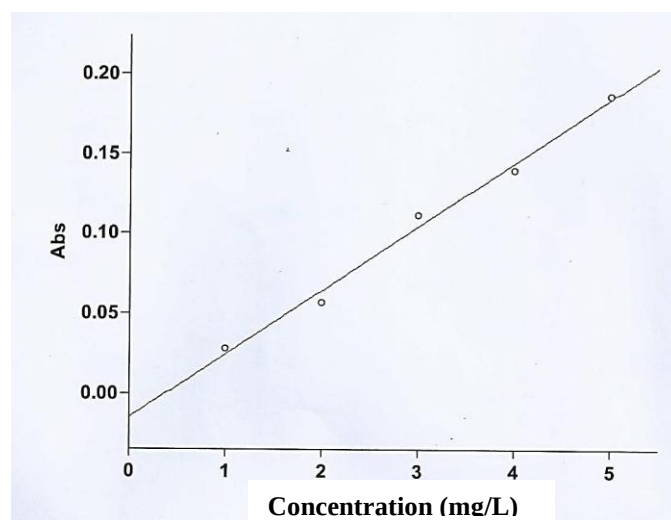


Figure 3. Solution calibration curve for Pb (II) nitrate solution

The result shows that adsorption of Pb (II) increased at a steady rate as pH increased up to about 7, attaining a maximum value of around 59.06%. However, after pH 7, there was a decrease in the adsorption. When the pH of the adsorbing medium was increased from 3 to 8, there was a corresponding increase in deprotonation of the adsorbent surface, leading to a decrease in H^+ ion on the adsorbent surface. This creates more negative charges on the adsorbent surface, which favors adsorption of positively charge species and the positive sites on the adsorbent surface.

Table 4. Effect of pH on the Adsorption of Pb (II) Ion by Prepared Charred Sample

pH	Final concentration (ppm)	Removal percent (%)
3	0.8720	12.80
4	0.6627	33.73
5	0.6162	38.38
6	0.5232	47.68
7	0.4069	59.06
8	0.4767	52.33

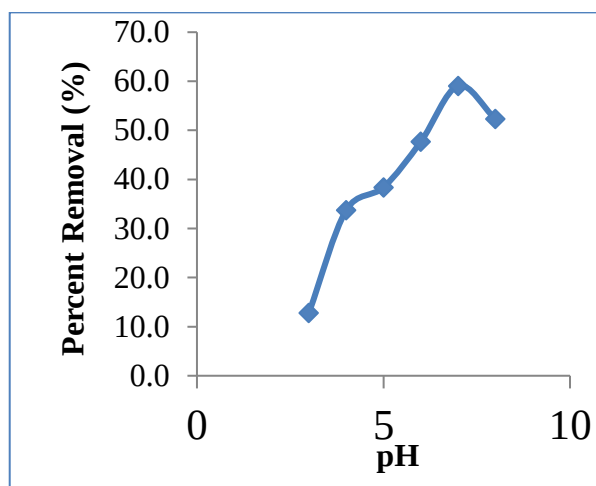


Figure 4. Effect of pH on the adsorption of Pb^{2+} ion by prepared charred sample

Table 5. Effect of Initial Concentration on the Adsorption of Pb (II) Ion by Prepared charred sample

Initial concentration (ppm)	Final concentration (ppm)	Removal percent (%)
1	0.4069	59.06
2	1.2857	35.72
3	2.3520	21.60
4	3.3030	17.43
5	4.1843	16.31

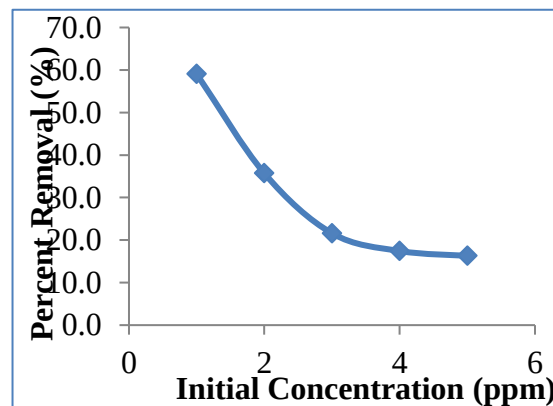


Figure 5. Effect of initial concentration on the adsorption of Pb^{2+} ion by prepared charred sample

Effect of initial concentration of Pb (II) ion solution

The initial concentration of metal ions in the solution is an important parameter since the metal ions concentration change over a broad range in industrial effluents. The batch adsorption experiments were carried out with different initial concentrations (1, 2, 3, 4, 5 mg/L). The variation of percentage removal of Pb (II) ion with different initial concentration for prepared charred sample is properly clarified in the Table 5 and Figure 5. The formation of

the layer is highly hindered at higher concentration and is due to interaction between Pb (II) ion on the surface and in the solution.

Effect of contact time on the removal of Pb (II) ion solution

The adsorption of Pb (II) ion was studied as a function of time in order to find out the equilibrium time required for maximum adsorption of metallic ions. Table 6 and Figure 6 show the adsorption of the Pb (II) ion using prepared charred sample. It is observed that the concentration of Pb (II) ion adsorbed on the prepared charcoal increased with time. This enhanced sorption of the metal ion with increase in agitation time may be due to the decrease in boundary layer resistance to mass transfer in the bulk solution and an increase in kinetic energy of the hydrated metal ions.

Table 6 Effect of Contact Time on the Adsorption of Pb (II) Ion by Prepared Charred Sample

Contact Time (min)	Final concentration (ppm)	Removal percent (%)
15	0.6627	33.73
30	0.5465	45.35
60	0.4069	59.06
90	0.4767	52.33
120	0.5116	48.84

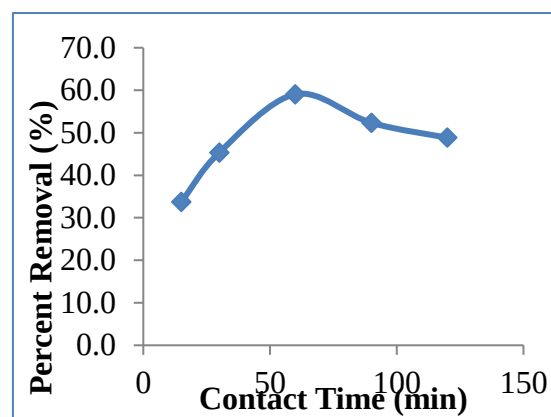


Figure 6. Effect of contact time on the adsorption of Pb²⁺ion by prepared charred sample

Effect of dosage of adsorbent

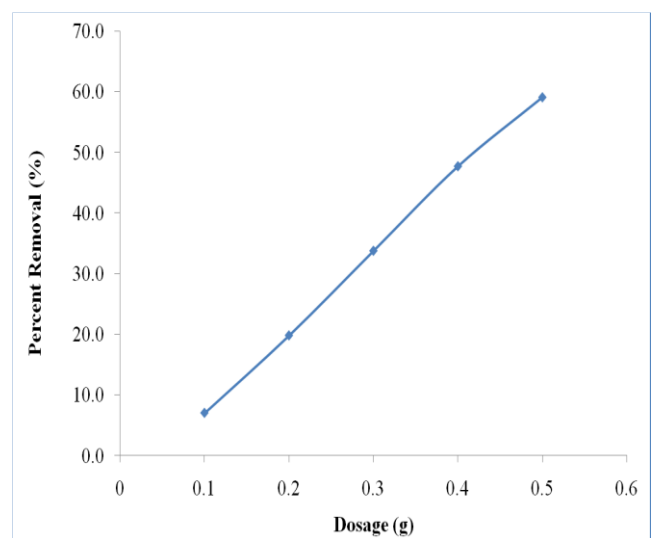
Equilibrium studies were performed for analyzing the performance of all the adsorbents. The variation of removal percentage of Pb (II) ion versus adsorbent dosage for adsorbent doses ranging from 0.1- 0.5 g/L and other working parameters will consider to be constant (pH at 7 and initial ions concentration at 1ppm) is suitably illustrated in Figure 7 and Table 7. It is clearly noted from this graph that the maximum adsorption removal achieved by using 0.5 g/L of prepared charred sample was 59.06%. On the other hand, the removal percentage of Pb (II) ions are increased as the amount of adsorbent is increased gradually from 0.1g to 0.5 g/L. So, the maximum removal will be low at low solid loading and increased with increasing adsorbent dosage. While almost negligible decrease of removal efficiency over the specific adsorbent weight i.e beyond optimum weight.

Adsorption Isotherm Studies

Adsorption isotherm reveals the relationship between the mass of adsorbate adsorbed per unit weight of adsorbent in equilibrium and liquid-phase equilibrium concentration of the adsorbate. In this study the coefficient of Langmuir and Ferundlich isotherms of adsorbents in existence of lead are determined from experimental data.

Table 7. Effect of Dosage on the Adsorption of Pb (II) Ion by Prepared Charred Sample

Dosage (g)	Final concentration (ppm)	Removal percent (%)
0.1	0.9302	6.98
0.2	0.8023	19.77
0.3	0.6627	33.73
0.4	0.5232	47.68
0.5	0.4069	59.06

**Figure 7 Effect of dosage on the adsorption of Pb²⁺ ion by prepared charred sample**

Pb²⁺ ion
prepared charred sample

Table 8. Data Treatment for Sorption of Pb²⁺ Ion by Prepared Charred Sample

Dosage (g)	C _o (mgL ⁻¹)	C _e (mgL ⁻¹)	X (mgL ⁻¹)	x/m (mg g ⁻¹)	m/x (mg ⁻¹ g)	1/C _e (mgL ⁻¹)	Log C _e	Log x/m
0.1	1	0.9302	0.698	6.980	0.1432	1.075	-0.0314	0.8438
0.2	1	0.8023	0.989	4.943	0.2023	1.246	-0.0956	0.6937
0.3	1	0.6627	1.124	3.747	0.2669	1.509	-0.1786	0.5740
0.4	1	0.5232	1.192	2.980	0.3355	1.911	-0.2813	0.4742
0.5	1	0.4069	1.186	2.370	0.4215	2.458	-0.3547	0.3404

Table 9. Values of Langmuir and Freundlich Isotherm Constant for Removal of Lead

Sorbents	Langmuir constants			Freundlich constants		
	X _m (mg g ⁻¹)	b (Lmg ⁻¹)	R ²	K (mg g ⁻¹)	n	R ²
Coconut frond char	5.917	1.7071	0.983	3.5481	1.618	0.993

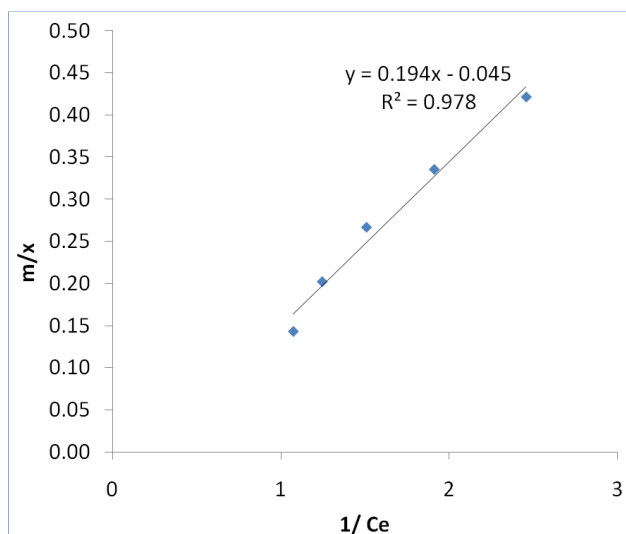
Langmuir Isotherm

Figure 8 Langmuir isotherm: sorption of Pb^{2+} on prepared charred sample

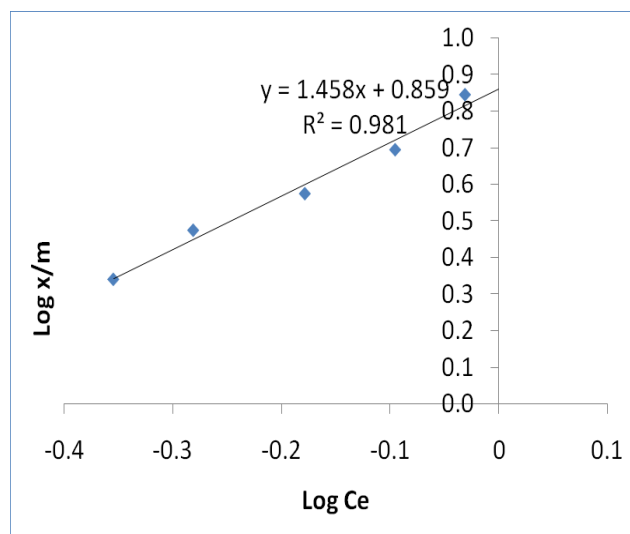
Freundlich Isotherm

Figure 9 Freundlich isotherm: sorption of Pb^{2+} on prepared charred sample

Figures 8 and 9 show the linear plot of Langmuir and Freundlich isotherms for adsorption of Pb (II) ion on prepared charred sample. The model parameters obtained by applying Langmuir and Freundlich models to the experimental data are given in Table 8 and 9. Based on Table 9, the adsorption inclined towards the Freundlich isotherm because it gives a higher value of correlation coefficient ($R^2 = 0.993$) compared to Langmuir isotherm (0.983). It can be said that the adsorption of Pb (II) ion using prepared char from coconut frond should use the monolayer adsorption on a surface that is homogenous in adsorption affinity. It can be found that the regression coefficient R^2 obtained from Freundlich model are closer to 1 than that of the Langmuir model, suggesting that the Freundlich isotherm fits better with the adsorption of Pb (II) ion on prepared char from coconut frond. The adsorption capacity obtained in this study was 5.917 mg/g. It can be concluded that prepared char from coconut frond can be used for the removal of Pb (II) ion from aqueous solutions.

Conclusion

In this work, charcoal sample was prepared from coconut frond by using primitive method. The removal of lead ion in aqueous solution was studied by using char from coconut frond. The moisture content of coconut fronds powder (raw) and charred samples were found to be 1.15 % and 1.12 %. The ash content of coconut fronds powder (raw) and charcoal samples were found to be 6.52 % and 7.94 %. The bulk densities of coconut fronds powder raw and charcoal sample were found to be 0.72 % and 1.25 %. The pH of coconut fronds powder (raw) and charred samples were found to be 6.0 and 6.6.

The aim of this study was to investigate the sorption capacity of charred sample from coconut fronds for Pb^{2+} ion from aqueous solution and the effect of pH, initial Pb^{2+} ion concentration, contact time and dosage on aqueous solution. The charred sample was found to be 59.06 % for the removal of lead Pb^{2+} ion at pH 7, 60 min contact time and 1 ppm of Pb^{2+} ion concentration by using 0.5 g/2 mL dosage of adsorbent at room temperature. FT-IR and SEM analyses after removal of Pb^{2+} ion. On SEM analysis, Pb^{2+} ion was sorbed on prepared charred sample was observed. From the results, prepared charred sample adsorbed Pb^{2+} ion from aqueous solutions and the concentration of the metal ion adsorbed increased with decrease

in initial concentration, increase in dosage, increase in contact time and increase in pH. The experimental data was analyzed with the Langmuir and Freundlich adsorption isotherm equations.

It is therefore suffices to conclude that coconut fronds are agricultural wastes, readily available effective adsorbent for the removal of Pb^{2+} ion from wastewater as a way of treatment before discharge into the environment.

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SORPTION PROPERTY OF ACTIVATED CARBON-ALUMINIUM COMPOSITE ON COPPER (II) FROM AQUEOUS SOLUTION

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Abstract

This research work is dealt with the removal of copper (II), one of the most toxic heavy metals in biological systems, from aqueous solution by activated carbon (AC) and activated carbon-aluminium (AC-Al) composite. The activated carbon (AC), was obtained from djenkol bean shell at 450 °C for 2 h. And then activated carbon-aluminium (AC-Al) composite sorbent was prepared by the activated carbon with aluminium sulphate was heated at 450 °C for 2 h. Several techniques, including EDXRF, SEM, were used to characterize the synthesized materials. The physicochemical properties of activated carbon (AC) and activated carbon-aluminium (AC-Al) composite were observed at 6.4 and 6.95 % of moisture content, 0.87 and 0.58 g/mL of bulk density, and 9.86 and 7.1 of pH. The effects of concentration, dosage, and contact time at pH 7 on the adsorptive removal of copper (II) on activated carbon (AC) and activated carbon-aluminium (AC-Al) composite have also been studied. The AC-Al composite material was seemed to exhibit excellent sorption properties with rapid removal capacity for copper (II). The maximum removal property of AC-Al was 72 %.

Keywords: activated carbon, activated carbon-aluminium composite, toxic heavy metals, sorbent

Introduction

AC is a black, amorphous solid containing major portion of fixed carbon content and other materials such as ash, water vapor and other volatile matters in small percentage. AC also contains physical characteristics such as internal surface area, pore volume and particle size large surface area results in a high capacity for absorbing chemicals from liquids and gases. It is composed of 87 % to 97 % carbon but also other elements depending on the processing method used and raw material it is derived from.

Adsorption process is generally classified as physisorption (characteristic of weak van der Waals forces) or chemisorption (characteristic of covalent bonding). Physical adsorption occurs when an adsorbate is kept on the adsorbent's surface by a weak van der Waal's force of attraction. Adsorption of oxygen on charcoal is an example of physical adsorption. Chemical adsorption occurs when an adsorbate is kept on the adsorbent's surface by a strong chemical bond. Adsorption of hydrogen on nickel is one of the examples of it.

Adsorption is present in many natural, physical, biological and chemical systems and is widely used in industrial applications such as heterogeneous catalysts, activated charcoal, capturing and using waste heat to provide cold water for air conditioning and other process requirements (adsorption chillers), synthetic resins, increasing storage capacity of carbide-derived carbons and water purification.

The term heavy metal refers to any metallic chemical element that has a relatively high density. It is toxic or poisonous even at low concentrations. Heavy metals are natural components of the Earth's crust. They cannot be degraded or destroyed. To a small extent they enter our bodies via food, drinking water and air. As trace elements, some heavy metals (e.g., copper, selenium, zinc) are essential to maintain the metabolism of the human body. However, at higher concentrations they can lead to poisoning. Heavy metal poisoning could result, for instance, from drinking-water contamination (e.g., lead pipes), high ambient air concentrations

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near emission sources, or intake via the food chain. Examples of heavy metals include mercury (Hg), cadmium (Cd), arsenic (As), chromium (Cr), copper (Cu) and lead (Pb).

The aim of this research work was to study the sorption property of activated carbon (AC) and activated carbon-aluminium (AC-Al) composite from djenkol bean shell.

Materials and methods

Sample Collection

The chemicals used in this work include aluminium sulphate ($\text{Al}_2(\text{SO}_4)_3$), Copper (II) sulphate pentahydrate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$). All chemicals used in this work produced by British Drug House Chemicals Ltd. (BDH). Activated carbon was prepared from djenkol bean shells which were collected from KhaingShweWar Market, Tharkayta Township, Yangon Region, Myanmar.

Preparation of Activated Carbon (AC) Powder and Activated Carbon-Aluminium (AC-Al) Composite Powder

The collected djenkol bean shells were taken and grind with motor and pestle. The dried powder (50g) was heated at 450°C for 2 hours. Activated carbon powder was obtained.

Aluminium sulphate solution was prepared by dissolving 10 g of aluminium sulphate in 200ml distilled water. 50g of djenkol dried powder was added to the aluminium sulphate solution in 250ml beaker and this solution was stirred with magnetic stirrer for one hour. This solution was filtered with filter paper. The filtrate was heated at 450°C for 2 hours in furnace. Activated carbon-aluminium composite (AC-Al) was obtained.

Characterization of the Prepared Samples

The physicochemical properties (pH, moisture and bulk density) of activated carbon (AC) and activated carbon-aluminium (AC-Al) composite powders were determined. The prepared activated carbon (AC) and activated carbon-aluminium (AC-Al) composite powders were characterized by SEM and EDXRF.

Sorption Studies for Copper (II) from Aqueous Solution by Activated Carbon (AC) and Activated Carbon-Aluminium (AC-Al) Composite

The removal efficiency of activated carbon (AC) and activated carbon-aluminium (AC-Al) composite were determined on aqueous copper (II) from aqueous solution by using UV-Vis spectrophotometer under optimized conditions for effect of dosage, effect of concentration, and effect of contact time at pH 7.

Results and Discussion

Physicochemical Analysis of Activated Carbon (AC) and Activated Carbon-Aluminium (AC-Al) Composite

Table (1) shows the moisture content, bulk density, pH and ash content of activated carbon (AC) and activated carbon-aluminium (AC-Al) composite. The pH and Bulk density of activated carbon-aluminium (AC-Al) composite was lower than that of activated carbon (AC) but was high in moisture content.

Characterization of Activated Carbon (AC) and Activated Carbon-Aluminium (AC-Al) Composite

SEM analysis

The scanning electron micrographs of before and after adsorbed activated carbon-aluminium (AC-Al) composite are shown in Figure 1. From SEM analysis, the activated carbon-aluminium (AC-Al) composite has porous and flat like structure.

Table 1 Physicochemical Properties of Activated Carbon (AC) and Activated Carbon-Aluminium (AC-Al) composite

Physicochemical properties	Activated Carbon (AC)	Activated Carbon-Aluminium (AC-Al) Composite
pH	9.86	7.10
Moisture (%)	6.40	6.95
Bulk density (gcm^{-3})	0.87	0.58

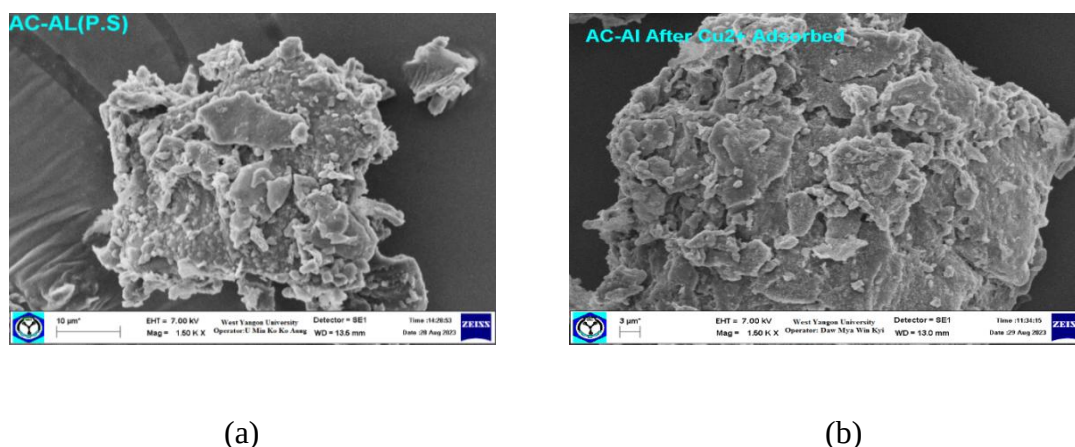


Figure 1 Scanning electron micrographs of (a) activated carbon (AC) before adsorbed and (b) activated carbon-aluminium (AC-Al) composite after adsorbed

EDXRF analysis

According to the EDXRF spectrum analysis, it was found that K (59.64%), Cl (23.861 %), Ca (10.81 %), Fe (2.198 %), S (1.480 %), Br (0.622 %), Mn (0.598 %), Zn (0.260 %), Cu (0.248 %), and Rb (0.308 %) in the djenkol bean shell sample and K (67.015 %), Cl (17.102 %), Ca (10.51 %), Fe (2.635 %), S (0.808 %), Br (0.446 %), Mn (0.734 %), Zn (0.277 %), Cu (0.248 %), and Rb (0.278%) were also contained in the activated carbon (AC) of djenkol bean shell .

Sorption Studies for Copper (II) from Aqueous Solution by Activated Carbon (AC) and Activated Carbon-Aluminium (AC-Al) Composite

Activated carbon (AC) and activated carbon-aluminium composite (AC-Al) shows nearly 40-50% adsorptive removal of heavy metal ions Cu(II) under optimized conditions of dosage 0.5 g, initial concentration 100 mgL^{-1} , and 15 m of contact time at pH 7.

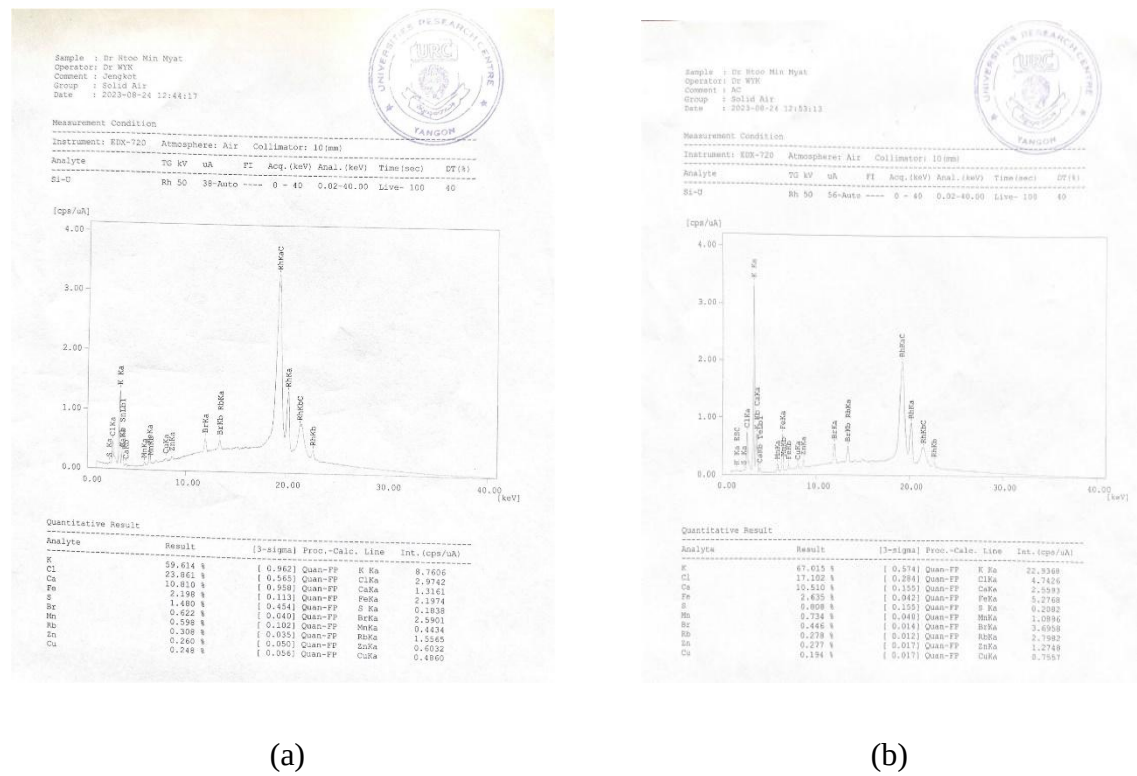


Figure 2 EDXRF spectra of (a) djenkol bean shell powder sample and (b) Activated carbon (AC) of djenkol bean shell

Table 2 Relationship between Absorbance and Concentration of Copper (II)

Concentration (ppm)	Absorbance (at 620nm)
100	0.024
200	0.028
300	0.032
400	0.036
500	0.040
600	0.044

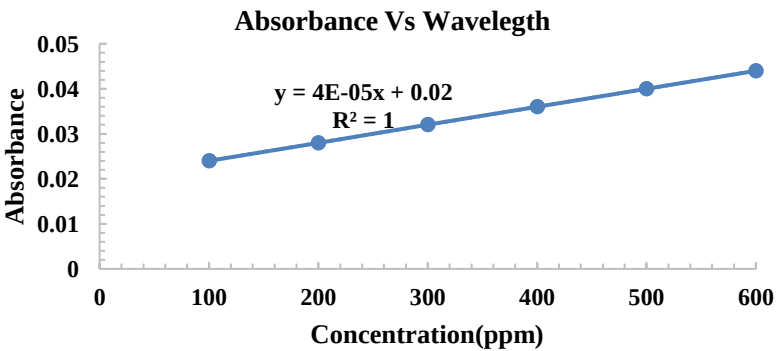
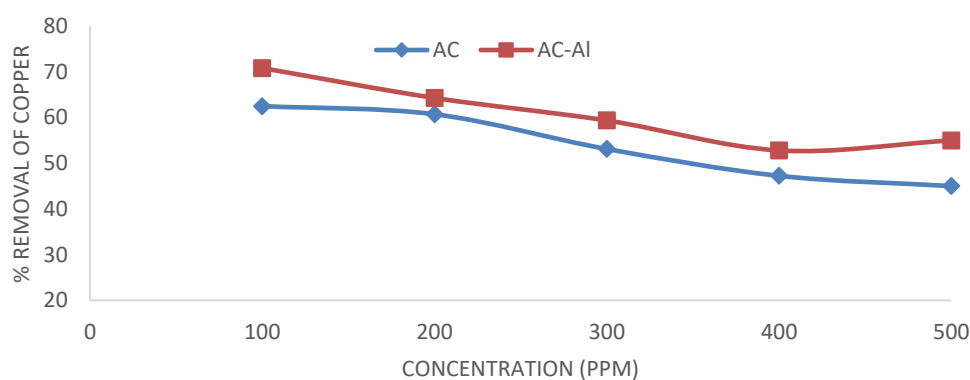


Figure 3 Standard calibration curve for copper(II) by spectroscopic method

Table 3 Effect of Concentration of Activated Carbon (AC) and Activated Carbon-Aluminium (AC-Al) Composite

Initial Concentration (ppm)	Removal percent of copper(II) (%)	
	Activated Carbon	Activated Carbon-Aluminium Composite
100	62.5	70.8
200	60.7	64.2
300	53.1	59.3
400	47.3	52.8
500	45.0	55.0

**Figure 4 Effect of concentration of activated carbon (AC) and activated carbon-aluminium composite (AC-Al)****Table 4 Effect of Dosage of Activated Carbon (AC) and Activated Carbon-Aluminium (AC-Al) Composite**

Dosage (g)	Removal percent of copper(II) (%)	
	Activated Carbon	Activated Carbon-Aluminium Composite
0.1	40	42
0.2	45	48
0.3	50	52
0.4	56	60
0.5	60	68

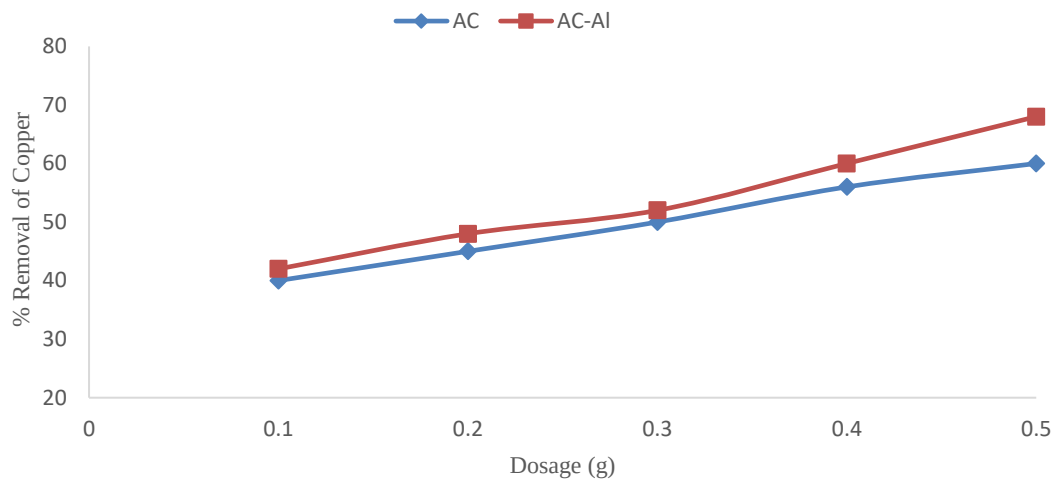


Figure 5 Effect of Dosage of activated carbon (AC) and activated carbon-aluminium composite (AC-Al)

Table 5 Effect of Contact Time of Activated Carbon (AC) and Activated Carbon-Aluminium (AC-Al) Composite

Time (m)	Removal percent of copper(II) (%)	
	Activated Carbon	Activated Carbon-Aluminium Composite
5	40	45
10	50	52
15	65	67
20	67	67
25	65	68

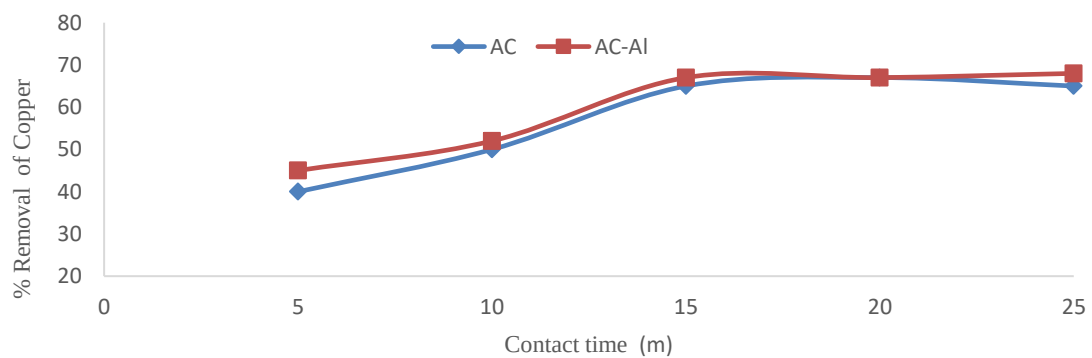


Figure 6 Effect of contact time of activated carbon (AC) and activated carbon-aluminium composite (AC-Al)

Conclusion

In this research, AC-Al composite was developed and compared AC from uptake of copper(II). Instrumental analysis such as SEM was carried out to characterize AC-Al composite. Adsorbent was preponderantly a mesoporous adsorbent. The maximum sorption property of AC-Al was observed at 0.5g of maximum dosage, 100ppm of initial concentration of copper(II) and 15 m of contact time at pH 7. The physicochemical properties of AC-Al composite were observed such as moisture content (6.95 %), bulk density (0.58 g/mL) and pH (7.1). According to this research work, djenkol bean shell is capable to use as adsorbent to remedy the toxic contaminant in water.

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COMPARISON BETWEEN THE POWER CONVERSION EFFICIENCY OF DYE-SENSITIZED SOLAR CELLS BASED ON NATURAL AND SYNTHETIC PHOTOSENSITIZERS

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Abstract

The performances of the natural dye-based solar cell were compared with those of the synthetic dye-based solar cell in this research. From titanium isopropoxide, titanium dioxide was produced for the photoanode. TiO₂'s preferred (101) orientation revealed favorable results in terms of structural properties. Composite metal oxide (CuO-ZnO) was prepared to be used in the counter electrode. For natural dye photosensitizer, *Tradescantia Spathacea* leaves were utilized, while Eosin Y was employed for synthetic dye photosensitizer. Using a UV-Vis spectrophotometer, the dyes' absorption spectra were determined. For *Tradescantia Spathacea* and Eosin Y, the dyes' average absorption values were sharp and high. The photoelectric performance of the cells confirmed that the PCEs of *Tradescantia spathacea* and Eosin Y were 1.93% and 2.698% under dark conditions; on the other hand, the PCEs of *Tradescantia spathacea* and Eosin Y were 2.446% and 7.415% under light conditions, respectively.

Keyword- natural dye, synthetic dye, photosensitizer, photoelectric performance

Introduction

The rapid advancement of society and the depletion of fossil fuels have led to the increasing importance of renewable energy sources in the modern era. The fact that the demand for energy is still rising should be noted (Ahmed M. Ammar, *et.al.*, 2019). One of the causes is the country's rapidly expanding population and markedly rising level of life. The improvement of the industry is another factor (Amarachukwu N. Ossai, *et.al.*, 2020). One essential resource for the advancement of human civilizations is electricity (Riyaz Ahmad Mohamed Ali, *et.al.*, 2010). The usage of electric transportation, heating, and widespread electrical access is expected to result in a 90% expansion of power consumption between now and 2040. Nonetheless, the existing energy supply and consumption structure is unsustainable and has to be stabilized immediately (Al Amin, M. Al Emran, *et.al.*, 2019). Furthermore, the current generation is being forced by climate change and global warming to look for ecologically beneficial energy solutions that will support long-term sustainable development for future generations (Amal M. AL-Kahlout, *et.al.*, 2015). There are several ways to obtain electricity, including through the use of coal, natural gas, or biomass. It should be remembered that using fossil fuels has a significant negative environmental impact. It is essential to protect the environment when producing energy (S. Davisan1, *et.al.*, 2023). As a result, a shift toward renewable resources should be made in the energy production process. Due to their significant temporal and geographical unpredictability, renewable energy sources must be handled with caution and accounted for in the national energy plan in order to maintain a supply that is well-balanced (Khalil Ebrahim Jasim, 2014). With its enormous potential for energy contribution, solar photovoltaic technology can meet all of the world's energy needs. Photovoltaic (PV) systems for harvesting and providing electricity should thus be easily accessible in view of this reality (Di Wei, 2014).

With photovoltaic technology, sunlight is directly converted into high-quality electrical energy. It is possible to distinguish between three main types of photovoltaic solar cells, or generation. At the moment, the first two cover the market (Jihuai Wu, *et.al.*, 2017). The first generation, which is the most well-known, is built on crystalline silicon. Although the cost of

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producing silicon wafers and the environment are somewhat expensive, this technique is the most efficient. The second generation of solar cells, known as thin-film technology, is primarily based on amorphous silicon (a-Si), copper-indium-diselenide/copper-indium-gallium-diselenide (CIS/CIGS), cadmium sulfide (CdS), and cadmium telluride (CdTe) (Chuen-ShiiChou, *et.al.*, 2010). It has made it possible to switch out expensive conventional silicon solar cells for more affordable CIGS ones. However, dye-sensitized solar cells (DSSC) are the kind of solar cells that are drawing interest from research groups worldwide. They are part of the third generation of solar cells that generate clean energy and needs inexpensive equipment for fabrication (Chih-Hung Tsai, *et.al.*, 2015). Unlike traditional solar cells, which rely on a semiconductor-based p-n junction, DSSCs are composed of four primary parts: The photoanode, also known as the working electrode, has a mesoporous semiconductor layer that is primarily composed of titanium dioxide (TiO₂). The counter electrode is covered in a catalyst, usually platinum. The electrolyte, which contains the redox couple, is responsible for collecting electrons at the counter electrode and regenerating the dye sensitizer. The dye sensitizer is absorbed by the TiO₂ molecules (Mingxing Wu, *et.al.*, 2012). In this research, the dye sensitized solar cells based on natural dye and synthetic dye were fabricated and their power conversion efficiencies were measured.

Materials and Methods

Preparation of Titanium Dioxide Films

To produce TiO₂ powder, 1 g of urea [CO(NH₂)₂] and 200 ml of distilled water (H₂O) were stirred for five minutes and then, 50 ml Titanium Isopropoxide (C₁₂H₂₈O₄Ti) were slowly added in this solution. Organic titanium salt served as the starting chemical for TTIP, which was then diluted and hydrolyzed using distilled water. Urea was then utilized to adjust the pH and stabilize the TiO₂ wall. The resulting suspension was stirred for 30 minutes. It was placed 80°C in the oven for 24 h. TiO₂ particles were produced when the synthetic resin was calcined to eliminate organic matter at the end of the preparation process.

After preparation, the synthesized TiO₂ was examined to know its thermal properties by using Thermogravimetric Analysis (TGA) and Differential Thermal Analysis (DTA). Then the synthesized TiO₂ was heated at 500°C for 1 h. After that these calcined TiO₂ powders were analyzed their structural properties by using XRD measurement. According to the XRD results, the structural property of the anatase TiO₂ showed good behavior with preferred (101) orientation. Figure 1.1 and 1.2 showed the TGA/DTA and XRD measurement of synthesized TiO₂.

To be coated with TiO₂ paste on FTO glass substrate, the FTO glass substrates were soaked in acetone for 15 minutes and distilled water was used to wash them for another 10 minutes. Then a small amount of TiO₂ powder and the solvent 2-methoxyethanol were mixed in the agate motor to be homogeneous. The Doctor Blade Coating Method was then utilized to form TiO₂ films.

Preparation of Composite (CuO-ZnO) Films for Counter Electrode

To prepare composite CuO-ZnO powder, 60 ml of isopropanol (C₃H₈O) was mixed with 4.5 g of zinc acetate dihydrate [Zn(CH₃COO)₂·2H₂O] and 2 g of copper acetate dihydrate [Cu(CH₃COO)₂·2H₂O] and stirred at 75 °C for 2 h. It was continuously stirred all the time and the solution with light blue color was obtained. After this process, the mixture was aged for two days in a dark chamber. After two days ago, the upper liquid was drained and the remaining sediment was evaporated at 82 °C to form the gel. The gel turns to powder after an hour and a half of heating at 82 °C. By examining with TGA/DTA measurement, its thermal properties was analyzed. Then that powder was annealed for 1 h at 500 °C. Diffraction peaks of CuO and ZnO appeared in the XRD pattern which confirmed the presence of both materials. Figure 1.3

and 1.4 revealed the results of produced composite CuO-ZnO from TGA/DTA and XRD measurement.

To make composite films for counter electrode, a suitable amount of composite CuO-ZnO powder and the solvent 2-methoxyethanol were put in the agate motor. To be fine paste, it was pressed with the pestle. Simple coating method called the Doctor Blade Method was also applied in the coating composite films.

Preparation for Natural Dye and Synthetic Dye Photosensitizers

Tradescantia Spathacea leaves were filtered after being cleaned with distilled water. Then they were ground and weighed. 12 grams of crushed leaves were taken and mixed with 50 mL of 70% ethanol. After that it was stored overnight at room temperature. On the following day, the extracted sample was stirred using magnetic stirrer at 50°C for 1 hr. The procedure continued with the filtration of the sample to remove large residue. Subsequently, the extracts were centrifuged at 1500 rpm using a Denley BS400 (UK) centrifuge machine for fifteen minutes to separate any remaining residues.

To prepare Eosin Y synthetic dye, 0.1 g of Eosin Y was dissolved into 50 mL of ethanol and it was stirred with magnetic stirrer at room temperature. Then two or three drops of acetic acid were added to this solution. Figure 1.5 (a), (b) and 1.6 (c), (d) showed the preparation of natural dye and synthetic Eosin Y dye.



(a)



(b)

Figure 1.5 (a) and (b) Preparation of *Tradescantia Spathacea* dye



(c)



(d)

Figure 1.6 (c) and (d) Preparation of Eosin Y dye

Electrolyte Preparation

First, 1.6 g of potassium iodide with 20 mL of acetonitrile were combined and agitated for 3 hr. Then 0.254 g of iodine (I_2) was added to the solution and mixed in. Finally, the electrolyte solution was ready for use in dye-sensitized solar cells, and it was sealed to prevent evaporation. Figure 1.7 (e) and (f) showed the preparation of electrolyte solution.

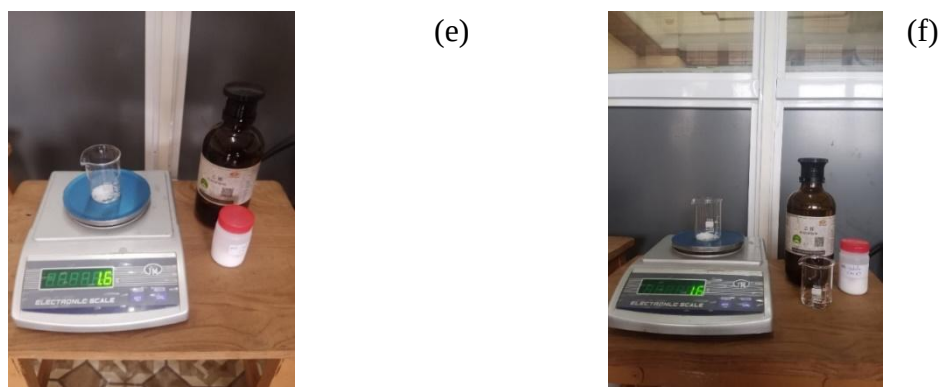


Figure 1.7 (e) and (f) Preparation of electrolyte solution

Fabrication of Dye-sensitized Solar Cells

The TiO_2 electrodes immersed in the natural dye and Eosin Y dye solutions for 24 h. The dye solutions were covered with glass plate to prevent evaporation. The substrates were rinsed in distilled water so as to remove excess dye. DSSCs were assembled and the composite oxide coated counter electrode on the top of FTO, so that the conductive side of the counter electrode faced the TiO_2 film. The electrolyte solution (Iodide/triiodide) was placed at the edges of the plates. Capillary action drew the liquid electrolyte into the gap between the electrodes. The electrodes were securely attached together with binder clips. The schematic diagram of the fabrication processes is presented in Figure 1.8 (g) to (l). The current density-voltage (J-V) curves were measured with New-port Oriel Sol A solar simulator at AM 1.5 G (100 mWcm^{-2}) with Keithley 4250 source meter.

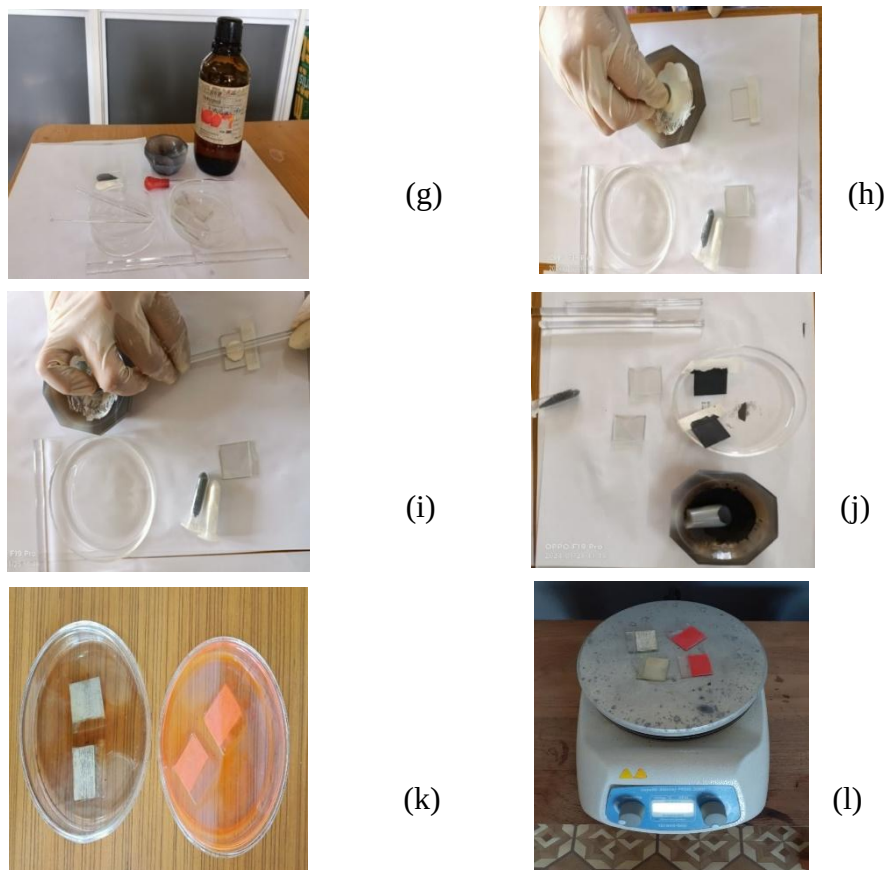


Figure 1.8 (g) to (l) Fabrication of Dye-sensitized Solar Cells

Results and Discussion

Thermal Analysis of Titanium Dioxide and Composite Metal Oxide (CuO-ZnO)

The thermogravimetric or derivative thermogravimetric analysis of dry TiO_2 powder prepared at 80°C for 24 h as shown in Figure 1.9. Titanium isopropoxide (TTIP) was stable up to 92.67°C , based on TGA results. Dehydration or the removal of water started at 92.67°C and completed at 161.90°C . Additionally, the weight loss occurred at 161.90°C . The thermal stability of $\text{C}_{12}\text{H}_{28}\text{O}_4\text{Ti}$ was observed in the horizontal region between 161.90°C and 601.23°C . Above roughly 200°C , $\text{C}_{12}\text{H}_{28}\text{O}_4\text{Ti}$ decomposed with the removal of $4(\text{CH}_3)_2\text{CHOH}$. In other words, $\text{C}_{12}\text{H}_{28}\text{O}_4\text{Ti}$ decomposed into TiO_2 and $4(\text{CH}_3)_2\text{CHOH}$ at temperatures up to 200°C . The endothermic peak of 92.67°C , corresponding to the DTA results, dehydrated from $\text{C}_{12}\text{H}_{28}\text{O}_4\text{Ti}$. The result of melting, vaporization, desorption, sublimation, etc. represented an endothermic peak. In the equation that follows, titanium isopropoxide reacted with water to produce TiO_2 .



It was observed to heat at 500°C , 600°C and 700°C respectively. After annealing process, they were characterized by XRD measurement.

The TG/DTA analysis of dry CuO-ZnO powder prepared at 82°C shown in Figure 1.10. The primary weight loss occurred at 239.47°C and the secondary weight loss occurred at 366.08°C . Phase transition formed to occur at about 366.08°C indicating the transition from metal hydroxide to metal oxide with weight loss 66.243 % and then the exothermic peak 239.47°C to dehydration of adsorption water. The endothermic peak of 366.08°C dehydrates from OH of crystal structure and was observed the pure CuO-ZnO composite material.

Identification the Structural Property of Titanium Dioxide and Composite Metal Oxide (CuO-ZnO)

In XRD pattern, (hkl) planes of synthesized TiO_2 at calcination temperature 500°C : (1 0 1), (1 0 3), (0 0 4), (1 1 2), (2 0 0), (1 0 5), (2 1 1), (2 0 4) and (1 1 6) showed that TiO_2 has anatase structure. The average crystallite of anatase TiO_2 at 500°C is 10.617 nm. Small crystallite sizes are preferred in dye-sensitized solar cells as more surface area enhances the interaction of the nanoparticles with the dye, optimizing charge transfer and reducing charge recombination. The crystallite size of less than 100 nm is suitable for a scaffold to hold large number of dye molecules. Anatase TiO_2 was therefore a good choice for the excellent performance of DSSC.

Both CuO and ZnO peaks appeared in the XRD pattern which confirmed the presence of both materials. It was found that the peaks at 2θ value of 34.14 , 56.36 and 67.63 belonging to CuO-ZnO composite metal oxide. Because of the average crystallite size of CuO-ZnO composite material was 34.037 nm the surface area of this material became larger. The higher the adsorption was, the larger the surface area of the material. The results can be seen in Figure 1.11, Figure 1.12, Table 1.1 and 1.2.

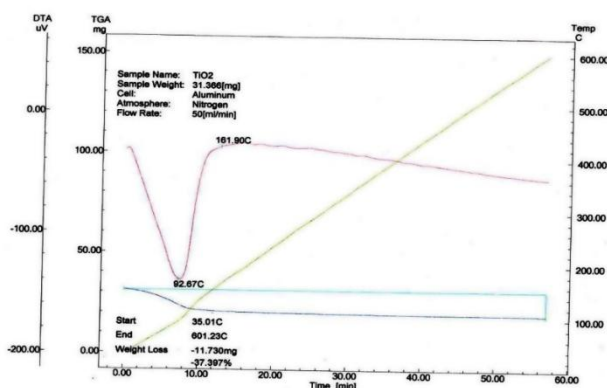


Figure 1.9 TG/DTA of synthesized TiO_2 powder

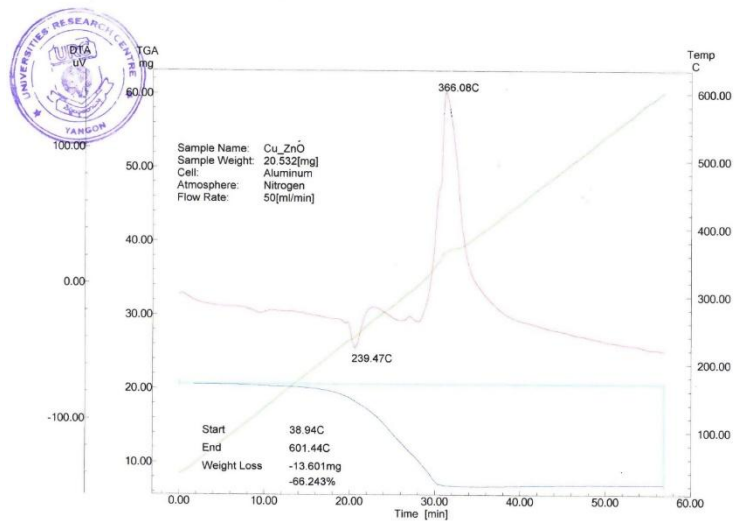


Figure 1.10 TG/DTA of synthesized CuO-ZnO composite powder

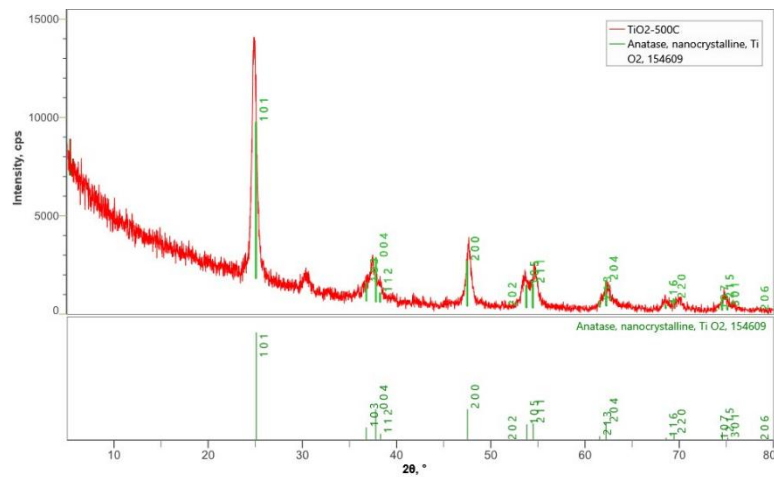
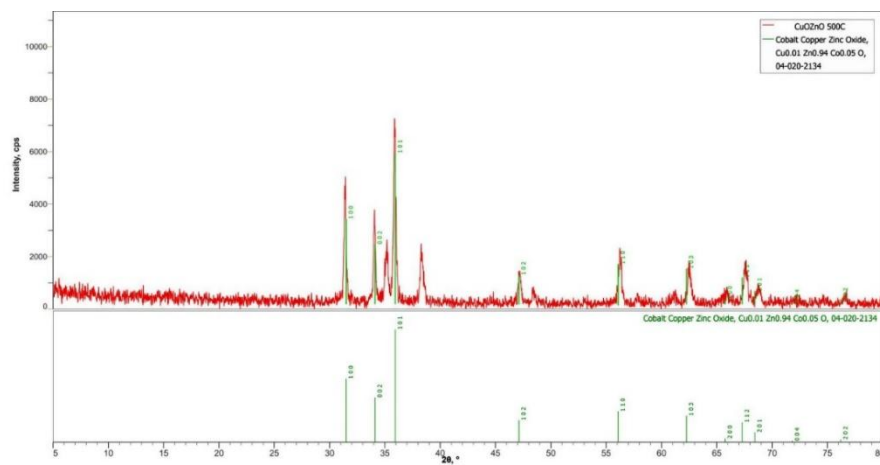
Figure 1.11 XRD pattern of TiO₂ at 500 °C

Figure 1.12 XRD pattern of CuO-ZnO at 500 °C

Table 1.1 Average crystallite size of TiO₂ at 500 °C

FWHM	2-Theta (deg)	theta	theta in rad	d in rad	Crystallite size (nm)	(hkl) plane
0.56	25.00	12.500	0.218	0.0099	12.997	1 0 1
0.69	36.70	18.350	0.320	0.0121	10.930	1 0 3
0.70	37.70	18.850	0.329	0.0122	10.804	0 0 4
0.71	38.20	19.100	0.333	0.0123	10.753	1 1 2
0.79	47.40	23.700	0.414	0.0139	9.851	2 0 0
0.83	51.40	25.700	0.449	0.0145	9.567	2 0 2
0.85	53.70	26.850	0.469	0.0149	9.418	1 0 5
500°C TiO ₂ Average Crystallite Size					10.617	

Table 1.2 Average crystallite size of pure composite CuO-ZnO at 500 °C

FWHM	2-Theta (deg)	theta	theta in rad	d in rad	Crystallite size (nm)	(hkl) plane	Phase Name
0.190	31.400	15.700	0.274	0.0033	39.187	1 0 0	ZnO
0.170	34.060	17.030	0.297	0.0030	44.097	0 0 2	CuO/ZnO
0.230	35.880	17.940	0.313	0.0040	32.757	1 0 1	ZnO
0.230	47.170	23.585	0.412	0.0040	34.004	1 0 2	ZnO
0.250	56.250	28.125	0.491	0.0044	32.509	1 1 0	CuO/ZnO
0.290	62.540	31.270	0.546	0.0051	28.917	1 0 3	ZnO
0.270	67.570	33.785	0.590	0.0047	31.941	1 1 2	CuO/ZnO
500 °C CuO-ZnO Average Crystallite Size					34.037		

Optical Property of Natural and Synthetic Photosensitizers

Figure 1.13 (a) describes the optical absorption spectra of *Tradescantia Spathacea* dye at 50 °C. The sharp absorbance values are 1.098 at 434.4 nm and 0.644 at 664.5 nm. So the absorption peaks are found to be in the visible range. As a result, the dye is confirmed to be chlorophyll pigment because the dye extract of chlorophyll pigment has an absorbance spectrum that ranges from 400–450 nm to 650–700 nm (Zularif Zolkepli, *et.al.*, 2019, Mahmoud A. M, *et.al.*, 2017, A. Yusoff, *et.al.*, 2014).

The optical absorption spectrum of the Eosin Y dye is shown in Figure 1.13 (b). The high absorbance value was 3.45 at 556.1 nm. The absorption spectrum of the dye extract of anthocyanin pigment is between the region of 480 and 600 nm (Michael Grätzel, 2003, R. Syafinar, *et.al.*, 2019). This agrees with the absorption spectrum of Eosin Y that contains anthocyanin pigments with the absorption peak wavelength at 556.1 nm. The measured and reference values are described in Table 1.3.

Table 1.3 Absorbance Wavelength and Nature of Dyes

Dye	Pigments	Holding Process (hr)	Measured Value Wavelength (nm)	Reference Value Wavelength (nm)
<i>Tradescantia Spathacea</i>	Chlorophyll	24	434.4 and 664.5	400-450 and 650-700
Eosin Y	Anthocyanin	24	556.1 nm	480-600

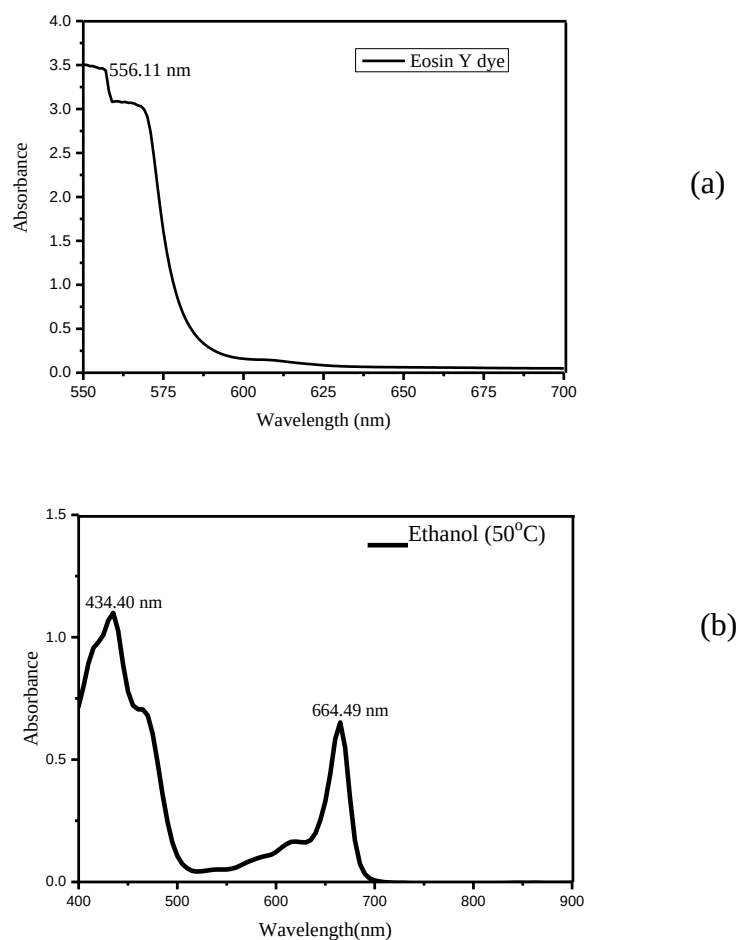


Figure 1.13 (a) Optical absorption spectrum of *Tradescantia Spathacea* dye extract in solvent ethanol (50 °C) (b) Optical absorption spectrum of Eosin Y dye extract in solvent ethanol

Working Principle of DSSC

Using a source meter to measure the current and voltage (I-V) characteristics under solar radiation, the solar cell parameters of natural dye-sensitized solar cells based on chlorophyll and anthocyanin dye derived from *Tradescantia Spathacea* and Eosin Y were analyzed.

The current-voltage characterizations were used to evaluate the essential DSSC characteristics based on natural and synthetic dyes, including the fill factor (Ff), efficiency (η), open-circuit voltage (Voc), and short circuit current (Isc).

The current-voltage curves of the DSSCs using the natural dye and synthetic dye sensitizers were shown in Figure 1.14 and 1.15. Table 1.4 and 1.5 showed the important parameters of these DSSCs.

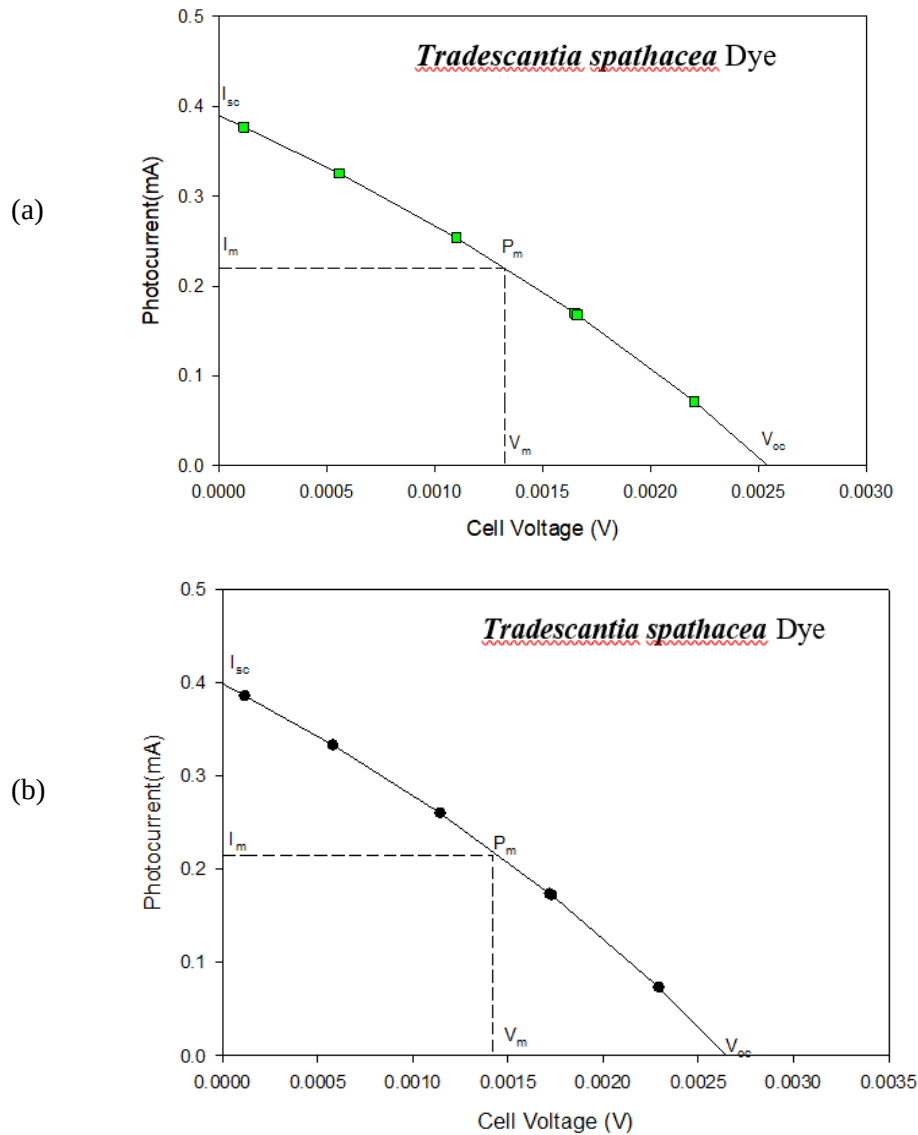


Figure 1.14 Current-voltage curve of the DSSC using the natural dye sensitizers extracted from *Tradescantia spathacea* leaves (a) in dark condition and (b) in light condition

Table 4 Photovoltaic characteristics of DSSCs using natural and synthetic photosensitizers

Sample	P_{in} (mW/cm ²)	I_m (mA)	V_m (V)	J_m (mA/cm ²)	I_{sc} (mA)	J_{sc} (mA/cm ²)	V_{oc} (V)
NDSSC (in dark condition)	0.01496	2.20E-01	0.00132	2.20E-01	3.96E-01	3.96E-01	0.00255
NDSSC (in light condition)	0.01496	2.26E-01	0.00162	2.26E-01	3.99E-01	3.99E-01	0.00273
DSSC (in dark condition)	0.01496	2.41E-01	0.00168	2.41E-01	4.64E-01	4.64E-01	0.00292
DSSC (in light condition)	0.01496	4.56E-01	0.00243	4.56E-01	7.85E-01	7.85E-01	0.00563

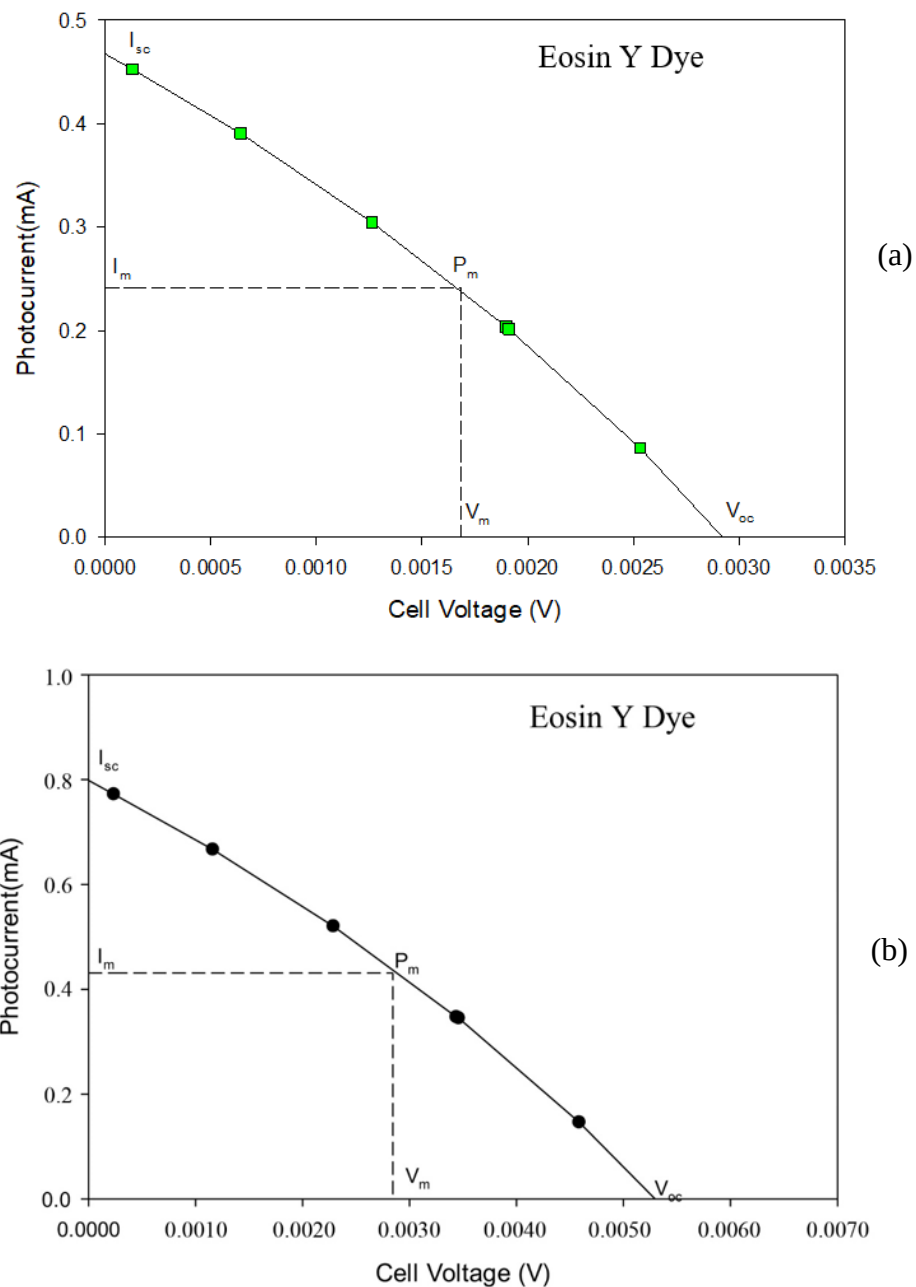


Figure 1.15 Current-voltage curve of the DSSC using the synthetic sensitizers extracted from Eosin Y powder (a) under dark condition and (b) under light condition

Table 5 Maximum electrical power output, efficiency and fill factor F_f of dye sensitized solar cells (DSSCs) based on natural dye and synthetic dye photosensitizers

Sample	P_m (mW/cm ²)	Efficiency (η) (%) (In dark condition)	Efficiency (η) (%) (In light condition)	Fill Factor (F_f) (In dark & light condition)
NDSSC	2.89E-01	1.930	2.446	0.287, 0.336
DSSC	4.03E-01	2.698	7.415	0.298, 0.250

Conclusion

Two different types of dye-sensitized solar cells based on photosensitizers were being produced in trial form as part of the ongoing research endeavor. The primary components of dye-sensitized solar cells would be made of materials that were carefully extracted, employed, and confirmed via analysis. Based on the dyes, the photoelectric performance of the cells revealed that the PCEs of Eosin Y and *Tradescantia Spathacea* were 2.698%, 1.93% in dark condition and 7.415%, 2.446% in light condition respectively.

Even if dye-sensitized solar cells still don't have the same efficiency as conventional solar cells, they are still the way of the future for the solar industry. In the future, dye-sensitized cells can become more effective if ways to lessen their downsides are found. In the next few years, they may potentially outperform conventional solar cells in terms of efficiency.

In this project both of the dyes used as DSSC sensitizers were organic dyes. Because of their inexpensive cost, easy fabrication method, environmental friendliness, and widespread availability, they were potentially suitable replacements for synthetic inorganic sensitizers. Although the two solar cells that were tested and made did not perform as well as expected, the necessary conditions have been found to allow them to move on with certainty.

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Fabrication and Characterization of Electrode of TiO₂ Based Dye Extracted From *Moringa oleifera* Lam., (Oleifera Leaves) for Dye-Sensitized Solar Cell (DSSC)

Cho Lay Nwe¹, May Thingyan Moe¹ and Myat Shwe Wah²

Abstract

The natural pigments containing chlorophyll extracted from *Moringa Oleifera* (Moringaceae) was studied as possible sensitizer for TiO₂ by assembling dye-sensitized solar cell (DSSC). Extraction of natural dye was done using different solvents. Fluorine doped Tin Oxide (FTO) was used as a transparent conductive substrate. The TiO₂ powder was fabricated on FTO by blade method as a window electrode of dye-sensitized solar cell. The window electrodes were sintered at temperature 450°C for half an hour. The fabricated TiO₂ layer was identified by X-ray Diffraction (XRD) and Scanning Electron Microscopy (SEM). The optical absorption spectra of extracted dye solution were investigated with UV-VIS spectrophotometer.

Keywords: Blade Method, FTO glass, Dye, TiO₂, DSSC, XRD, SEM and UV-Vis Spectrophotometer

Introduction

Photovoltaic cell (PV) is the most direct way to convert solar radiation into electricity and is based on the photovoltaic effect. Practically, all photovoltaic devices incorporate a p-n junction in a semiconductor across which the photovoltage is developed [2][3]. Dye sensitized solar cell produce electricity through electron transfer [6]. Sunlight passes through the conductive glass electrode. The dye absorbs the photons of light and one of the electrons in the dye moves from the ground state to an excited state. The excited electron jumps to the titanium dioxide (TiO₂) layer and diffuses across the film [4]. The electron then reaches the conductive electrode, travels through the wire, and reaches the counter electrode [5]. In this work, the window electrodes was fabricated by Blade Method and then the fabricated sample was sintered at temperature 450°C for half an hour [1]. The fabricated TiO₂ layer was characterized by X-ray Diffraction (XRD) and Scanning Electron Microscopy (SEM). The optical absorption spectra of extracted dye solution were investigated with UV-VIS spectrophotometer.

Materials and Method

***Moringa Oleifera* Lam., (Oleifera Leaves)**

Moringa oleifera Lam., (Oleifera Leaves) is a multipurpose tropical tree. It is mainly used for food and has numerous industrial, medicinal and agricultural uses, including animal feeding.

Moringa is a small to medium evergreen or deciduous tree that can grow to a height of 10-12 m [7][8].

Conductive Glass

To construct the window electrode solar cell, one conductive glasses have been employed. The glass substrate was pre-cleaned detergent, and then cleaned in methanol and acetone for 10 min each.

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Blade Method

The transparent conductive glass has been prepared by using tin oxide with Doctor Blade Method.

Experimental Procedure

Extraction of *Moringa oleifera* Lam., (Oleifera Leaves)

Moringa Oleifera Lam., (Oleifera Leaves) leaves were collected from garden. The samples were annealed at 150°C for 20min in the oven. And then, the samples were grinding with A-gate mortar for 15min and filtered with smaller 40 mask to get fine powder. 2g of powder were weighted and crushed adding 10 mL solvent. The extracted dyes were filtered two times with cotton cloth and stored in dark bottle covered with aluminium foil paper. Four different solvents of various polarities such as methanol, ethanol, acetone and hot water were used for extraction dye from *Moringa Oleifera* leaves. The procedure of the preparation-steps for *Moringa Oleifera* are shown in Figure 1 (a), (b) and (c).

Preparation of TiO₂ Electrode

2 g of TiO₂ powder was deposited in a beaker mixed with 20ml of Acetic acid and colorless detergent. The mixture was well mixed with the help of a glass rod for half an hour for the production of suspension with a consistency of a thick paint produced. The prepared paste was coated on FTO glass with surface resistance of 6-10 ohms by using doctor blade technique and the area of the cell was 1inch². Then the electrodes were sintered at temperature 450°C for half an hour. After the annealing was completed, the TiO₂ coated conductive glass was allowed to cool slowly at room temperature. The TiO₂ coated glass plate was soaked in *Moringa Oleifera* dye and was kept at a dark place. The glass plates were washed with water and then ethanol and were kept in air for 30 minutes in room temperature to remove surface water.

The procedure of the preparation-steps for *Moringa Oleifera* is shown in Figure 1. Figure 1(a) shows the natural pigments containing chlorophyll extracted from *Moringa Oleifera*. Figure 1(c) shows Doctor Blade Method to form a thin film on a substrate. Figure 1(d) shows the preparation-steps for the working electrode with compatible dye solution while Figure shows furnace.



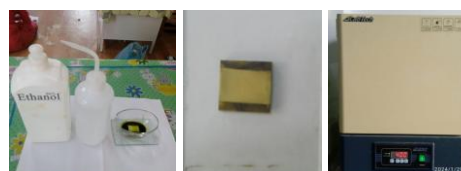
(a) Preparation steps for *Moringa Oleifera*



(c) Blade method to form a film on a substrate



(b) The natural pigments containing chlorophyll from *Moringa Oleifera*



(d) Preparation steps for Working Electrode

Figure 1 Preparation-steps for *Moringa Oleifera*

Results and Discussion

Structural Properties of TiO₂ Film

Structural studies of the TiO₂ films with heat-treated at 450°C for 30 minutes were done with X-ray diffraction (XRD) technique. The crystalline sharp peaks in the diffraction pattern were identified by using the International Centre for Diffraction Data (ICDD). The crystalline size was calculated by using Scherer's equation; $D = (k\lambda)/(B \cos\theta)$ where, B is the peak width measured at half intensity (radian), λ is the wavelength measured in Å, k is the particle shape factor or Scherer constant ($k = 0.9$) and D is the diameter of the crystallites (Å).

The XRD spectrum for TiO₂ films at 450°C are depicted in Figure 2. XRD diffraction peaks belonging to (101), (103), (004), (112), (200), (105), (211), (204) and (116) were observed in all which are these TiO₂ well matched with the powder diffraction data of Anatase, TiO₂, 01-071-1167> was also well matched with diffraction peaks (101), (103), (004), (112), (200), (105), (211), (204) and (116). For the sample at 450°C, the diffraction peaks were pronounced sharper indicating that the crystallinity of TiO₂ was improved at this processing condition. The average crystallite sizes estimated by using Scherer's equation were found to be 16.6 nm. The lattice constant was obtained from peak locations and miller indices yielded the parameters of TiO₂. Agreement of lattice constant values ($a = b \neq c$) proved that TiO₂ has tetragonal structure are shown in Tables 2.

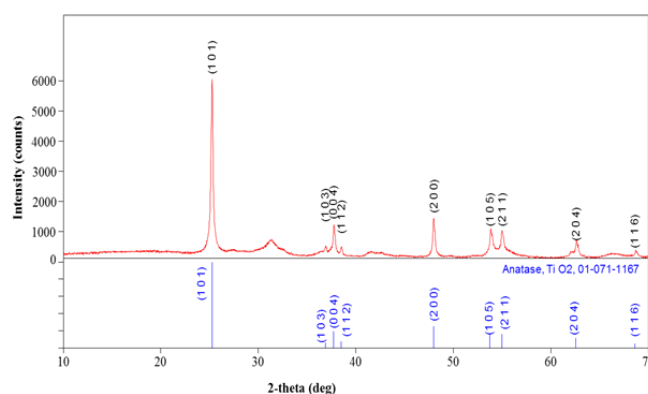


Figure 2 The XRD spectrum for TiO₂ film at 450°C

Table 2 The values of the 2-Theta, hkl, FWHM and crystallize sizes

No.	2-theta (deg)	d (ang.)	Height (counts)	FWHM (deg)	Int. I (counts deg)	Phase name	Size (ang.)
1	25.244(4)	3.5251(6)	4103(6)	0.217(6)	1484(9)	Anatase(1,0,1)	391(10)
2	27.43(4)	3.249(5)	31(6)	0.57(15)	23(5)	Unknown	151(39)
3	31.149(10)	2.8690(9)	248(16)	1.59(2)	497(7)	Unknown	54.0(8)
4	36.26(3)	2.4755(1)	76(9)	0.60(6)	86(9)	Unknown	146(14)
5	36.905(9)	2.4337(6)	184(14)	0.37(4)	131(12)	Anatase(1,0,3)	234(26)
6	37.757(4)	2.3807(2)	763(28)	0.201(12)	293(6)	Anatase(0,0,4)	436(26)
7	38.515(13)	2.3356(7)	231(15)	0.18(2)	70(2)	Anatase(1,1,2)	478(65)
8	41.671(19)	2.1656(1)	75(9)	1.72(5)	138(6)	Unknown	51.5(16)
9	47.975(5)	1.89478(	1048(3)	0.191(9)	340(4)	Anatase(2,0,0)	475(23)
10	49.75(3)	1.8314(1)	29(5)	0.64(15)	36(4)	Unknown	143(33)
11	52.02(8)	1.757(3)	26(5)	0.27(14)	12(2)	Unknown	338(175)
12	53.826(7)	1.7018(2)	680(26)	0.257(17)	337(10)	Anatase(1,0,5)	361(24)
13	54.979(11)	1.6688(3)	487(22)	0.46(3)	432(12)	Anatase(2,1,1)	203(13)
14	62.084(15)	1.4938(3)	119(11)	0.51(5)	110(9)	Anatase(2,1,3)	190(20)
15	62.636(4)	1.48194(	465(22)	0.190(11)	159(8)	Anatase(2,0,4)	511(29)
16	66.34(8)	1.4080(1)	49(7)	1.20(7)	63(5)	Unknown	82(5)
17	68.708(6)	1.36503(	160(13)	0.184(15)	38(2)	Anatase(1,1,6)	547(44)

Surface Morphology of TiO₂ Layer

Surface morphology of TiO₂ was examined by scanning electron microscopy (SEM). SEM images of TiO₂ layers heat-treated at 450°C are shown in Figure 3. The TiO₂ layers were uniformly spread over the substrate and it reveals the micro-grain structure with small crystallite sizes. The micron size tetragonal TiO₂ grains are visualized on the surface of TiO₂film. The grain size in the TiO₂ layer is about 0.644 μm .

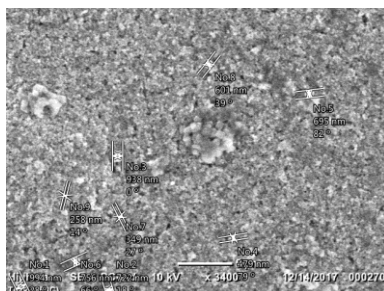


Figure 3 The SEM image of TiO₂ film with magnification x 3400 with acceleration voltage 10kV

Optical Absorbance of Monringa Oleifera dye Solutions

The UV-visible absorption spectra of Monringa Oleifera dye solutions synthesis with different solvents (methanol, ethanol, acetone and hot water) in the wavelength range of 300 – 900 nm were shown in Figure 4. Among the solvents, Monringa Oleifera dyes extracted concentration with acetone was optimized. The maximum peak was observed at 615 nm. The peak intensities increased with increasing dye concentrations.

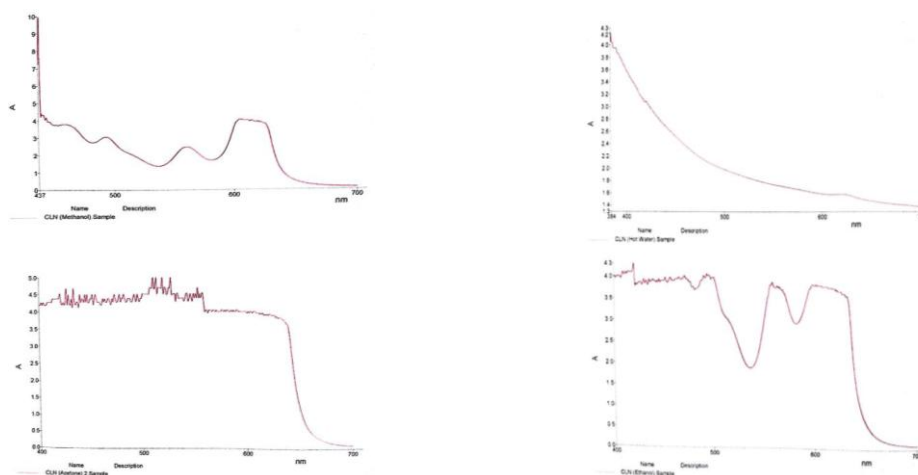


Figure 4 Absorption Spectrum of the different solvents for Monringa Oleifera Extracts

Figure 4 exhibits the result of UV-visible spectroscopic measurement of the dyes from Monringa Oleifera with different solvents such as methanol, ethanol, acetone and hot water for 25 °C in the range of 300 nm - 900 nm. The optimal solvent is ethanol because its peak shifts towards longer wavelength. Moreover, the wavelengths of absorption edge were 560 nm and 700 nm at room temperature and the maximum peak was observed at 550 nm. Ethanol is better than methanol, acetone and hot water for solubility of dye. It is expected that the concentration of dyes would be higher in ethanol than methanol, acetone and hot water, probably because of a higher solubility.

Conclusion

The main objective of this study was to make a cost-effective window electrode dye sensitized solar cell (DSSC). TiO_2 pasted was prepared on fluorine doped tin oxide (FTO) glass by Blade technique. The TiO_2 electrode sintered at 450°C for 30 min was shown an improved crystallinity with crystallite size of 39.1 nm. The grain size is 0.644 μm . This study reported that acetone performed as a good solvent for dye extraction. In this research, all these elements found in the samples are fascinating because they are very useful in real life. The conclusion reports that an efficient natural dye from Monringa Oleifera which is locally available in Myanmar has been identified. With the advantages such as ready availability, quick and easy preparation procedures and environmental friendliness DSSC solar cell sensitized with this natural dye deserves further exploration.

Acknowledgements

I would like to express appreciation to Rector Dr Than Zaw Oo, Pro-rector Dr Thanda, Pro-rector Dr Thazin Lwin and Pro-rector Dr Yin Yin Lwin, West Yangon University for their encouragement and kind permission to undertake the present research.

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SYNTHESIS AND CHARACTERIZATION OF COBALT DOPED ZINC FERRITE ($\text{Co}_x \text{Zn}_{1-x} \text{Fe}_2\text{O}_4$) NANOPARTICLES

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Abstract

In this research, Cobalt Zinc Ferrite nanoparticles were synthesized by Solid State method. Cobalt zinc ferrite nanoparticles with composition of $\text{Co}_x\text{Zn}_{1-x} \text{Fe}_2\text{O}_4$ (where $x = 0.1, 0.3$ and 0.5) were synthesized with Ball Milling Machine. The doping effect of cobalt ions on crystalline phase and particle size were investigated by X-ray Diffraction (XRD). The XRD results showed that a single-phase inverse spinel structure is obtained for all x compositions. The crystallized size trendily decreases with the increases in x compositions. Morphology of nanoparticles was observed using the Scanning Electron Microscopy (SEM) showed that the grain size distribution was evenly distributed for all compositions with grain sizes ranging from $2\text{-}10\text{ }\mu\text{m}$. Fourier Transform Infrared Spectroscopy (FTIR) results the absorption peak of octahedral site and tetrahedral site of the samples with the variation of Co composition. These ferrite nanoparticles are suitable for fabrication of a sensitive electrochemical sensor due to its excellent magnetic properties.

Key words: Cobalt Zinc Ferrite ($\text{Co}_x \text{Zn}_{1-x} \text{Fe}_2\text{O}_4$), Solid State Method, Ball Milling Machine, XRD, SEM and FTIR

Introduction

Spinel ferrite is the class of oxide materials with remarkable electrical and magnetic properties, which have been investigated and applied during the last few decades. In addition to these, they exhibit ferrimagnetism, originating from the magnetic moment of anti-parallel spins between Fe^{3+} ions at tetrahedral sites and Co^{2+} ions at octahedral sites. Due to the magnetic properties, ferrite have various applications in numerous fields. Literature contains several physical as well as chemical method to synthesize the spinel ferrites like solid-state reaction, high energy ball milling, sol-gel, hydrothermal synthesis, chemical precipitation, combustion synthesis, micro-emulsion and microwave hydrothermal.

Among the synthesis methods, the solid state sintering method is promising for mass production. The structural, transport and magnetic properties of the $\text{CoZnFe}_2\text{O}_4$ are strongly dependent on the synthesis method, crystallite size etc. This paper reported that the structural and temperature dependent magnetic properties of Co substituted zinc ferrite synthesized via high temperature conventional solid state method.

Materials and Methods

Materials

The high purity of cobalt oxide (CoO), zinc oxide (ZnO) and ferric oxide (Fe_2O_3) are used as starting materials.

Method

Among the synthesis methods, the solid state sintering method is promising for mass production. Cobalt-Zinc ferrites were prepared by using a conventional solid state sintering method.

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Experimental Procedure

Sample Preparation

Analytical grade ferric oxide (Fe_2O_3), cobalt oxide (CoO) and zinc oxide (ZnO) were used as the raw materials in this research. The raw materials was selected for technical processing condition as the ultimate requirements of the finished products were very sensitive to composition. In this work, high purity materials were used to prepare reproducible ferrite materials. A flow chart of Cobalt- Zinc ferrite was shown in Figure 1. Ferrite powders were prepared by stoichiometric proportion ($x= 0.1, 0.3$ and 0.5) mol by conventional solid state sintering method as shown in Figures 2(a),2(b),2(c) and 2(d). The quantities of the composition were listed in the Table 1. The metal oxides were mixed and then grinded in an A-gate mortar and then were synthesized with ball milling machine. The mixture was sintered at 1000°C for 4hrs in the furnace. After sintering, the powder was pressed into pellets by using 3 Tons of hydraulic press. The morphological studied of nanoparticles was observed using the Scanning Electron Microscopy (SEM). The molecular vibration of samples with the variation of Co composition was observed by Fourier Transform Infrared Spectroscopy (FTIR).

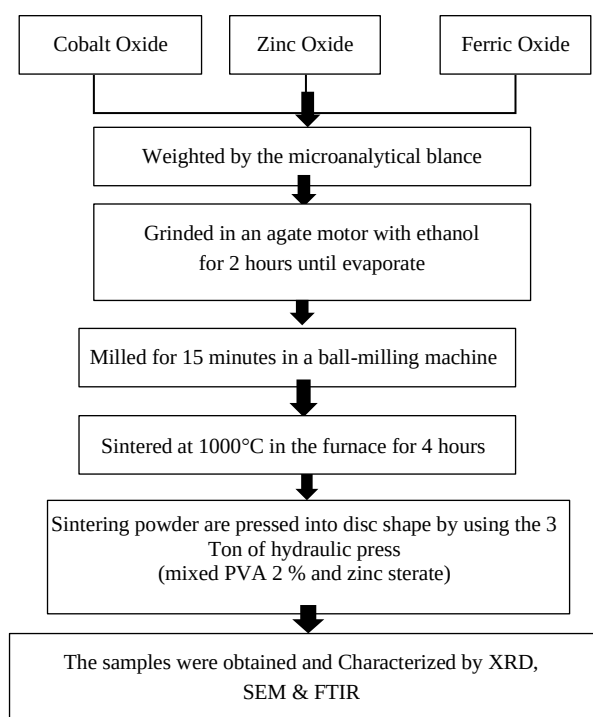


Figure 1 Flow Chart of Cobalt Zinc Ferrite



Figure 2(a) Experimental procedure of Cobalt Zinc Ferrite nanoparticle were prepared by stoichiometric proportion ($\text{Co}_{0.1}\text{Zn}_{0.9}\text{Fe}_2\text{O}_4$)



Figure 2(c) Experimental procedure of Cobalt Zinc Ferrite nanoparticle were prepared by stoichiometric proportion ($\text{Co}_{0.5}\text{Zn}_{0.5}\text{Fe}_2\text{O}_4$)



Figure 2(b) Experimental procedure of Cobalt Zinc Ferrite nanoparticle were prepared by stoichiometric proportion ($\text{Co}_{0.3}\text{Zn}_{0.7}\text{Fe}_2\text{O}_4$)



Figure 2(d) Grinding starting materials with ethanol and sintering temperature at 1000°C for 4 hours

Results and Discussion

Structural Properties of Cobalt Zinc Ferrite

The structural studies of the cobalt zinc ferrite with heat-treated at 1000°C are depicted in Figure 3 (a) for $x=0.1$, Figure 3 (b) for $x=0.3$, and Figure 3(c) for $x=0.5$. It shows the formation of spinel ferrite phase in all the samples. The quantities of the composition were listed in the Table 1. The broad XRD line indicates that the ferrite particles are in nano size. XRD diffraction peaks belonging to (111), (220), (311), (222), (400), (331), (422), (511), (333), (440), (531), (442), (620), (533), (622) and (444) were observed in all these Cobalt-Zinc Ferrite. The maximum intensity of the peak was found in the (311) plane which indicated that in the direction of the (311) plane of diffraction. The average crystallite size decreases from 66.4 nm to 50.1 nm when the partial substitution of Co increases as shown in Table 2. The lattice parameter decreases from 8.51966 to 8.51257 Å with increases in cobalt content as shown in Table 3. The higher the value of lattice parameter with increase in cobalt content is attributed to the replacement of larger Zn^{2+} cation in the interstitial site. Agreement of lattice constant value ($a=b=c$) proved that Cobalt Zinc Ferrite has cubic structure as shown in Table 3. The value of interplanar spacing, d_{hkl} is a function of miller indices (h , k and l) as well as the lattice parameter. For crystal structures having cubic symmetry, $a = d_{hkl}\sqrt{h^2 + k^2 + l^2}$ where, a = lattice constant; d = interplanar distance; and (h , k , l) are the Miller indices.

Table 1 The calculated weight fraction for different molar concentrations

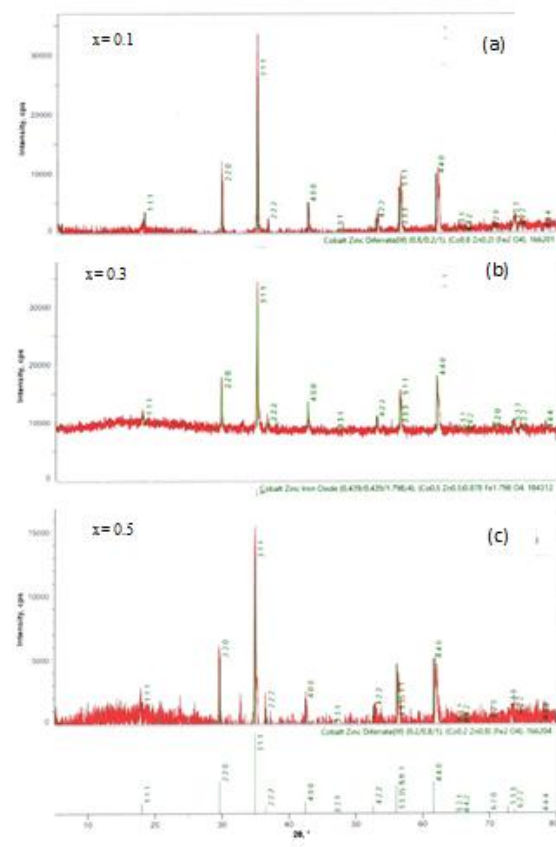
Ratios	Weight of Fe_2O_3	Weight of ZnO	Weight of CoO	Total weight
$\text{Co}_{0.1}\text{Zn}_{0.9}\text{Fe}_2\text{O}_4$	9.96	4.57	0.47	15g
$\text{Co}_{0.3}\text{Zn}_{0.7}\text{Fe}_2\text{O}_4$	10.02	3.57	1.41	15g
$\text{Co}_{0.5}\text{Zn}_{0.5}\text{Fe}_2\text{O}_4$	10.07	2.57	2.36	15g

Table 2 The values of 2θ , Interplanar distance(d) $\text{\AA}$, hkl, FWHM and crystallite sizes of Cobalt Zinc Ferrite

Samples	2-Theta(deg)	Interplanar distance(d) $\text{\AA}$	hkl	FWHM	XS (nm)
$\text{Co}_{0.1}\text{Zn}_{0.9}\text{Fe}_2\text{O}_4$	34.840	2.568	311	0.131	66.4
$\text{Co}_{0.3}\text{Zn}_{0.7}\text{Fe}_2\text{O}_4$	34.680	2.566	311	0.117	61.7
$\text{Co}_{0.5}\text{Zn}_{0.5}\text{Fe}_2\text{O}_4$	34.620	2.564	311	0.142	50.1

Table 3 The lattice parameters for $x = 0.1$, $x = 0.3$ and $x = 0.5$

Compositions	Lattice Parameters ($\text{\AA}$)		
	a	b	c
$\text{Co}_{0.1}\text{Zn}_{0.9}\text{Fe}_2\text{O}_4$	8.51966	8.51966	8.51966
$\text{Co}_{0.3}\text{Zn}_{0.7}\text{Fe}_2\text{O}_4$	8.51660	8.51660	8.51660
$\text{Co}_{0.5}\text{Zn}_{0.5}\text{Fe}_2\text{O}_4$	8.51257	8.51257	8.51257

Figure 3 (a),(b)&(c) The XRD spectra for $\text{Co}_{0.1}\text{Zn}_{0.9}\text{Fe}_2\text{O}_4$, $\text{Co}_{0.3}\text{Zn}_{0.7}\text{Fe}_2\text{O}_4$ & $\text{Co}_{0.5}\text{Zn}_{0.5}\text{Fe}_2\text{O}_4$

Scanning Electron Microscope (SEM) Analysis

The SEM images of nickel zinc ferric nanoparticles ($\text{Co}_x\text{Zn}_{1-x}\text{Fe}_2\text{O}_4$) for Co ($x = 0.1, 0.3$ and 0.5) at 1000°C are indicated in Figures 4 (a), 4 (b) and 4 (c), respectively. The morphological investigation revealed the presence of particles showing the spherical in shape

and homogeneously distributed. It was showed that the particles with clear grain boundaries in Figure 4 (c). It was observed that the grain size decreases as the concentration of Co^{2+} ion increase.

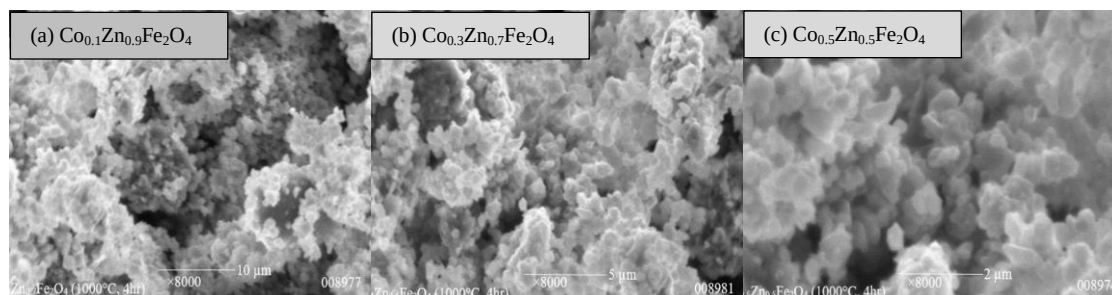


Figure 4 (a),4(b)&4 (c) SEM images of $\text{Co}_{0.1}\text{Zn}_{0.9}\text{Fe}_2\text{O}_4$, $\text{Co}_{0.3}\text{Zn}_{0.7}\text{Fe}_2\text{O}_4$ & $\text{Co}_{0.5}\text{Zn}_{0.5}\text{Fe}_2\text{O}_4$

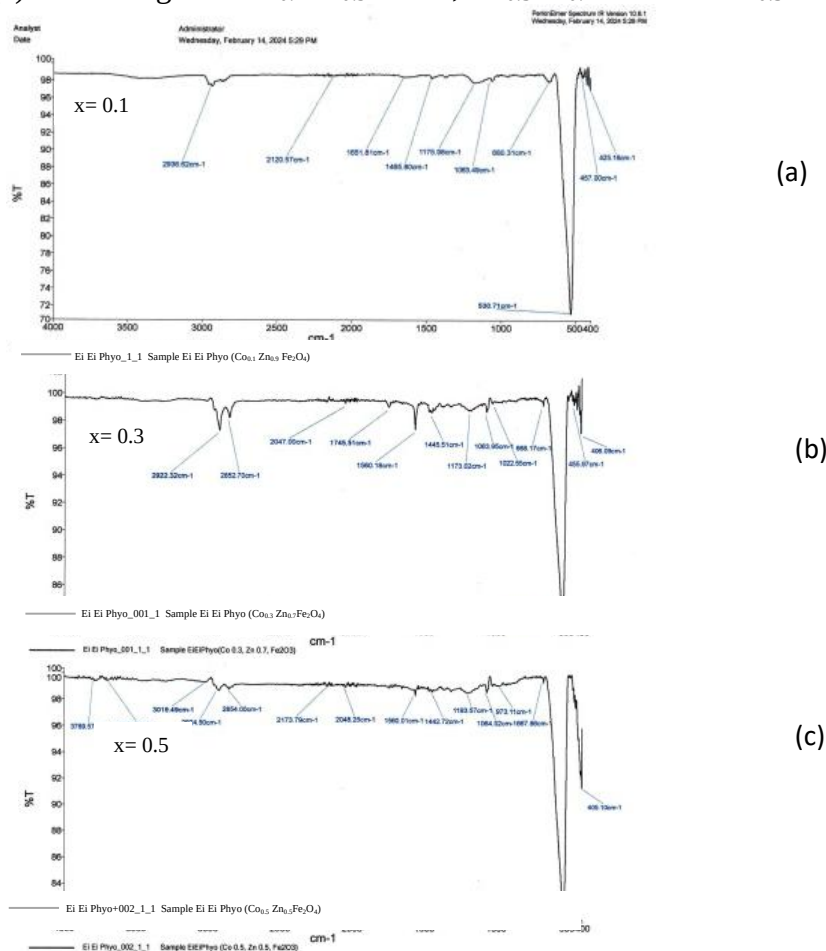


Figure 5(a),5(b)&5(c) FTIR spectrographs of ferrite nanoparticles sintered at 1000°C for 4hrs

Fourier Transform Infrared (FTIR) Analysis

The FTIR spectrum was observed the frequency range of 4000 cm^{-1} - 500 cm^{-1} which are presented in Figures 5(a),5 (b) and 5 (c), respectively. The sintered samples show characteristic absorptions of ferrite phase with a strong absorption at 530.71 cm^{-1} , 534.87 cm^{-1} and 531.96 cm^{-1} , respectively. In order to confirm the formation of the spinel phase and to understand the nature of the residual carbon in the samples.

The vibrational spectra of ferrites studied and attributed the sharp absorption band around 600 cm^{-1} to the intrinsic vibrations of the tetrahedral groups which corresponding restoring force causes stretching of Fe^{3+} - O^{2-} bonds and the other hands band around 800 cm^{-1}

¹, 900 cm⁻¹ and 1200 cm⁻¹ is attributed to vibration of octahedral groups which are the bond bending vibrations. There are broad absorption peaks around 1200 cm⁻¹ and 2000 cm⁻¹ corresponding to the presence of small amounts of residual carbon in the samples. These absorptions in the present case are very weak which indicates that the residual carbon has mostly burnt away during the sintering process as shown in Figure 5(a), 5 (b) and 5(c), respectively.

Conclusion

The conclusion reports that the magnetic properties of CoZnFe₂O₄ with a chemical formula Co_x Zn_{1-x} Fe₂O₄ (x = 0.1, 0.3 and 0.5) mol were prepared by conventional solid state sintering method. The Cobalt Zinc Ferrite sintered at 1000°C for 4hrs were shown an improved crystallinity with crystallite size of 66.4, 61.7 and 50.1, respectively.

The Morphological observation of particles using a Scanning Electron Microscope (SEM) showed that the particle size distribution was evenly distributed for all compositions with particle sizes ranging from 2 μm to 10 μm, whereas in each of the average sized of crystallite also changed as a function of compositions. The FTIR spectrum is recorded between 4000 cm⁻¹ - 500 cm⁻¹. The result showed the two main band of absorption. The sintered samples show characteristic absorptions of ferrite phase with a strong absorption around 600 cm⁻¹ and weak absorption around 800 cm⁻¹, 900 cm⁻¹ and 1200 cm⁻¹.

It was focused on determination of their compositional, structural and molecular vibration properties. CoZnFe₂O₄ was a technologically important material as an electromagnetic interference (EMI) suppresser and electromagnetic shielding in sensitive human implants. It was focused on optimizing the structural properties and implementing Cobalt Zinc Ferrite materials in various magnetic applications.

Acknowledgements

We would like to express appreciation to Rector Dr Than Zaw Oo, Pro-Rector Dr Thanda, Pro-Rector Dr Thazin Lwin and Pro-Rector Dr Yin Yin Lwin, West Yangon University for their encouragement and kind permission to undertake the present research.

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ARDUINO BASED HOME AUTOMATION USING IR REMOTE CONTROL

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Abstract

Home automation refers to the use of technology to control and automate various household tasks and functions. These systems typically involve the integration of devices and systems within a home, allowing them to communicate and be controlled remotely. The infrared (IR) remote control devices are used to operate in the most of modern household applications, such as television, set top box, home theatre and air conditioner etc. In this propose system, IR remote control is used to control the home appliances. Arduino is used for controlling the whole process. The remote control transmits a beam of infrared using an infrared light emitting diode; this infrared ray is picked by the IR sensor. After receiving signal from IR remote, Arduino sends related signal to switching devices which are responsible for switching ON or OFF of the home appliances.

Keywords: Arduino UNO, Universal remote control, IR sensor, 20x4 LCD display

Introduction

Many electrical and electronics appliances such as the television set, standing fan, ceiling fan, air conditioner, lighting bulbs, video players, radio, etc. require switching to turn on and turn off traditionally. This manual switching of any home appliance is an inconvenient method for physically disabled or elderly or even for the young and busy individuals when frequent switching operation is required (A Roy Delgado,2013). Thus, an easier method of switching is developed to replace this manual switching method, using an advanced switching method for electronic home appliances. In the proposed system, IR based wireless communication technology is implemented along with Arduino board. This method can be easily handled and it requires less manpower. It is more sophisticated, safe to use, and is more secure IR remote is used for giving the signal to the IR sensor, and then the signal is fed into the Arduino (N.Neil, 2016). Block diagram of an Arduino based home automation system IR remote control is shown in Figure 1.

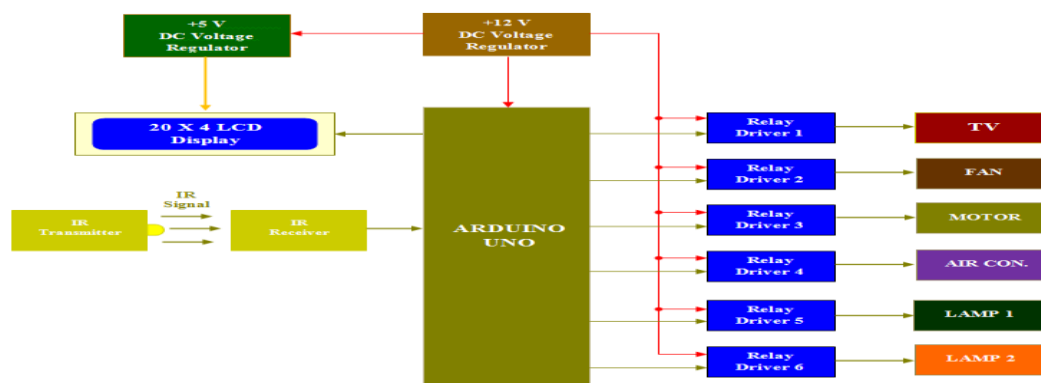


Figure 1. Block Diagram of an Arduino based home automation system using IR remote control

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Methodology of the System

IR Radiation

Infrared (IR) radiation refers to electromagnetic waves with wavelengths longer than those of visible light, but shorter than microwaves. It is a form of radiant energy that is not visible to the human eye. The infrared spectrum is typically divided into three regions:

Infrared Remote (IR) Control Fundamental

Infrared (IR) communication is a widely used and easy to implement wireless technology that has many useful applications. A typical infrared communication system requires an IR transmitter and an IR receiver (Abdulaleem A. Rasheed,2014). The IR receiver is a photo diode and pre-amplifier that converts the IR light into an electrical signal. In IR signal modulation, an encoder on the IR remote converts a binary signal into a modulated electrical signal. This electrical signal is sent to the transmitting LED.

The transmitting LED converts the modulated electrical signal into a modulated IR light signal. The modulated IR signal is a series of IR light pulses switched on and off at a high frequency known as the carrier frequency. In receiver section, The receiver diode detects all frequencies of IR light, but it has a band-pass filter and only lets through IR at 38 kHz. It then amplifies the modulated signal with a pre-amplifier and converts it to a binary signal before sending it to a microcontroller (C. Woodford,2016). Handheld IR remote control transmitter and receiver use in this propose system is shown in Figure 2.



(a) IR remote control transmitter



(b) IR remote control receiver

Figure 2. IR remote control transmitter and receiver

IR LED

An IR LED is a type of diode or simple semiconductor. Electric current is allowed to flow in only one direction in diodes. As the current flows, electrons fall from one part of the diode into holes on another part. Infrared diodes have a package that is opaque to visible light but transparent to infrared. IR LED is shown in Figure 3.

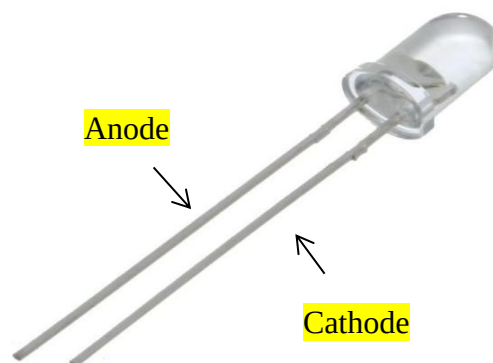


Figure 3. Infrared LED

Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328 it can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). The Arduino Uno has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. Figure 4 shows an Arduino Uno board.

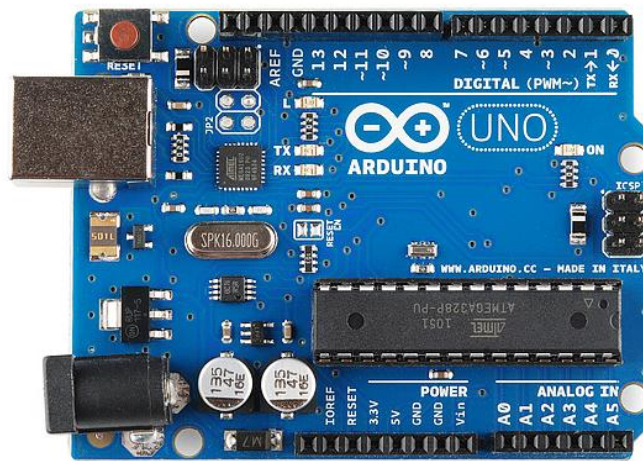


Figure 4. An Arduino UNO board

Relay Switch

The electro-mechanical relay is an output device (actuator) which comes in a whole host of shapes, sizes and designs, and has many uses and applications in electronic circuits. But while electrical relays can be used to allow low power electronic or computer type circuits to switch relatively high currents or voltages either "ON" or "OFF", some form of **relay switch circuit** is required to control it. Figure 5 shows the relay switch circuit using NPN transistor.

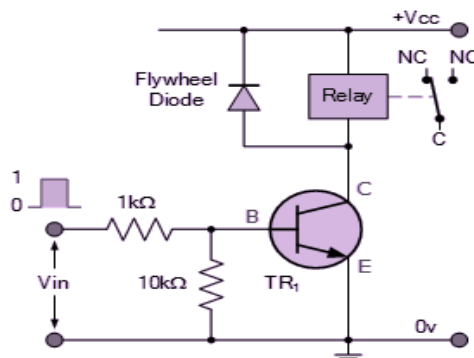


Figure 5. Relay switch circuit using NPN transistor

20x4 LCD Module

LCD (Liquid Crystal Display) screen is an electronic display module and find and wide range of applications. These modules are preferred over seven segments and other multi segments LEDs. In a **20x4 LCD** module, there are four rows in display and in one row twenty characters can be displayed and in one display eighty characters can be shown. The cursor of this module has 5x8 (40) dots.

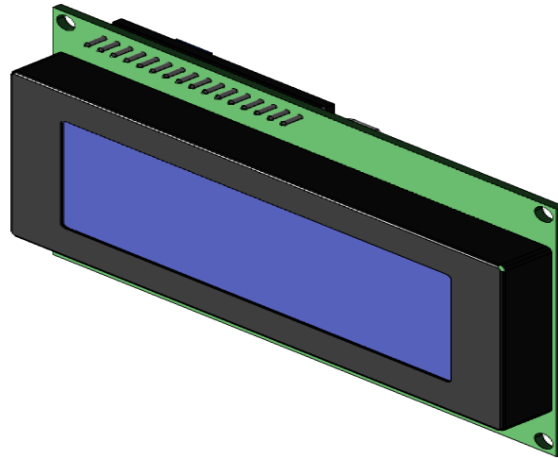


Figure 6. 20x4 alphanumeric LCD

Circuit Operation of System

The construction of the Arduino based home automation system using IR remote control circuit consists of two parts: the hardware and software implementations. Both software and hardware will be accomplished using Arduino Uno board.

This circuit is constructed with an Arduino Uno board, handheld remote control transmitter, remote control receiver and six channels relays board. System design is based on digital control techniques, all I/O ports are used as only digital ports.

Hardware Design

Switched mode regulator is used in this system. Power management system of this construction is shown in Figure 7. DC supply 5V is used for IR sensor and LCD module while DC supply 12V is used for Arduino Uno board. CSC7224 IC is used as switching converter IC. The CSC7224 is a high performance current mode Pulse Width Modulated (PWM) switching power converter. SMPS works the input voltage range from the 100V AC to 240V AC. AC main input voltage (100 V – 240 V) is supply to Bridge rectifier BD1 via 0.1Ω/0.5W resistor.

Rectified DC output voltage of the bridge rectifier BD1 is filter by C1 (22μF/400V) filter capacitor. This DC voltage is applied to primary winding of the switching converter transformer. Driver circuitry or switching circuit is the heart of an SMPS. The transformer's primary side is controlled by the switching circuit CSC7224.

The switching frequency is 120 – 132 KHz. Smaller ferrite core transformer has been used for in this high frequency operation. The switching circuit has two components, IC1, and the C3. IC1 is the main driver IC CSC7224. C3 is the feedback filter capacitor which is needed for the working of our driver IC. D3 is an ultra-fast recovery diode. The transformer acts a huge inductor across the power driver IC CSC7224.

Therefore during the switching off-cycle, the transformer creates high voltage spikes due to the leakage inductance of the transformer. These high-frequency voltage spikes are suppressed by the diode clamp across the transformer. EMI filtering is done by the CY1

capacitor. It increases the immunity of the circuit to reduce the high EMI interference. The output from the transformer is rectified and converted to DC using D1 and D2, two rectifier diodes.

The filter section consist of two filter capacitor C7 and C8. It is a Low ESR capacitor for better ripple rejection. The output voltage is sensed by the R6, R4 and ZD1. After sensing the line, PC817, the optocoupler is controlled and galvanically isolating the secondary feedback sensing portion with the primary side controller. The Optocoupler has a transistor and a LED inside of it. By controlling the LED, the transistor is controlled.

Since the communication is done by optically, it has no direct electrical connection, therefore satisfying the galvanic isolation on the feedback circuit too. Transistor of the optocoupler is indirectly controls the CSC7224 IC. If the voltage is not sufficient across the output the switching cycle is immediately suspended.

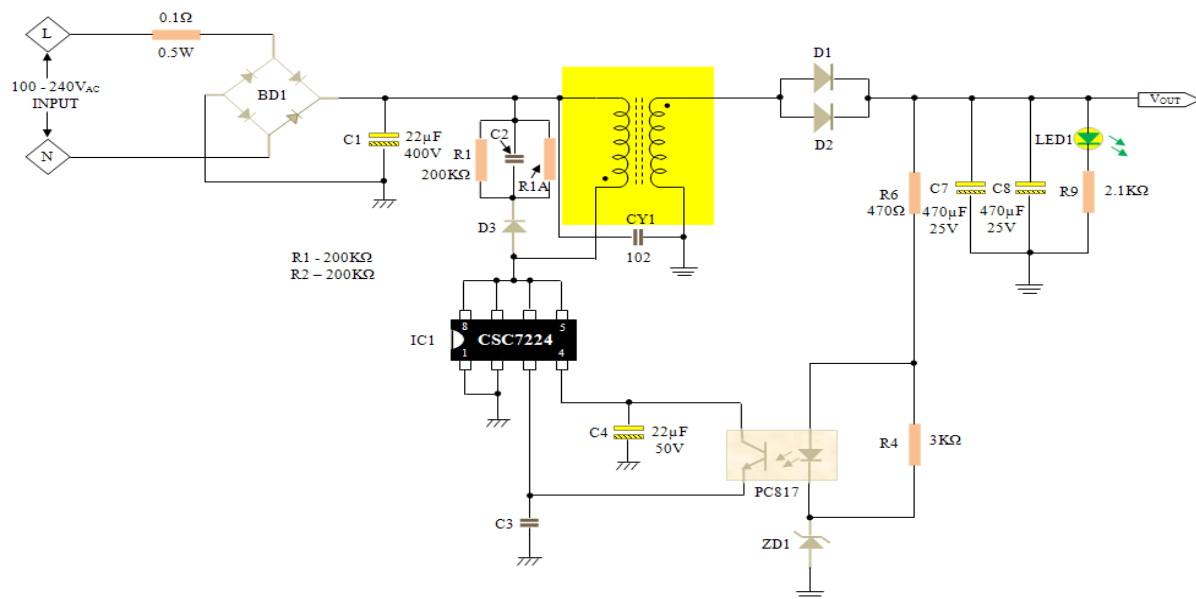


Figure 7. Power management of the Arduino based home automation system using IR remote control

Software Design for the Arduino Based Home Automation

The software program for the Arduino based home automation using remote control system is written in Arduino programming language. Arduino Uno is programmed using Arduino IDE software.

The program flow chart of the proposed Arduino based home automation system using IR remote control system has been shown in Figure 9 which explains the whole software design procedures. The controller waits for the input from the IR sensor and remote. The remote sends the corresponding train of pulses after the user presses the desired button of the remote. The controller receives the code transmitted from the remote and decodes it in the controller. The received information is decoded form in the first step of the simulation. Once the information is decoded for switching ON or OFF a particular device, the corresponding relay is triggered by the microcontroller and finally the corresponding device is switched ON and OFF using a simple IR remote.

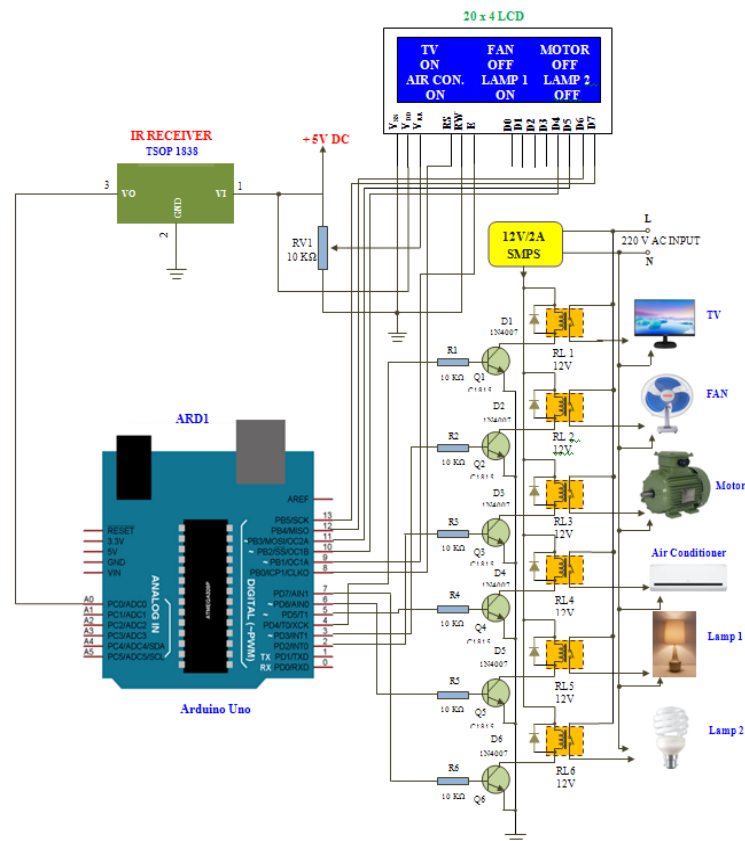


Figure 8. Schematic diagram of the Arduino based home automation system using IR remote control

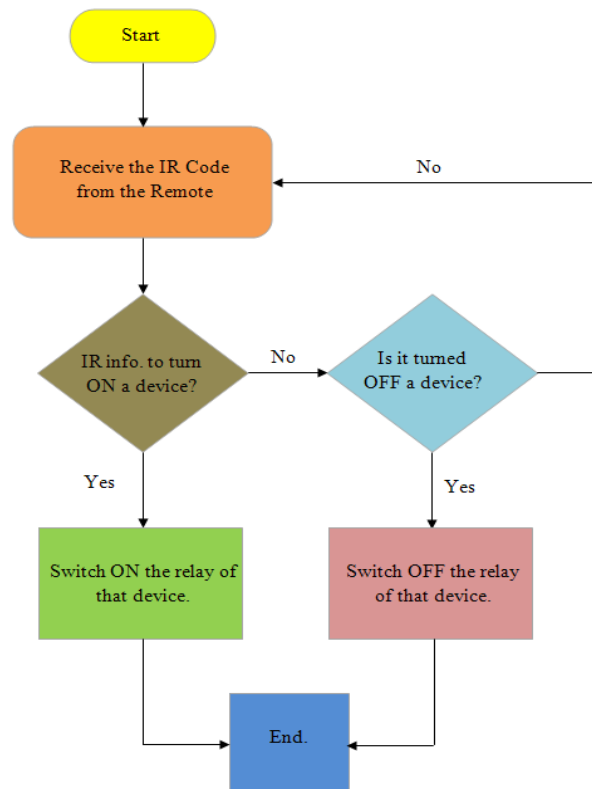


Figure 9. Program flow chart of the Arduino based home automation using IR remote control system

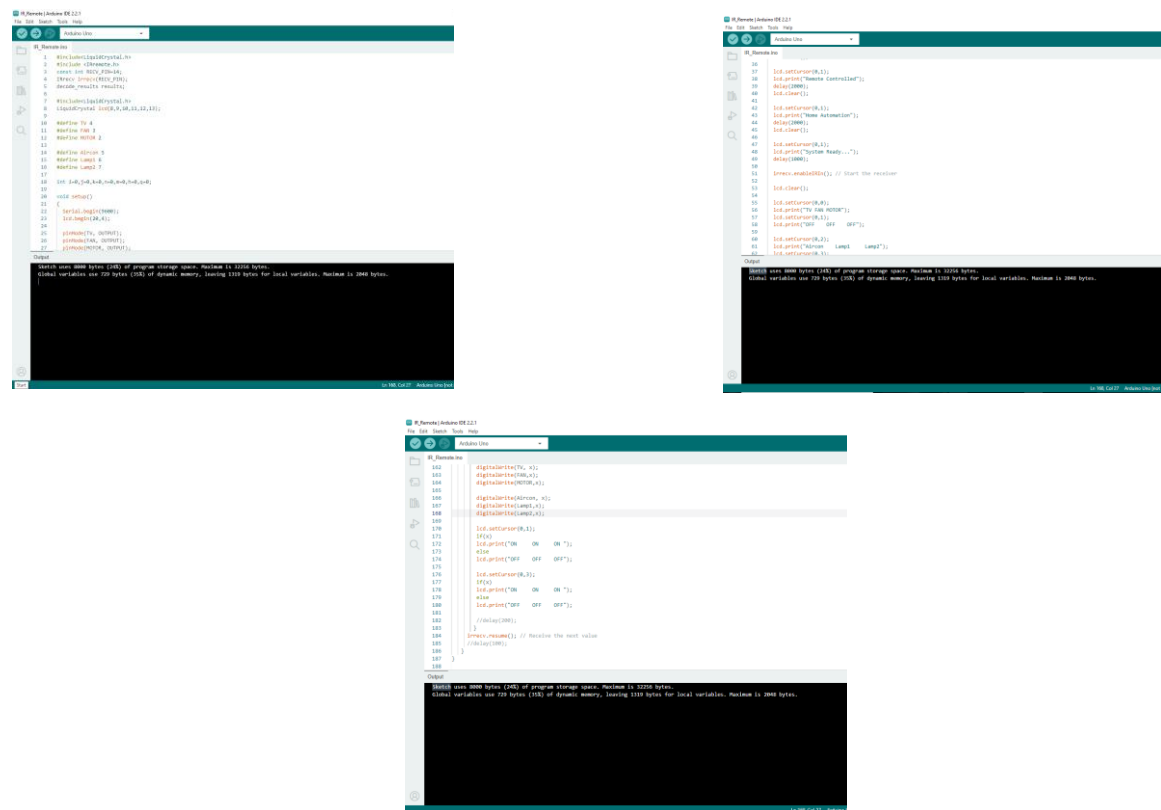


Figure 10. Program window of the Arduino based home automation using IR remote control System



Figure 11. Photograph of the circuit board

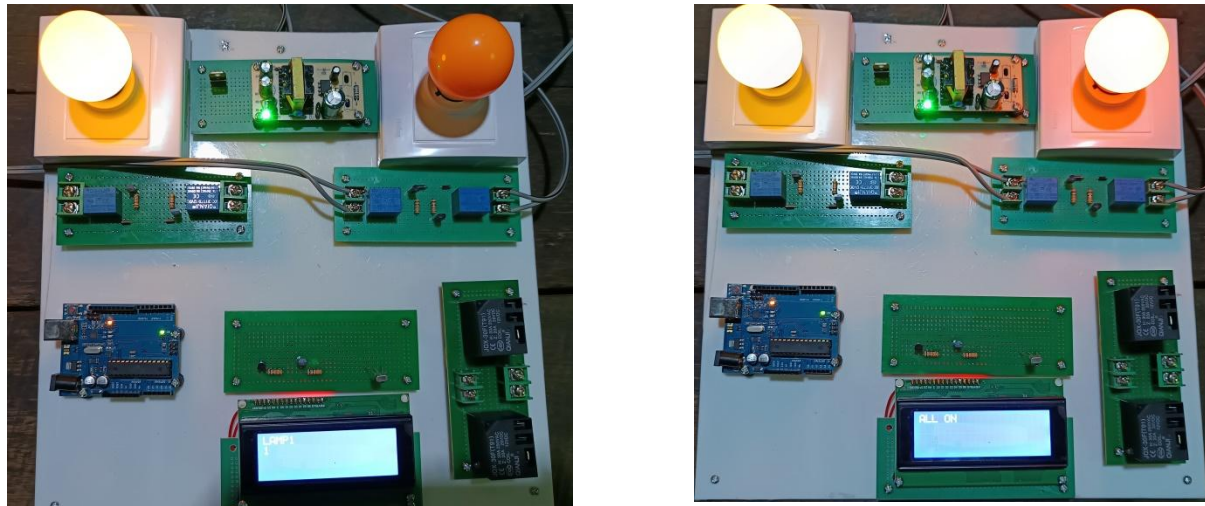


Figure 12. Photographs of the circuit operation

Results and Discussion

Power button on the remote control transmitter is used to determine the all home appliances ON or OFF condition. We have selected key 1 to toggle the relay 1 (TV), key 2 to toggle the relay 2 (FAN), key 3 to toggle the relay 3 (MOTOR), key 4 to toggle the relay 4 (AIR CON), key 5 to toggle the relay 5 (LAMP 1) and key 6 to toggle the relay 6 (LAMP 2) NPN transistors (2SC1815) NPN transistors which can act as an electronic switch to turn ON/OFF the relays based on the signal from the Arduino microcontroller. Output data measurement of the Arduino based home automation using IR remote control system is shown in Table 1.

Table 1. Output data measurement of the Arduino based home automation using IR remote control system

TRANSISTOR SWITCH VOLTAGE OUTPUTS STATUS	Q1 (TV)			Q2 (FAN)			Q3 (MOTOR)			Q4 (Aircon)			Q5 (Lamp1)			Q6 (Lamp2)		
	B	C	E	B	C	E	B	C	E	B	C	E	B	C	E	B	C	E
All OFF condition	0 V	10.44 V	0 V	0 V	10.44 V	0V	0 V	10.44 V	0 V	0 V	10.44 V	0 V	0 V	10.44 V	0 V	0 V	10.44 V	0 V
All ON condition	0.7 V	0.098 V	0 V	0.7 V	0.097 V	0 V	0.7 V	0.11 V	0 V	0.7 V	0.11 V	0 V	0.7 V	0.11 V	0 V	0.7 V	0.1 V	0 V
TV ON and others OFF	0.7 V	0.098 V	0 V	0 V	10.44 V	0V	0 V	10.44 V	0 V	0 V	10.44 V	0 V	0 V	10.44 V	0 V	0 V	10.44 V	0 V
TV ON and others OFF	0.7 V	0.98 V	0 V	0 V	10.44 V	0 V	0 V	10.44 V	0 V	0 V	10.44 V	0 V	0 V	10.44 V	0 V	0 V	10.44 V	0 V
TV & FAN ON and others OFF	0.7 V	0.098 V	0 V	0.7 V	0.097 V	0 V	0 V	10.44 V	0 V	0 V	10.44 V	0 V	0 V	10.44 V	0 V	0 V	10.44 V	0 V
MOTOR ON and others OFF	0 V	10.44 V	0 V	0 V	10.44 V	0V	0.7 V	0.11 V	0 V	0 V	10.44 V	0 V	0 V	10.44 V	0 V	0 V	10.44 V	0 V
TV, FAN & MOTOR ON and others OFF	0.7 V	0.098 V	0 V	0.7 V	0.097 V	0 V	0.7 V	0.11 V	0 V	0 V	10.44 V	0 V	0 V	10.44 V	0 V	0 V	10.44 V	0 V
FAN- ON and others OFF	0 V	10.44 V	0 V	0.7 V	0.097 V	0V	0V	10.44 V	0 V	0 V	10.44 V	0 V	0 V	10.44 V	0 V	0 V	10.44 V	0 V
TV, FAN, MOTOR & Aircon. ON and others OFF	0.7 V	0.098 V	0 V	0.7 V	0.097 V	0 V	0.7 V	0.11 V	0 V	0.7 V	0.11 V	0 V	0 V	10.44 V	0 V	0 V	10.44 V	0 V

Conclusion

In this research report, the Arduino based home automation using IR remote control circuit is mainly based on Arduino Uno board. The boards are inexpensive and the hardware designs are also open source. The Arduino IDE was used in developing the sketches that were uploaded as firmware into the microcontroller. Thereafter, the system could work without the user's intervention. The IR remote control was used to control the electric appliances by Arduino Uno board. This system can control only six electric appliances. It can be further control several external devices by little modification in the sketch (program). If any invalid button (not defined in the software) on remote is pressed, Arduino Uno board will not response for this action. This circuit is generally used for a light, television, fan or similar electronic devices that the person will want to turn on/off from a bed. The paper presents the construction of an infrared remote controller for multiple home appliances circuit which is a device that enables the user to operate or control the on - off function from approximately 10 meters away. The advantage of this circuit is absolutely free from ambient light interference and provides control range of about 10 meters without the use of any focusing lens.

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MICROCONTROLLER BASED DAILY STAFF ATTENDANCE RECORDING SYSTEM UTILIZING FINGERPRINT SENSOR

Thazin Hlaing¹, Phyu Thel Ei¹, Kay Zin Win¹, Thet Mar Oo¹

Abstract

Attendance system has an important role for any organization such as office, schools, universities and so on. Most of the educational institutions and government organizations still use paper based attendance method for maintaining the attendance records. There is a need to replace these traditional methods of attendance recording with biometric attendance system. This innovative research is intended for daily staff attendance recording system for utilizing fingerprint sensor. Fingerprint based attendance system will help to record the presence of students or staffs. It is reliable and displays the time and date to check whether the staff is on time or late. The system utilizes an 8-bit microcontroller development board, a graphic liquid crystal display, a real time clock circuit and a fingerprint sensor module. It is necessary to register the fingerprint data of every staff before using the system. On every morning within a specific period, the staff can enroll their attendance by using fingerprint sensor. The system will record attendance of staff with date and time. The recordings can be searched and displayed on the LCD screen. The system can manually or automatically delete the recorded data. This is very smart and reliable. It can prevent illegal attendance reporting usually made on daily registry papers or books.

Keywords: Arduino Mega, Inch TFT LCD Module, Real Time Clock Module, Finger Print Sensor Module

Introduction

An employee attendance monitoring system helps in knowing the employee's rate of absence, which will allow management to know when to have replacement workers for the job and for other costs that may further rise. Effective time and attendance management is a crucial aspect of running a successful organization (John David Warren, Josh Adams, and Harald Molle, 2014). It not only ensures that employees are present and punctual but also plays a significant role in productivity, payroll accuracy, compliance, and overall workforce management. Accurate and reliable time attendance management is vital for ensuring precise payroll processing. Traditional manual methods, such as paper timesheets or punch cards, are prone to errors and time theft, leading to incorrect calculations and wasted resources (Adith Jagdish Bolor and Samarth Shah, 2011). With the design of Microcontroller Based Daily Staff Attendance Recording System Utilizing Fingerprint Sensor, businesses can automate the process, eliminating the risk of manual errors and unauthorized timekeeping practices. The design consists of an Arduino Mega development board, a 3.5 inch TFT LCD display, a micro SD memory card, a real time clock module, a finger print sensor module, a few control input switches, a piezo buzzer and a couple of LEDs. The system is capable of recording sign in and sign out time for each staff. The system can record attendance data starting from Monday to Friday. This data is temporarily stored on the eeprom memory of microcontroller. But eeprom memory is limited and it is important to erase to store new data for another week. The daily record data can permanently before store on a micro DS memory card. Finger print data of each staff can be individually registered or erased from the memory of fingerprint sensor module using control input switches. Moreover, the weekly attendance data of individual staff can be displayed on the LCD screen (Simon Monk, 2010) (Thomas 1. Floyd ,2010). Basic structure of the whole system is illustrated with a block diagram in Figure 1.

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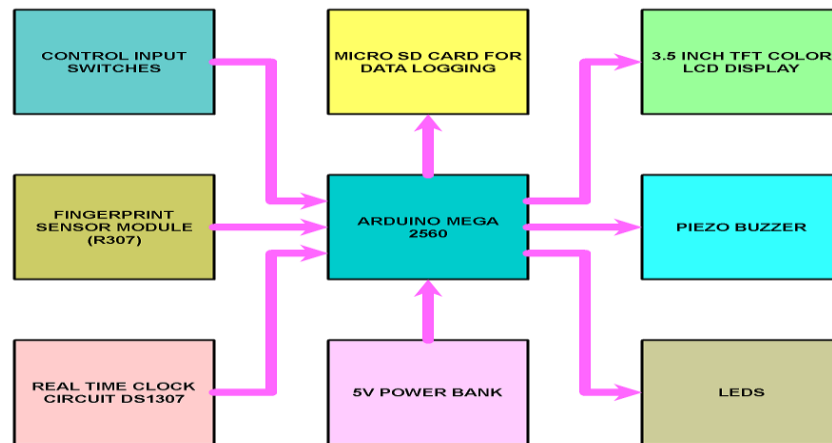


Figure 1. Block diagram of the biometric attendance register and data logging system

Construction of the System

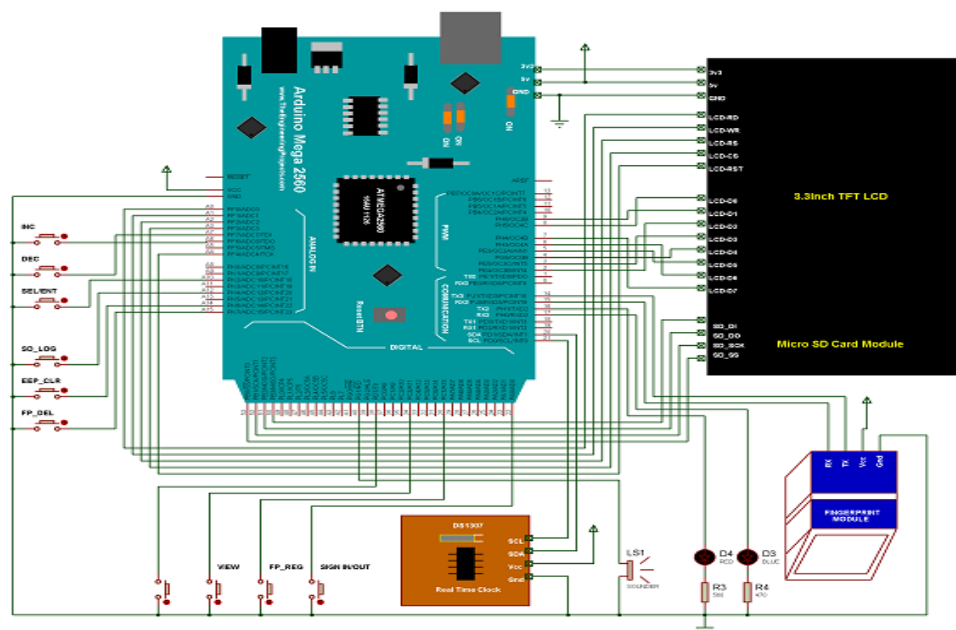


Figure 2. Schematic diagram of biometric daily staff attendance recording system

The design of biometric daily staff attendance recording system is shown in Figure 2. A total of seven different main parts are included in the system design. They are Arduino Mega2560 development board, a 3.5 inch TFT Graphic LCD with SD_SPI Interface display module, a biometric fingerprint sensor (AS608), a real time clock circuit (DS1307), a few input switches, a piezo buzzer, and two LEDs.

First of all, it is important to consider LCD display. In this case, it is required to display the records of sign in and sign out time for each staff, display the ID, name, and photo of each staff. Moreover, the LCD display required to be large enough and clearly display the color photos. Therefore, a 3.5 inch TFT Graphic Color LCD is chosen for the design. But the display required a lot of pins for LCD display control, data pins and SPI pins for micro SD card access. Therefore, using Arduino Uno board is impossible in this design. Therefore, Arduino Mega is considered and selected for larger amount of I/O pins, program memory and random access

memory. Eight data pins of LCD display (D0 to D7) are connected with digital pin 8,9,2,3,4,5,6, and 7 respectively. The five control pins of LCD pins: RD, RW, RS, CS and RST pins are connected with A0 to A4 pins of Arduino Mega. The on board micro SD memory access SPI pins (DI, DO, SCK and SS) of LCD are connected with the SPI pins (50, 51, 52, and 53) of Arduino Mega.

A micro SD memory card is used to store the daily records of staff attendances. The fingerprint sensor module used in the design is AS608. It is capable of storing up to 162 finger print data on the module, which is larger than required staff members for the system. The module is a serial device and TX and RX pins of module is connected with the RX (15) and TX (14) pins (Serial 3) of microcontroller. The Vcc and Gnd pins of AS608 are connected with the 5V line and Ground line of Arduino Mega board.

A real time clock is used in the circuit to use clock data, date and time for recording sign in/sign out time. The real time clock is DS1307 module with backup lithium cell battery. The clock circuit interface with I2C pins of Arduino board. The SDA and SCL pins of Arduino Mega board is pin 20 and 21. The power pins of RTC circuit is connected with the 5V pin and Gnd pin of Arduino board.

A piezo buzzer is used to generate button press tone while successfully press the input switches. It is connected between the digital pin 40 and ground line of the circuit. The two LEDs are used to indicate deleting operations of EEPROM memory and fingerprint data from the fingerprint sensor module.

There are a total of ten control input switches. All the switches are connected between I/O pins and ground line. No pullup resistors are added in the design. The first three switch are INC, DEC and SELECT switches. They are used to select ID numbers of the staff while registering, viewing records and deleting fingerprints. The second three switches are SD_LOG, EEP_CLR and FP_DEL switches. The SD_LOG is used to store attendance data on micro SD card for the day. The EEP_CLR is used to delete the entire EEPROM memory. The FP_DEL is used to select and delete the fingerprint on the fingerprint sensor module. The last four switches are COVER, VIEW, FP_REG and SIGNIN/SIGNOUT switches. The COVER switch is used to display the title of circuit and name of developers. The VIEW switch is used to display the attendance of each staff for the current week. The FP_REG switch is used to store fingerprint of a new staff. The SIGNIN/SIGNOUT switch is used to record the sign in or sign out time of a staff.

Circuit Operation

The design of Biometric Staff Attendance Recording System is constructed to successfully upload the program codes into the memory of Arduino Mega development board. It is ready to test for its operation. The system can be operated with any 5V dc power source, a power bank or an android phone charger or power output of a computer USB port can be used as a power source. Connecting the system with 5V dc power supply is initiated with a beeping sound, title cover page and followed by default display screen as shown in Figure 3. (a) and (b). If there is no micro SD card inserted, will not initiate and start requesting to insert micro SD card as shown in Figure 3. (c). Therefore, it is important to install micro SD card properly in the back side of TFT LCD.

The system operation is very complicated divided into five different operations,

- (i) registering and deleting fingerprints,
- (ii) clearing EEPROM memory
- (iii) sign in/out and logging operation,
- (iv) viewing attendance records on the LCD display,
- (v) checking attendance files on micro SD memory card.

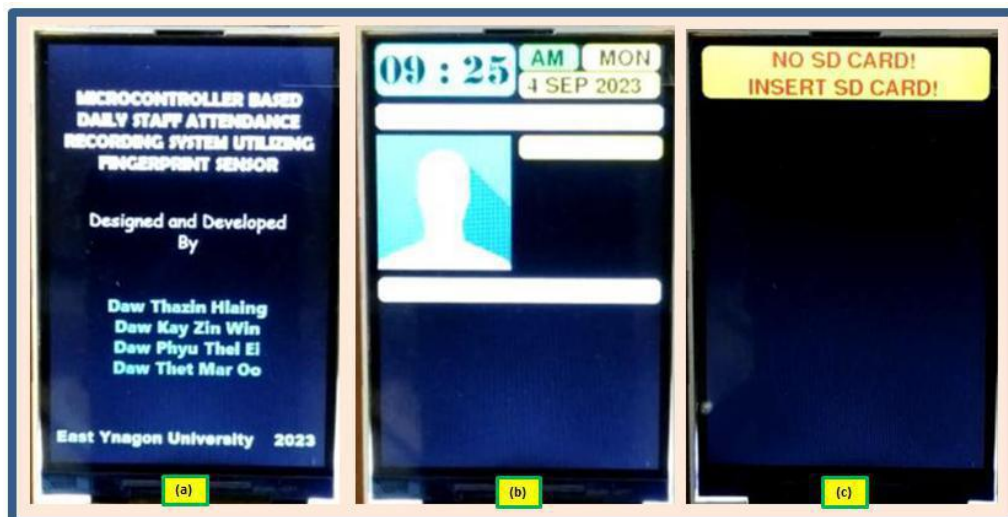


Figure 3. (a) Initial power-up display screen illuminate title and name of developer
(b) default display screen
(c) micro SD card problem

(i) Registering and Deleting Fingerprints

Registering a fingerprint is required to make arrangements for new staff. The ID No, name of staff and photo of staff are arranged and stored in the program coding. In case of registering a new fingerprint, FP_REG, INC, DEC and SEL/ENT switches are used in this operation as shown in Figure 4. Pressing FP_REG switch starts with ID No.1 or previous ID No. In this case desired ID No can be selected by using INC and DEC switches. Changing ID No. also change for different names and different photos for the staffs. If the photos and names are not prepared in the program coding, it will display blank. If desired no is appeared as shown in Figure 4(b), press the SEL/ENT switch to select the number. Then the system requests to place finger as shown in Figure 4(c). If the fingerprint scanner can read the image of the fingerprint properly, the display will change to Image Taken as shown in Figure 4(d). Then the image is converted to binary data file as shown in Figure 4(e). For the next step, the system request to remove the finger from the scanner as shown in Figure 4(f). Within a few seconds after removing the finger, the system asks again to replace the same finger on the scanner again as shown in Figure 4(g). Then the system rescans the finger and processes data. If there is no error in data processing, the display changes as shown in Figure 4(h) for FP Data Stored.

Deleting fingerprint is required if a staff member is transferred to another location or no longer working for the department. In this case, fingerprint file is selected and deleted from the fingerprint sensor module. The switch used for fingerprint deleting are shown in Figure 5(a). Pressing FP_DEL switch change to Fingerprint Delete page and ID number is required to search by using INC and DEC switches. If the desired ID number is appeared on the screen as shown in Figure 5(b), pressing SEL/ENT switch will delete fingerprint file of selected ID number as shown in figure.

(ii) Clearing EEPROM Memory

Clearing EEPROM memory is absolutely important to perform on the start of a week or on the end of a week. The memory contents of EEPROM memory is only about 4KB and it can be managed only a week of attendance record storage for 70 staffs. Therefore, it is important to erase the memory contents of EEPROM before using on the start of a week, or the data records will become overlap and true results cannot be achieved. Clearing EEPROM

memory is simple and easy, just press the EEP_CLR switch and entire EEPROM memory will be erased. The screenshot images of deleting process are shown in Figure 6 (b) and 6 (c).

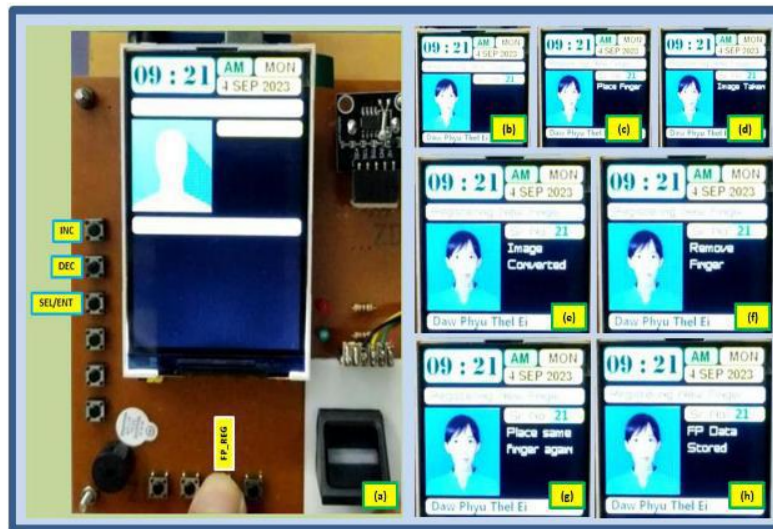


Figure 4. (a) Illustration of switches used to register a new finger print
 (b) Search and select for ID no 21
 (c) FP Scanner request for finger
 (d) FP Image taken by fingerprint sensor module
 (e) Image is converted to binary data
 (f) Request to remove the finger from scanner
 (g) Request to place the same finger on scanner again
 (h) FP data for ID no. 21 is stored on the memory of fingerprint sensor module

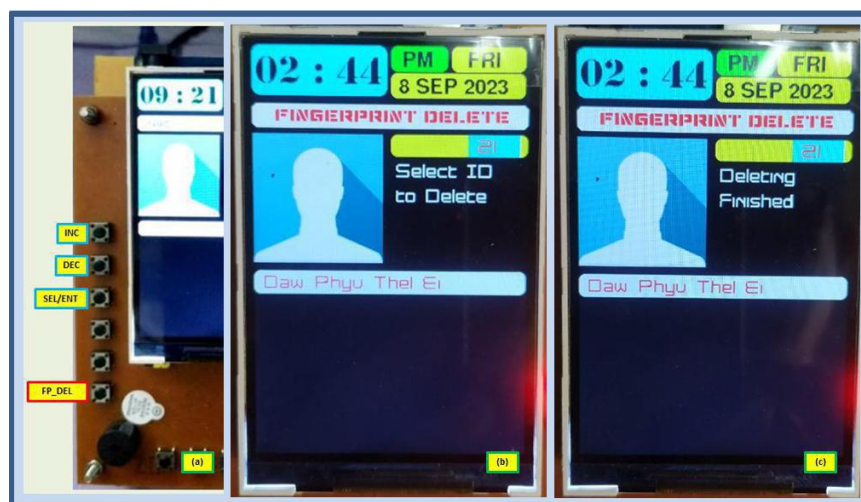


Figure 5. (a) Illustration of switches used to delete a fingerprint
 (b) Search and select for ID no 21
 (c) The fingerprint of selected ID is deleted

(iii) Sign In/Out and Logging Operation

Sign in/out operation and logging operations are daily use operations. The operation usage control input switches are illustrated in Figure 6 (a). The EEP_CLR switch is used to

erase the whole contents of EEPROM memory from MON to FRI. It is only necessary to perform only one time in a week (Monday morning or Friday Evening). Using the operation in

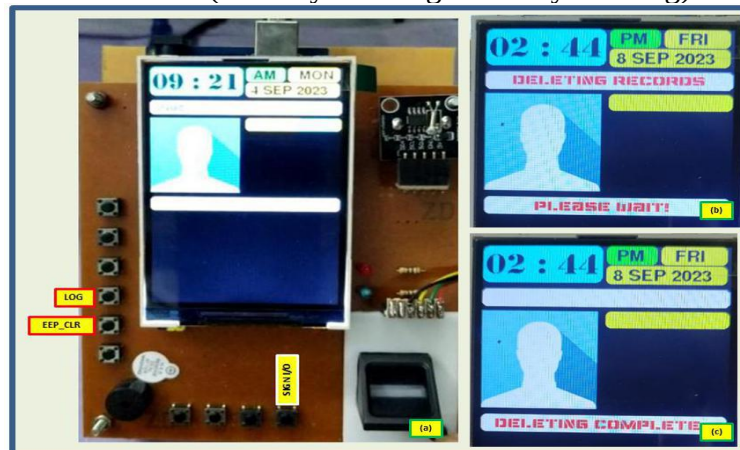


Figure 6. (a) Illustration of switches used to Clear EEPROM memory
(b) Switch press on EEP_CLR switch
(c) Screenshot photo of deleting complete

middle of week may not display previous attendance data when viewing the attendance list on the LCD screen. The clearing of previous attendance record is shown in Figure 7 (a).

Sign in for staff can be started by pressing SIGN_I/O switch and place the finger on the fingerprint scanner. Figure 7 (b) illustrate sign in time, staff ID, name and photos on the LCD display. In this image sign in ID was ID 34 and sign in time is 9:27AM. In Figure 7 (c) sign in operation was made for another staff, ID 35 at 9:28AM. If the fingerprint cannot find a matching record, the display illustrate as shown in Figure 7 (d). In this case, reposition the finger and try again for the second time. The second time of using the same ID for the same day determines sign out time. In Figure 7 (e) sign out time is recorded for ID 34 at 3:25PM. In Figure 7 (f) sign out time is recorded for ID 35 at 3:26PM.



Figure 7. (a) Clearing EEPROM memory on the start of a week (Monday)
(b) Sign in for ID No.34 at 9:27 AM
(c) Sign in for ID No.35 at 9:28 AM
(d) Fingerprint did not match for incorrect position
(e) Sign out for ID No.34 at 3:25 PM
(f) Sign out for ID No.35 at 3:26 PM

(iv) Viewing Attendance Records on the LCD display,

Display viewing records can be easily made on the circuit by using VIEW, INC and DEC switches as shown in Figure 8. The viewing records can be displayed on the LCD monitor only for a week by displaying the contents of EEPROM memory for each day with sign in and sign out time. But the display is limited, therefore data of only one staff is display at a time. Using INC and DEC switch can change the attendance data of each ID for all the staffs. Figure 9 (a) shows the daily records for ID 21 with date and sign in/out time on the LCD screen. Figure 9 (b) shows the daily records for ID 22 with date and sign in/out time on the LCD screen. In this displays, only ID no and name are illustrated. The ID photos are omitted, to achieve faster browsing data results on the LCD screen. After viewing the attendance results, EEPROM memory is cleared as shown in Figure 9 (c) and 9 (d). Then reviewing the attendance results shows zero data on the LCD for ID 22 and ID 21 as shown in Figure 9 (e) and 9 (f).

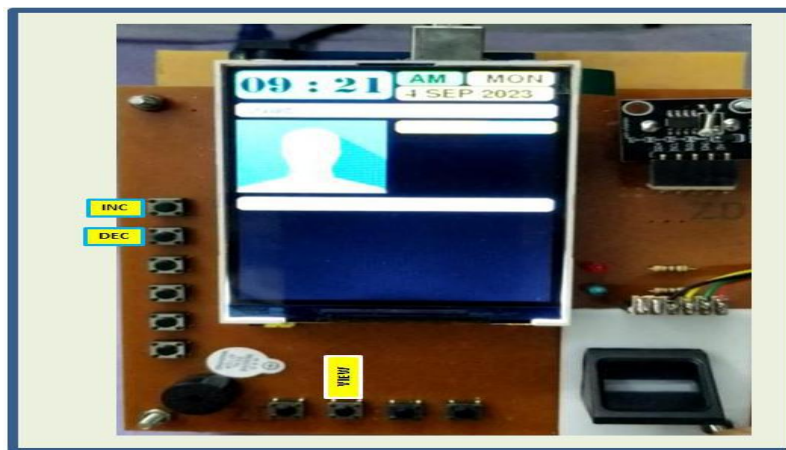


Figure 8. Illustration of switches used to View Record for the week



Figure 9. (a) View attendance records for ID No 21 before clearing EEPROM
 (b) View attendance records for ID No 22 before clearing EEPROM
 (c) Clearing EEPROM memory
 (d) Screenshot image of deleting complete screen
 (e) View attendance records for ID No 21 after clearing EEPROM memory
 (f) View attendance records for ID No 22 after clearing EEPROM memory

(v) Checking Attendance Files on Micro SD Memory Card

Although the EEPROM memory is limited for only one week of attendance data, logging on micro SD memory card can display monthly or yearly records. But in this demonstration, data logging is made for only one week starting from 4th Dec 2023 to 8th Dec 2023 (Monday to Friday). The contents of micro SD card are illustrated with windows file explore as shown in Figure 10. The first two digits are date, second two digits are month, and last four digit are year. On these diagram, the registered ID numbers can only show for name and sign in/out time. The date is not displayed and it is the file name. The results of viewing on LCD and viewing on micro SD card results are identical and correct. The file size of each file utilizes only 5kB on the micro

SD card. For a year data will utilize 52 weeks x 5 days x 5kB = 1300kB. Therefore, yearly data can be saved on the micro SD card with minimum 4GB data capacity.

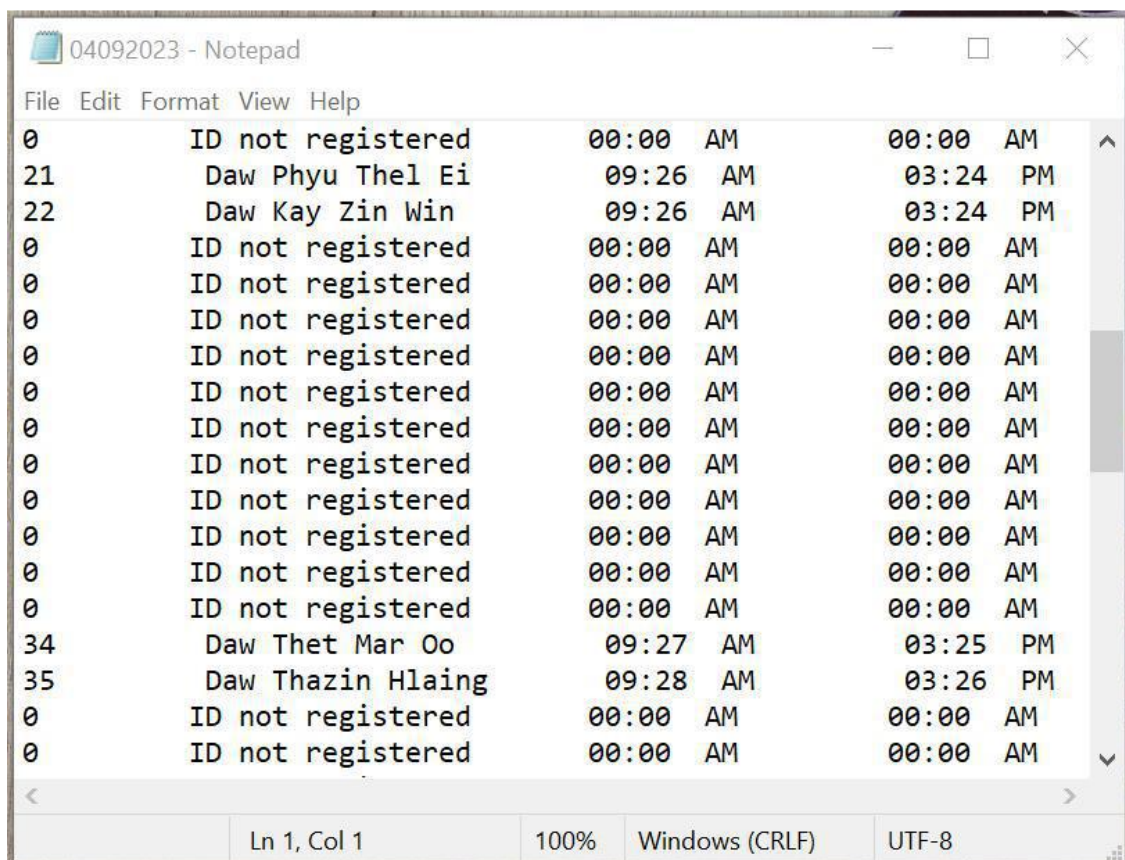


Figure 10. Attendance record file 04092023.txt content screenshot image

Conclusion

The model of Daily Staff Attendance Recording System is successfully designed and constructed. The model can be operated with any 5V dc power supply sources, including 5V power bank. The attendance records are initially stored in non-volatile EEPROM memory and it is reliable for power failure or battery changing interrupts. But the EEPROM memory of microcontroller is limited. Therefore, it is managed to store only for a week of data on the EEPROM memory. The monthly or yearly records can be made on a micro SD card in this design. Therefore, the data can keep attendance records for many years. The number of staff's management depends on the capacity of fingerprint sensor module. The module in this design is capable of storing up to 300 fingerprints. The system can identify and describe the names

and photos of the staff using fingerprint. The cost of circuit design is quite expensive due to the use of Arduino Mega microcontroller board, large TFT color LCD display and fingerprint sensor module. No one can make illegal sign in for other staff. Therefore, it is reliable, accurate and errorless.

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ARDUINO BASED TEMPERATURE DATA LOGGER

Swe Yee Htet¹, Khin Myat Mon¹, Myint Zu Thin¹, Thazin Oo¹, Lai Lai Htay¹

Abstract

A temperature data logger is a portable measuring instrument that can autonomously record temperature over a defined period of time. Digital data can be retrieved, displayed and evaluated after recording. It is commonly used in various industries, scientific research, and environmental monitoring to track and document temperature changes in a given environment. These devices are equipped with sensors that can accurately measure temperature and internal memory or storage capabilities to store the recorded data. In this propose system, the Arduino based temperature data logger is developed. It is design using LM35 as the temperature sensor, Arduino Uno as the data processing element. In this system, SD card is used as memory to store data sent from Arduino microcontroller, so that data can be accessed via an SD card connected to a computer. The SD card module uses a serial peripheral interface (SPI) connecting to communicate with Arduino Uno. The measurement is carried out located in Yangon.

Keywords: Arduino Uno, a LM35 temperature sensor, a 20 x4 LCD, SD card, DS3231 RTC module

Introduction

The data loggers are inexpensive devices equipped with a battery, microprocessor, memory storage and sensor. These devices can capture and record environmental parameters, including temperature and humidity. It allows for measuring, documenting, analyzing, and validating data. Temperature data loggers are one of the most frequently used monitoring devices across all industries (J. Andrew Thompson, L John Bahr and R Neil Thomson,2001). Temperature data loggers are optimized for temperature probes and sensors. These data loggers are electronic devices capable of storing several measurements. These devices accept one or multiple sensor inputs. The loggers collect samples and save the data at predetermined frequencies. This research paper, describes an inexpensive, easy-to-build, Arduino microcontroller based data logger system (S Judy Ritchie,1996-2003). Data logger is microprocessor-based system, which logs the information about the relays, which are connected to the data logger. In this propose system, environmental temperature is detected by LM35 temperature sensor. The LM35 is a precision temperature sensor IC (integrated circuit) that is commonly used to measure temperature in electronic circuits. The LM35 provides an analog voltage output that is linearly proportional to the Celsius temperature. The process is implemented by using Arduino microcontroller. The output voltage from LM35 temperature sensor is sent to Arduino microcontroller and then, corresponding output data is stored into the SD card module.

Block diagram of an Arduino based temperature data logger is shown in figure 1.

Methodology of the System

A data logger (also data logger or data recorder) is an electronic device that records data over time or in relation to location either with a built-in instrument or sensor or via external instruments and sensors. Increasingly, but not entirely, they are based on a digital processor (or computer). They generally are small, battery powered, portable, and equipped with a microprocessor, internal memory for data storage, and sensors. Some data loggers interface

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with a personal computer and utilize software to activate the data logger and view and analyze the collected data, while others have a local interface device (keypad, LCD) and can be used as a stand-alone device. One of primary benefits of using data loggers is the ability to automatically collect data on a 24-hour basis. The logging interval can be set for any period between 10 second (Judy Ritchie,1996-2003).

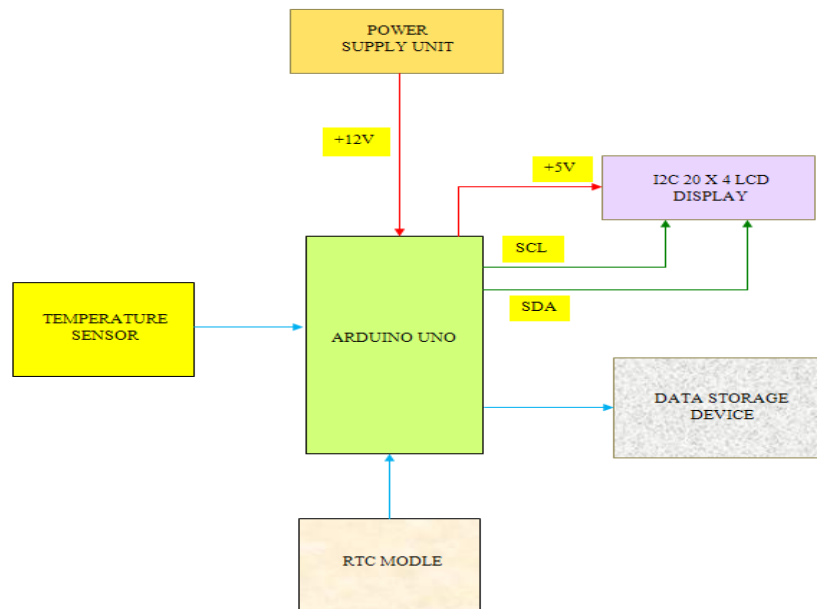


Figure 1. Block diagram of an Arduino based temperature data logger

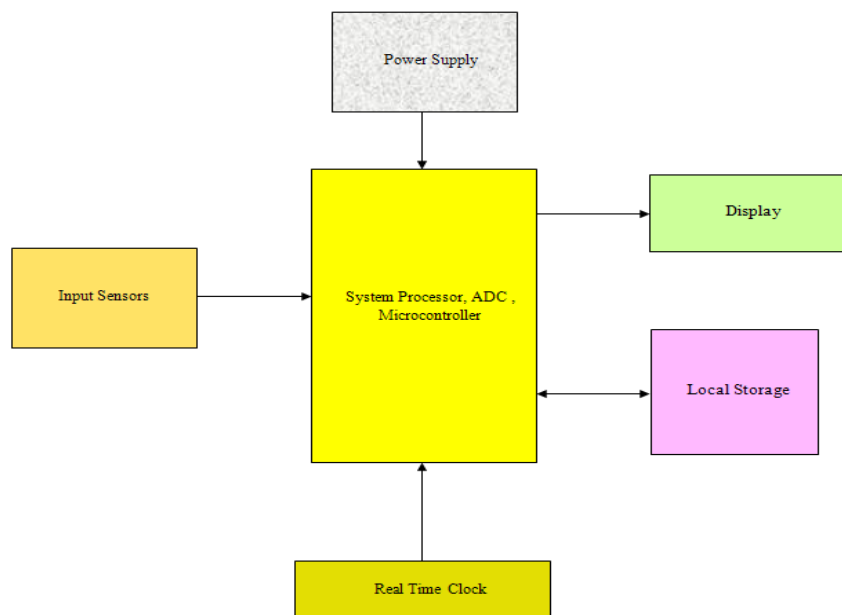


Figure 2. Basic diagram of a Data Logger

Microcontroller

A microcontroller is a small computer on a single integrated circuit that is designed to control specific tasks within electronic systems. It combines the functions of a central processing unit (CPU), memory, and input/output interfaces, all on a single chip. A typical microcontroller consists of a processor core, volatile and non-volatile memory, input/output

peripherals, and various communication interfaces. The processor core is responsible for executing instructions and controlling the other components of the microcontroller. The memory is used to store data and program code, while the input/output peripherals are used to interact with the external environment (Perez, S. J, Calva, M.A. Castaneda, R, 1997).

Integrated Circuit Temperature Sensor

Integrated Circuit (IC) temperature sensors are devices that are designed to measure temperature and are integrated into a single chip. There are two types of IC temperature sensor: analog temperature sensor and digital temperature sensor.

Storage Device

The storage device used in a temperature data logger plays a crucial role in storing the collected temperature data accurately and reliably. Common types of storage devices used in temperature data loggers are Internal Memory, SD Cards or Micro SD Cards, USB Flash Drives, Wireless Data Transmission, Built-in Data Transmitter and Non-volatile Memory.

Real Time Clock

A real-time clock (RTC) is a crucial component in a temperature data logger as it provides accurate time information for each temperature reading. The combination of temperature sensors and an RTC allows the data logger to record temperature data along with the corresponding timestamp. This information is valuable for analyzing trends, identifying patterns, and troubleshooting temperature-related issues.

Display

Using an LCD (Liquid Crystal Display) in a data logger can provide a visual interface to users, allowing them to monitor and interact with the device. An LCD provides a user-friendly interface for configuring settings, starting or stopping data logging, and viewing important information. LCDs are useful for displaying configuration parameters and calibration settings.

Including a clock on the LCD screen allows users to see the current time and date, which can be crucial for timestamping data. Moreover displaying real-time data on the LCD screen allows users to see the current status of the data being logged. LCDs can be equipped with sensors to display environmental parameters, such as temperature, humidity, or pressure, directly on the screen.

Hardware System Devices

In this research project, following hardware units have been used:

Arduino Uno

The Arduino UNO is a standard board of Arduino. It is based on an ATmega328P microcontroller. The board consists of digital and analog Input/Output pins (I/O), shields, and other circuits. The Arduino UNO includes 6 analog pin inputs, 14 digital pins, a USB connector, a power jack, and an ICSP (In-Circuit Serial Programming) header. It is programmed based on IDE, which stands for Integrated Development Environment. The components of Arduino UNO board are shown in figure 3.

In this Arduino Uno board, ATmeg328 microcontroller is a single chip Microcontroller of the ATmel family. The processor code inside it is of 8-bit. It combines **Memory (SRAM, EEPROM, and Flash), Analog to Digital Converter, SPI serial ports, I/O lines, registers, timer, external and internal interrupts, and oscillator**. The In-Circuit Serial Programming (ICSC) pin allows the user to program using the firmware of the Arduino board. Arduino Uno board has 16 MHz crystal oscillator. The pins numbered from A0 to A5 are analog pins. The function of Analog pins is to read the analog sensor used in the connection. The pins numbered from D0 to D13 are digital pins. These pins have the value HIGH or Low. **USB** allows the board to connect the computer. It is essential for the programming of the Arduino UNO board.

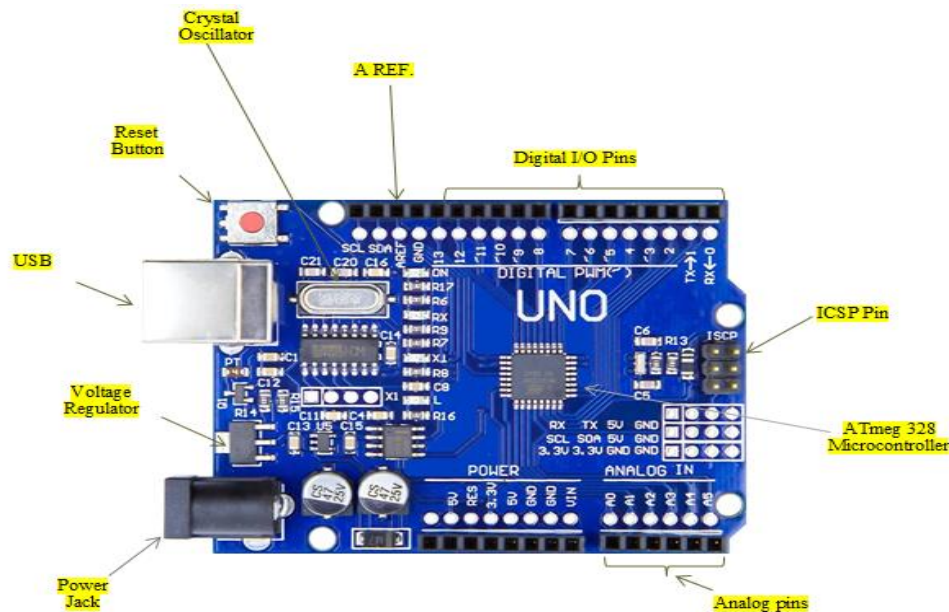


Figure 3. The components of Arduino UNO board

RTC Module DS 3231

The DS3231 RTC module is a real-time clock module using the DS3231 IC. The DS3231 IC is a very affordable and extremely accurate RTC with an I2C interface. It is very accurate because it uses an integrated temperature-compensated crystal oscillator (TCXO) along with a crystal. To keep track of time even if the main power source is removed, the DS3231 has a backup battery mounted at the back of the module. The chip automatically switches between main and backup power sources when necessary. The RTC keeps track of seconds, minutes, hours, day, date, month, and year data. It also automatically adjusts for months with less than 31 days and also for leap years. The clock can operate in either 24H or 12H (with AM/PM) formats. There are also two programmable time-of-day alarms and also a programmable square-wave output. Communication with the RTC is done through an I2C interface with a fixed default address of 0x68.

Aside from the RTC chip, this particular module also has a 24C32 EEPROM chip. An EEPROM is a kind of data storage device wherein you can read/write data. The 24C32 has 32 bytes (4K x 8 bits) of available data storage space. It shares the module's I2C bus with the DS3231 and has the default address of 0x57. The I2C SDA and SCL signals, as well as power and ground, are broken out to one side of the module to allow these signals to be looped out to another module. To enable communication, both the SDA and SCL lines have 4.7K pull-up resistors. DS3231 Module is shown in figure 4.

The DS3231 IC incorporates a battery input for maintaining accurate timekeeping even when the device's main power is interrupted. The built-in power-sense circuit continuously monitors the status of VCC to detect power failures and automatically switches to the backup supply. This means that even in the event of a power outage, the IC can still keep time. For backup power, the bottom of the board houses a battery holder for a 20mm 3V lithium coin cell.

Simple Serial Interface Connects to Most Microcontrollers

- Fast (400kHz) I2C Interface Battery-Backup Input for Continuous Timekeeping
- Low Power Operation Extends Battery-Backup Run Time
- 3.3V Operation

Operating Temperature Ranges: Commercial (0°C to +70°C) and Industrial (-40°C to +85°C)

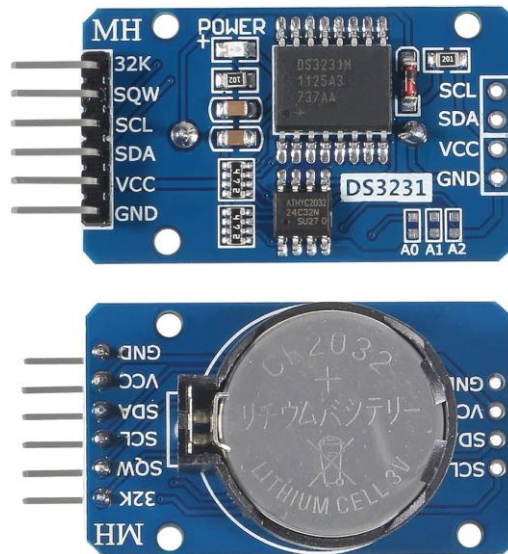


Figure 4. DS3231 RTC Modules

LM35 Temperature Sensor

The LM35 is a temperature sensor that can measure temperature in degrees Celsius with an output voltage that is directly proportional to the temperature being measured. The sensor is based on the LM35 integrated circuit, which is a precision analog temperature sensor. This sensor is commonly used in electronic circuits and systems to measure temperature. It has a linear output and a high accuracy of $\pm 0.5^{\circ}\text{C}$ at room temperature, making it suitable for a wide range of applications. The LM35 sensor works by converting the temperature of the object being measured into an analog voltage output. The output voltage of the LM35 increases by 10 mV for every 1°C increase in temperature. LM35 can measure from -55 degrees centigrade to 150 -degree centigrade. The accuracy level is very high if operated at optimal temperature and humidity levels. The conversion of the output voltage to centigrade is also easy and straight forward. The input voltage to LM35 can be from $+4$ volts to 30 volts. It consumes about 60 microamperes of current. Figure 5 shows the pin out diagram of a LM35 temperature sensor.

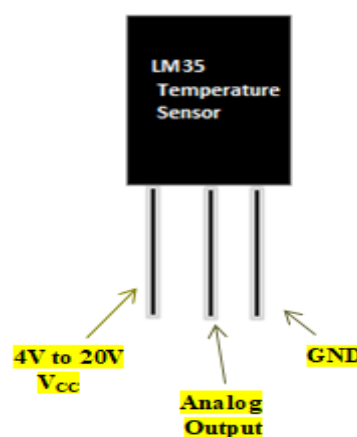


Figure 5. Pin out diagram of a LM35 temperature sensor

Micro SD Card Module

The module (Micro-SD Card Adapter) is a Micro SD card reader module, and the SPI interface via the file system driver, microcontroller system to complete the Micro-SD card read and write files. Arduino users can directly use the Arduino IDE comes with an SD card to complete the library card initialization and read-write. A total of six pins (GND, VCC, MISO,

MOSI, SCK, CS), GND to ground, VCC is the power supply, MISO, MOSI, SCK is the SPI bus, CS is the chip select signal pin.

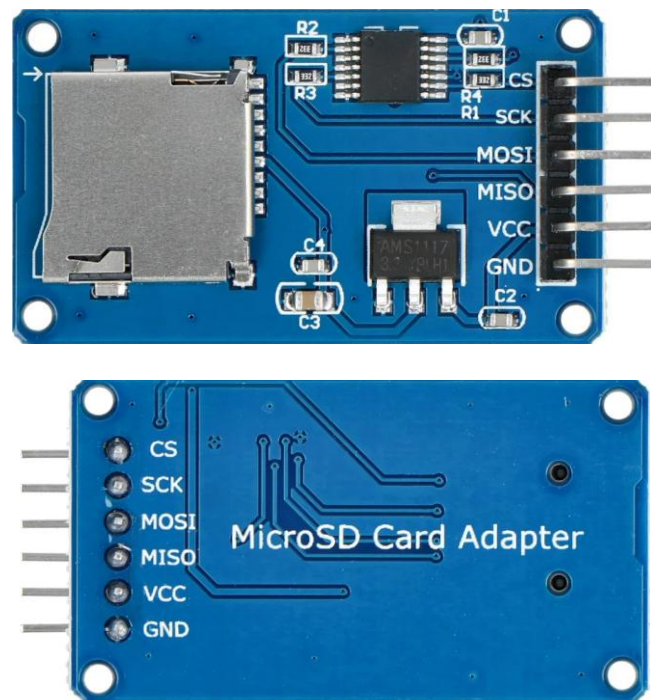


Figure 6. Micro SD card module

I2C Serial Adapter for LCD Module

I2C Serial Adapter for LCD Module is shown in figure 7. This I2C LCD Interface board used an I2C communication interface. It means it only needs 4 pins for the LCD display: VCC, GND, SDA and SCL. It will save at least 4 digital / analog pins on Arduino.



Figure 7. I2C Serial adapter for LCD Module

LCD Display

Figure 8 shows the 20 x 4 LCD display use in this temperature data logger circuit. The display is composed of a 20 character x 4 line LCD display with a blue backlight and white characters. Each of the character is composed of a 5 x 8 dot matrix for good character representation. The backlight has a potentiometer for adjustment of the contrast of the display for best viewing. The backlight intensity is not directly controllable though the I2C interface, however there is a jumper on the I2C board that supplies power to the backlight. That jumper can be removed and a voltage applied to the header pin nearest the 'LED' markings on the board to provide power to the backlight separately.



Figure 8. 20 x 4 LCD display

Circuit Operation of System

As shown in Figure 1, the construction of Arduino based temperature data logger consists of two parts: the hardware and software implementations. Both software and hardware will be accomplished using Arduino Uno microcontroller.

Hardware Design

Arduino based temperature data logger consists of four systems, namely temperature sensing system, data storage system, real time clock system and display system. Schematic diagram of the Arduino based temperature data logger is shown in Figure 9. This circuit is built with an Arduino UNO, a LM35 analog temperature sensor, an I2C 20 x 4 LCD module, DS3231 RTC module, a micro SD card and power supply. Pin 1 (V_s) of the LM35 temperature sensor is connected to Arduino's 5V supply and Pin 3 (GND) is connected to Arduino GND. Output data pin (pin2) of the LM35 temperature sensor is connected to Arduino analog pin 0 (A0). The LM35 temperature sensor gives the output in analog form. The analog output data is sent to analog input A0 pin of the Arduino.

The Arduino reads temperature data from the LM35 sensor and saves them (with date and time) to a text file stored on the SD card. The DS3231 real time clock chip is used to get time and date information. The DS3231 RTC module SDA (serial data) and SCL (serial clock) pins are respectively connected to ATmega328p hardware I2C module pins. V_{CC} is directly connected to +5V regulator output pin and GND is connected to Arduino GND. The SD card module is interfaced to Arduino microcontroller using the SPI communication (MISO, MOSI, SCK, CS). MISO and MOSI pins of the micro SD card module are connected to Arduino's digital pin12 and 11. Then, SCK and CS pins of the micro SD card module are connected to Arduino's pin 13 and 10 respectively. The digital pins 10, 11, 12 and 13 are hardware SPI module pins of ATmega328p microcontroller. Micro SD card module is supplied from circuit 5V source that comes from the 5V regulator IC LA7805's pin3. This module contains AMS1117-3.3V voltage regulator which is used to supply the SD card with 3.3V. Also this module contains an IC which is 74LVC125A and it's used as level translator (from 5V to 3.3V). The micro SD card module GND is connected to Arduino GND.

SD card need to be formatted into the FAT format before use. A 2GB or less card can be formatted in FAT or FAT32. Card larger than 2GB should be formatted in FAT32. Card larger than 32GB should be formatted in ex FAT.

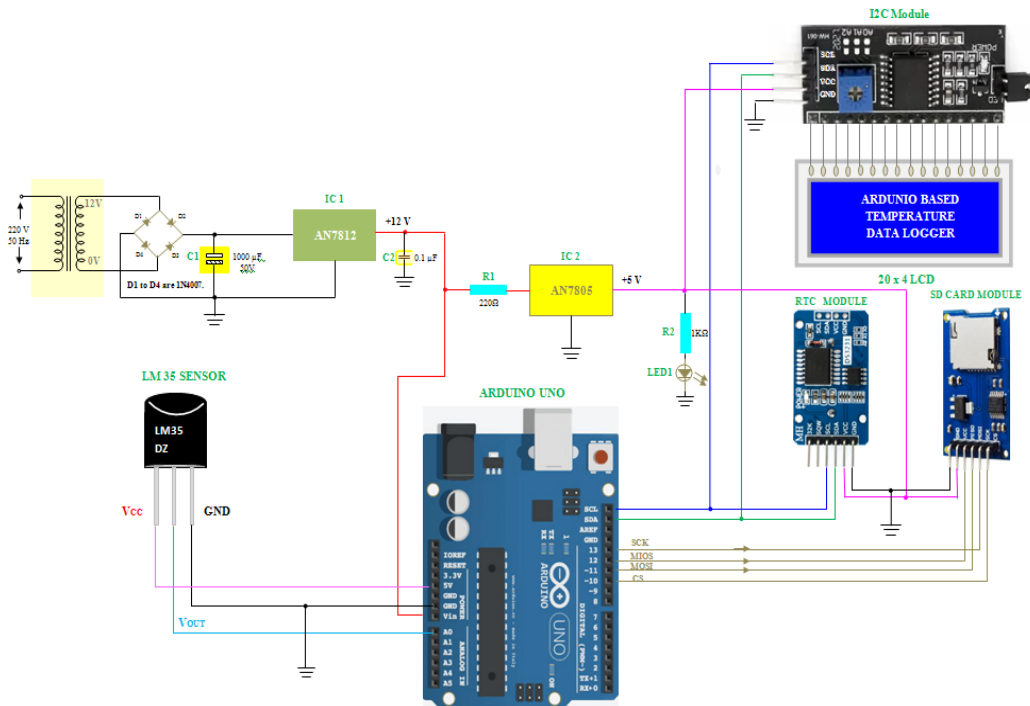


Figure 9. Schematic diagram of the Arduino based temperature data logger

Software Design

Software design is divided into two parts. First we write the Arduino program in Arduino software. Then we compile it to the Arduino hardware. This Arduino command is control the Arduino hardware, other circuit and display connection. The program flow chart of the proposed system has been shown in Figure 10 which explains the whole software design procedures.

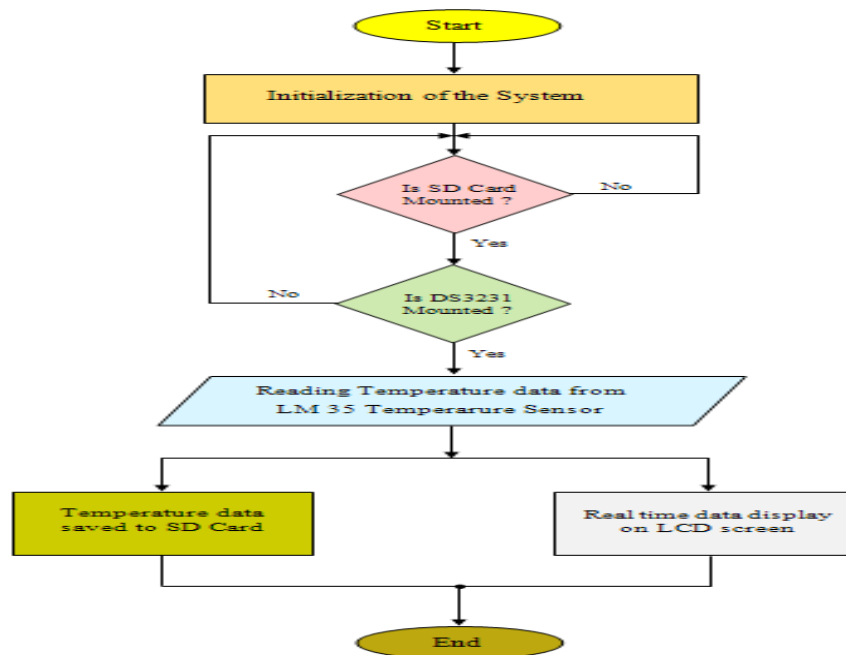


Figure 10. Program flow chart of the Arduino based home automation system using IR remote control

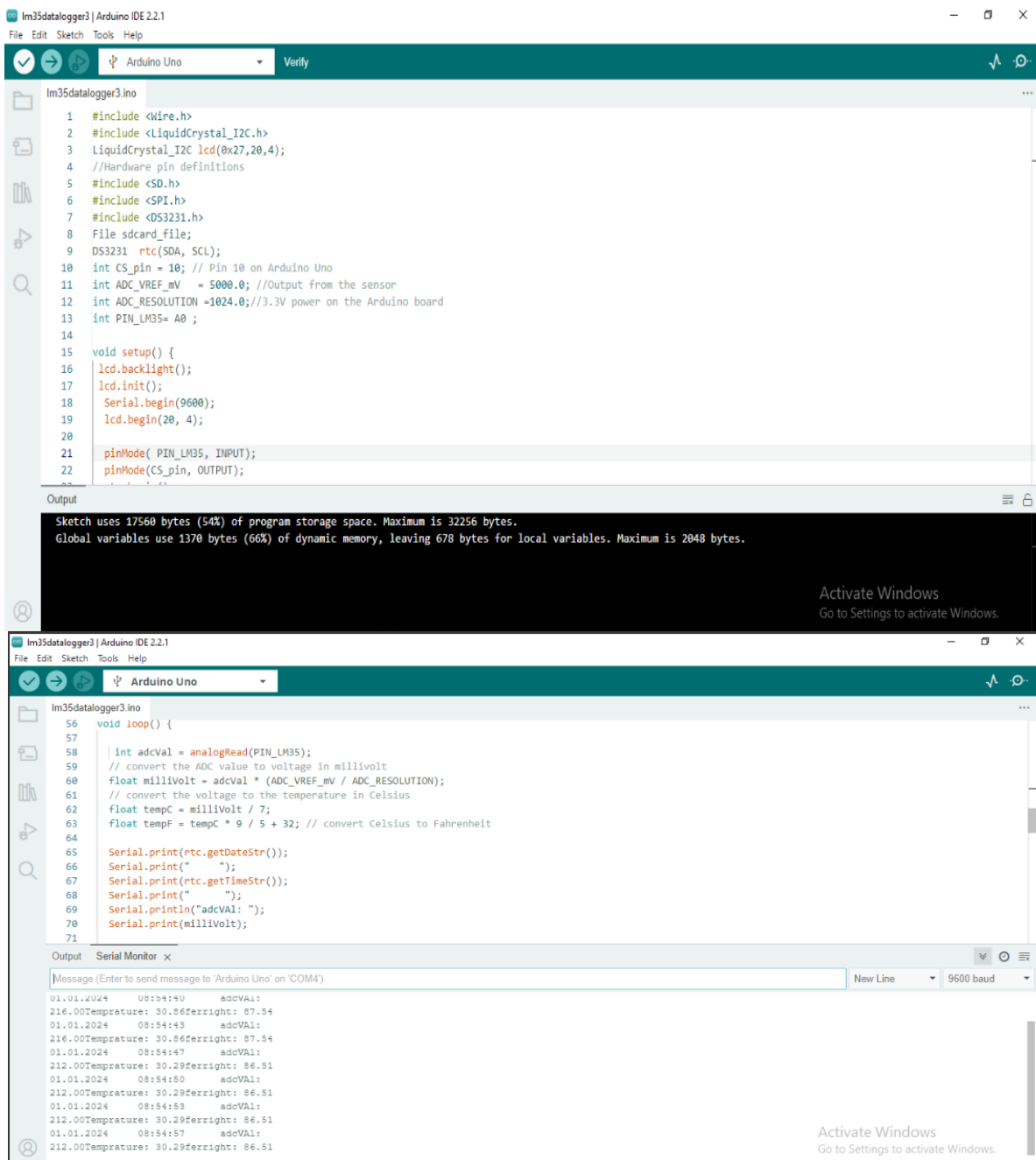


Figure 11. Window of simulation on program execution

Results and Discussion

This research work is about the design and development of an Arduino based temperature data logging system. In this system, receives analog data from LM35 temperature sensor was connected to the Arduino Uno's analog input. The data read from the Arduino was saved in a SD card. The temperature data of Hlaing township (MICT) February data was obtained from temperature data logger measurement. The statistical analysis is performed to illustrate the daily changes in temperature. The data logger system hardware and the related software has been designed, developed and tested successfully. An Arduino microcontroller was used in this research work but any other type of microcontroller can be used as long as it has a serial port. Also, any kind of temperature sensor can be used as long as it can be interfaced to the microcontroller. The data logger system can also be made more usable by including a large memory so that the collected data can be stored locally before it is sent to the PC.

Photograph of the Arduino based temperature data logger is shown in figure 12. Output data measurement of the temperature data logger is shown in APPENDIX A.



Figure 12. Photograph of the Arduino based temperature data logger

Conclusion

This research work is about the design and development of an Arduino based temperature data logging system. In this system, receives analog data from LM35 temperature sensor was connected to the Arduino Uno's analog input. The data read from the Arduino was saved in a SD card. The data logger system hardware and the related software has been designed, developed and tested successfully. An Arduino microcontroller was used in this research work but any other type of microcontroller can be used as long as it has a serial port. Also, any kind of temperature sensor can be used as long as it can be interfaced to the

microcontroller. The data logger system can also be made more usable by including a large memory so that the collected data can be stored locally before it is sent to the PC.

Acknowledgements

I am very grateful to Rector Dr Nay Win Oo, East Yangon University, for his permission to work this research. We would like to thank Pro-Rectors Dr Aye Aye Ko, Dr Wah Wah Lwin and Dr Thida Aung, East Yangon University, for their permissions to work on the present topic. We are greatly indebted to Professor Dr Hmwe Hmwe Kyu, Head of Department of Physics, East Yangon University, who provides with generous help and kind permission in this research paper. We are also deeply grateful to Professors Dr Khin Lay Nwe, and Dr Su Su Aung, Department of Physics, East Yangon University, for her help and guidance in this research paper.

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OPTICAL PROPERTIES OF NATURAL DYE EXTRACTED FROM THE *GARCINIA MANGOSTANA* L. (MANGOSTEEN PEEL)

May Thingyan Moe¹, Cho Lay Nwe¹, Su Su Mar¹ and Myat Shwe Wah²

Abstract

The present study focused on the natural dyes from mangosteen peel. Anthocyanin group extracted from mangosteen peel was used with different solvents as methanol, ethanol, acetone and hot water. The optical properties of extracted dye were studied by UV-Vis spectroscopic measurement. Characterization results showed high absorbance values 0.24 a.u., 0.27 a.u., 0.12 a.u. and 3.21 a.u. at 604.89 nm, 610.5 nm, 610.9 nm and 420.7 nm for methanol, ethanol, acetone and hot water, respectively. The optical band gap energies (E_g) for dye were obtained from absorption spectra in the range of wavelength 400 nm – 700 nm. The optimum values of absorption coefficient of mangosteen peel dye with methanol, ethanol, acetone and hot water solvents were 1.79 cm^{-1} , 1.77 cm^{-1} , 1.77 cm^{-1} and 2.57 cm^{-1} at room temperature.

Key words: Dye, Anthocyanin, band gap energies (E_g) and UV-Vis Spectrophotometer

Introduction

The sensitizing dye plays an important role in the absorption of the photons and generation of electron and hole pairs; the charge carriers are transferred to the photoelectrode and the electrolyte. In order to replace the expensive ruthenium compounds, many kinds of organic synthetic dyes have been actively studied and tested as low-cost materials. In nature, some fruits, flowers, leaves and so on show various colours and contain several pigments that can be easily extracted and then employed in DSSC. Hence, it is possible to use natural dyes as alternative photosensitizers with appreciable efficiencies and their advantages over synthetic dyes include easy availability, abundance in supply, can be applied without further purification, environmentally friendly and they considerably reduce the cost of devices.

In the study, the natural dyes was investigated from mangosteen peel and found that it has a good photoelectric performance as a sensitizer was available in Myanmar all the seasons. Using solvents of various polarities (methanol, ethanol, acetone and hot water) suitable solvent for extracting dyes have been chosen. The extracted dyes were characterized by UV-Vis absorption spectra.

Materials and Method

Materials

Anthocyanin (group of dyes) extracted from mangosteen peel in the laboratory. The solvents solution are methanol, ethanol, acetone and hot water, respectively.

Mangosteen *Garcinia Mangostana*

Mangosteen *Garcinia mangostana* is sweet and tangy purple colored fruit with white fleshy pulp. It is popularly grown in various part of the South-East Asian countries like Thailand, Malaysia, Singapore and South-West India. Mangosteen is also called as queen of fruits as shown in Figure1. Recent scientific studies suggest that mangosteen possesses strong antioxidant, anti-cancer, anti-inflammatory, anti-allergic, anti-microbial and anti-material properties. Xanthone and vitamins in mangosteen are considered the major active component.

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Method of Characterization

The absorption spectra of dye solutions were recorded using UV-Vis spectrophotometer (Shimadzu UV-1800) in the range of 400 – 700 nm.

The value of band gap energy (E_g) of mangosteen peel dye solutions plotted for direct transition $(\alpha h\nu)^2$ versus $h\nu$ of the sample. The determination of the band gap energy of samples was used by the equation (1).

$$(\alpha h\nu) = A (h\nu - E_g)^n \quad (1)$$

where, α = absorption coefficient, $h\nu$ = the energy of photon, E_g = the direct band gap, A = the constant

The absorption coefficient of the respective wavelengths is obtained by the division of the absorbance with the wavelength shown in equation (2).

$$\text{Absorption coefficient, } \alpha = 4\pi k / \lambda \quad (2)$$

where λ (nm) is taken from the cutoff wavelength of the dyes and k is the Boltzman constant with value of 8.617×10^{-5} eV/K.



Figure 1. Mangosteen (*Garcinia Mangostana*)

Experimental Procedure

Extraction of Natural Dye

Mangosteen peel were collected from local garden and washed with water and kept them some times in room temperature to remove the surface water. The samples were annealed at 150°C for 1hour in the oven. And then, the samples were grinding with A-gate mortar for 15min and filtered with smaller 40 mask to get fine powder. After that, the powder was mixed with 5mL of different solvents for 1day and the solution was then double filtered by the paper filter. The resulting filtrate was used as natural sensitizer. All dye solutions were stored in the dark. To observe the effect of solvent four different solvents of various polarities such as deionized methanol, ethanol, acetone and hot water were used for extraction dye from mangosteen peel. The experimental procedure for dye extraction as shown in Figure 2.

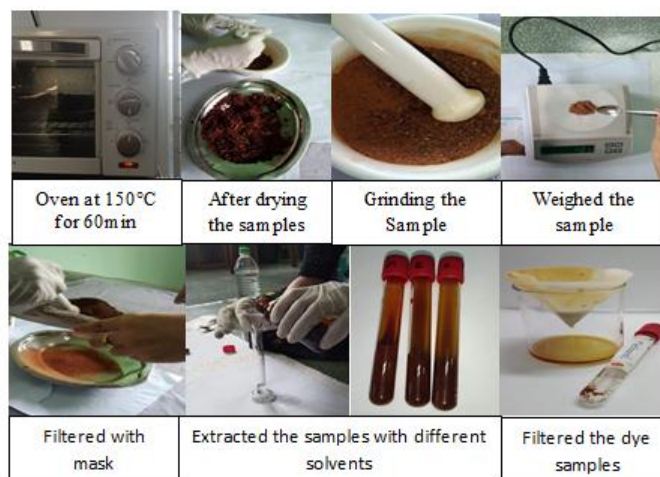


Figure 2. Experimental Procedure for dye extraction

Results and Discussion

UV-Vis Spectrophotometer Measurement

Ultraviolet-visible spectroscopy or ultraviolet-visible spectrophotometry (UV-Vis or UV/Vis) refers to absorption spectroscopy or reflectance spectroscopy in the ultraviolet-visible spectral region. The absorption spectra of dye with different solvents were recorded in the wavelength range of 400 to 700 nm using UV/Vis-1800 spectrophotometer in absorbance mode. Characterization results showed high absorbance values 0.24 a.u, 0.27 a.u, 0.12 a.u and 3.21 a.u at 604.89 nm, 610.5 nm, 610.9 nm and 420.7 nm for methanol, ethanol, acetone and hot water, respectively. The optical band gaps of extracted dye were then estimated from the plot of $(\alpha h\nu)^2$ versus $h\nu$. The absorption spectra of dye were shown in Figure from 3(a) to (d). In addition, the optical band gap of dye were estimated from the plot of $(\alpha h\nu)^2$ versus $h\nu$. The $(\alpha h\nu)^2$ versus $h\nu$ plot was shown in Figure from 4(a) to (d). The optical band gap of mangosteen peel dye with different solvents were found to be 2.08 eV, 2.16 eV, 2.23eV and 2.04 eV, respectively as shown in Figure 5 and Table 1. High transmission and wide band gap of dye with different solvents were the favorable properties of interfacial layer in photovoltaic (PV) devices.

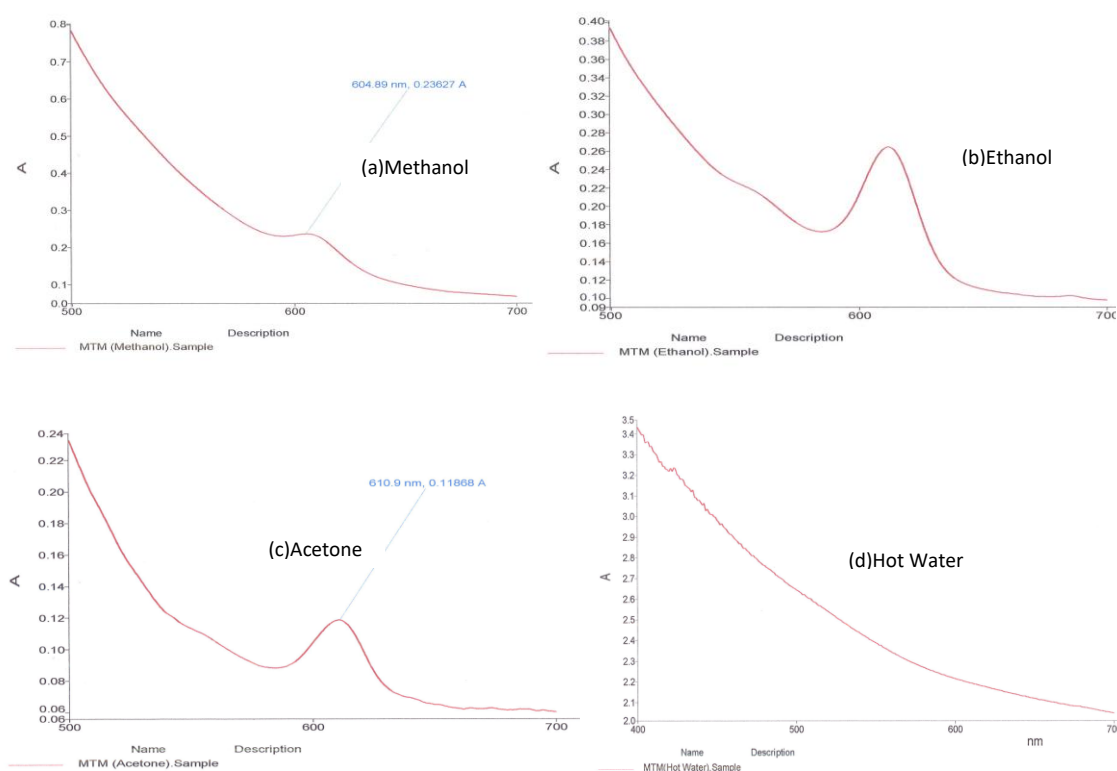


Figure 3(a),(b),(c) and (d) Absorption spectra of the different solvents at room temperature for Mangosteen peel *Garcinia Mangostana*

Table 1. The values of energy band gap for different solvents

Line Color	Wavelength (nm)	Solvents	Absorbance (a.u)	Absorption coefficient (cm^{-1})	Energy band gap (E_g) (eV)
Green shift	610.9	Acetone	0.12	1.77	2.23
Blue shift	604.89	Methanol	0.24	1.79	2.08

Line Color	Wavelength (nm)	Solvents	Absorbance (a.u)	Absorption coefficient (cm ⁻¹)	Energy band gap (E _g) (eV)
Red shift	610.5	Ethanol	0.27	1.77	2.16
Violet shift	420.7	Hot water	3.21	2.57	2.04

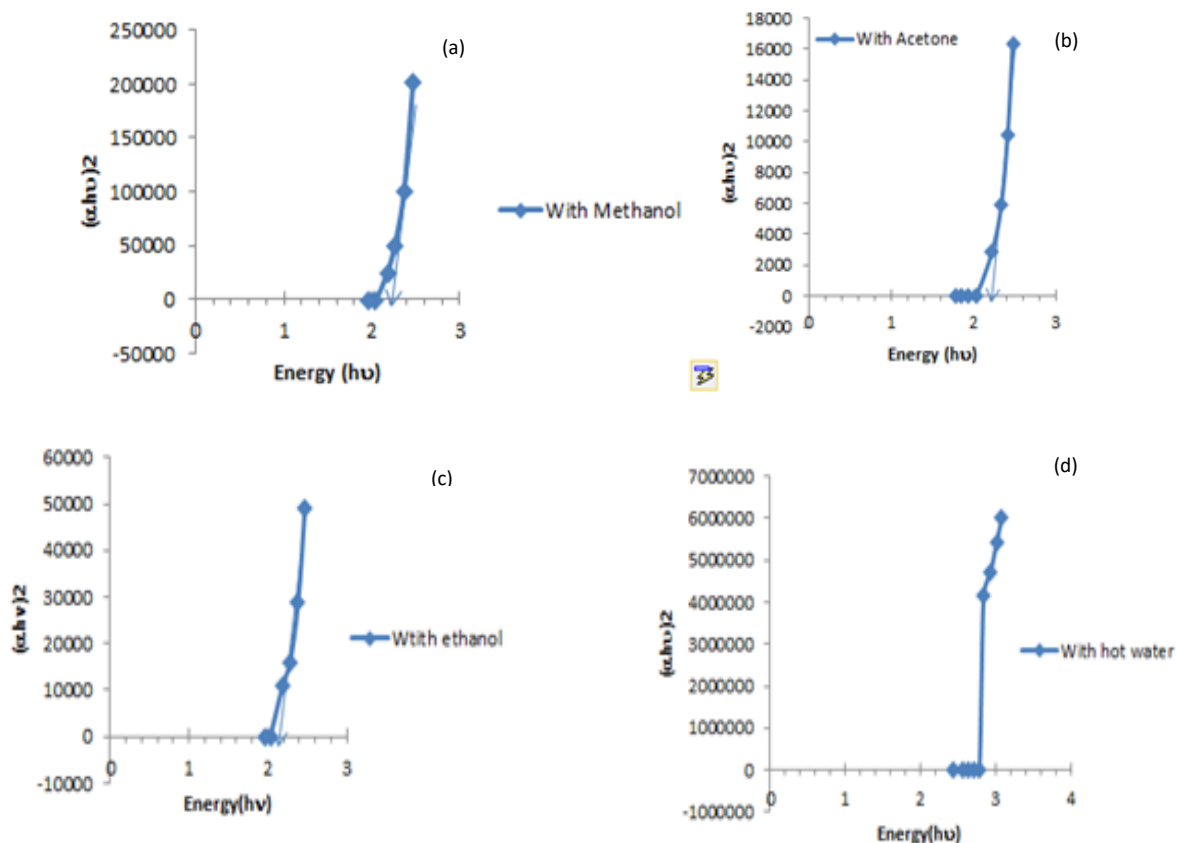


Figure 4 (a),(b),(c) and (d) Energy band gap of the different solvents at room temperature for mangosteen peel

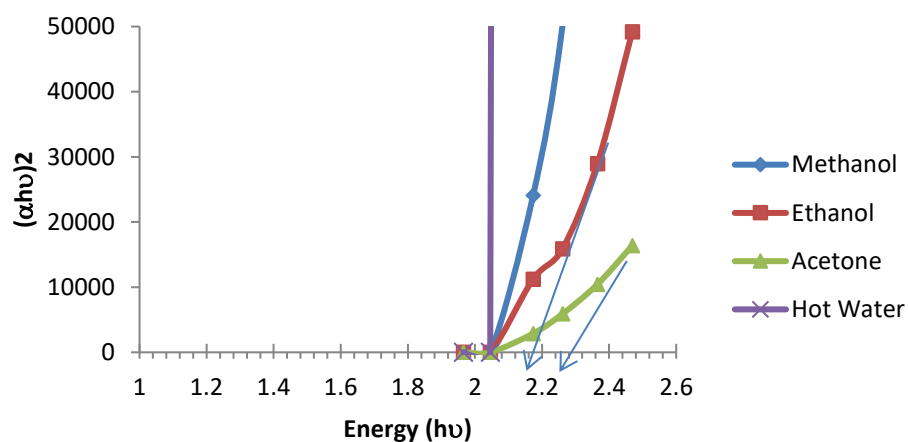


Figure 5. Plot of $(\alpha h\nu)^2$ vs $h\nu$ for mangosteen peel dye in different solvents at room temperature

Conclusion

The natural dyes were extracted from mangosteen peel as a sensitizer for dye-sensitized solar cells. The Optical properties of mangosteen peel extract were studied by UV-Vis spectroscopy. The Band gap energy of mangosteen peel dye was calculated using Equation (1) and Equation (2). Optical properties of mangosteen peel dye showed narrow band of absorbance from 400 nm to 700 nm. The values of absorption coefficient of dye in methanol were obtained 2.16 cm^{-1} , 2.07 cm^{-1} , 1.98 cm^{-1} , 1.91 cm^{-1} and 1.79 cm^{-1} at room temperature, respectively. In ethanol solvent, the absorption coefficient values were 2.16 cm^{-1} , 2.09 cm^{-1} , 1.99 cm^{-1} , 1.92 cm^{-1} and 1.77 cm^{-1} at room temperature. The absorption coefficient of acetone values were 2.16 cm^{-1} , 2.11 cm^{-1} , 2.04 cm^{-1} , 1.94 cm^{-1} , 1.77 cm^{-1} at room temperature. In hot water, the absorption coefficient values were 2.7 cm^{-1} , 2.64 cm^{-1} , 2.57 cm^{-1} , 2.49 cm^{-1} , 2.44 cm^{-1} at room temperature. This result showed strong absorbance in 400 nm to 700 nm wavelength. Varying the solvents would modulate the absorption properties of dyes. It was suggested that ethanol is better than methanol, acetone and hot water for solubility of dye. The high peak absorbance wavelength as red shift, low band gap and low absorption coefficient are obtained in methanol, ethanol, acetone and hot water at room temperature. The absorption intensity increases with different solvents for all extracting solvents. Therefore, mangosteen peel optical properties proved the dye as good absorber hence it can be used for cell fabrication.

Acknowledgements

I would like to express appreciation to Rector Dr Than Zaw Oo, Pro-rector Dr Thandar, Pro-Rector Dr Thazin Lwin and Pro-Rector Dr Yin Yin Lwin, West Yangon University for their encouragement and kind permission to undertake the present research.

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Preparation and Electrical Properties of Lithium Nickel Oxide (LiNiO₂)

Soe Thu Zar¹, Thida Aung² and Myat Shwe Wah³

Abstract

Lithium Nickel Oxide (LiNiO₂) was successfully prepared by solid state method. In this process, Lithium Carbonate (Li₂CO₃) and Nickel Oxide (NiO) were used as starting materials. These starting materials were weighed with equimolar ratio and mixed each other. The mixed materials were annealed at 450°C for 8 h and followed by 800°C for 15 h. The structural properties and electrical properties of the sample were characterized by powder X-ray diffraction and temperature dependent electrical conductivity measurement. Structural characteristics of crystal structure and the lattice parameters were investigated from the collected XRD pattern. Temperature dependent electrical conductivity measurement was performed in the temperature range 303 K- 723 K to study the conduction mechanism. It is widely used as solid-state mini/micro electrochemical devices viz. batteries, fuel cells, sensors, photoelectrochemical solar cells (PECSC).

Keywords: Lithium Nickel Oxide (LiNiO₂), X-ray diffraction, electrical conductivity and photoelectrochemical solar cells (PECSC)

Introduction

The research in the field of Solid-State Ionic encompasses investigations of the physical and chemical behavior of the solids with fast ion movement within the bulk as well as the technological aspects [3]. These materials widely refer to as "Superionic Solids" or "Solid Electrolytes" or "Fast Ion Conductors", show tremendous scope to develop all solid-state mini/micro electrochemical devices viz. batteries, fuel cells, sensors, photoelectrochemical solar cells (PECSC) etc [4].

Solid-State Ionics, thrust area of research in the branch of Materials Science, deals mainly with the solid materials which exhibit rapid/fast ion transport through the bulk. The ionic conductivity of these solids is exceptionally high and comparable to that of liquid/aqueous electrolytes [1]. Hence, they can be potentially used as excellent alternates of liquid/aqueous electrolytes to fabricate solid-state electrochemical devices viz. batteries [2].

Experimental Procedure

Preparation of Lithium Nickel Oxide

The starting materials of Analar (AR) grade Lithium Carbonate (Li₂CO₃) and Nickel Oxide (NiO) were weighed with equimolar ratio. The weighed powders Lithium Carbonate (Li₂CO₃) 25 g and Nickel Oxide (NiO) 25g were mixed and ground by and agate mortar to be homogeneous and to obtain fine powder. The powder was annealed at 450°C for 8 h and followed by 800°C for 15 h to be crystalline phase. The annealing process was performed by using DAIHAN LABTECH Furnace (1200°C). Finally, the as-prepared LiNiO₂ was obtained. Then the sample was made pellet by using SPECAC Hydraulic Pellet Maker. The electrical conductivity of the sample was investigated by temperature dependent electrical conductivity measurement to study the superionic conductivity of the sample.

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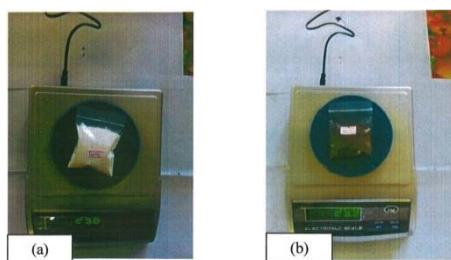


Figure 1 Photographs of the weighing of starting materials (a) Li_2CO_3 and (b) NiO

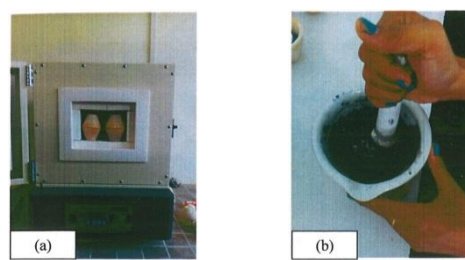


Figure 2 Photographs of the (a) starting materials annealing in DAIHAN LABTECH Furnace and (b) the crushing of as-prepared LiNiO_2 sample

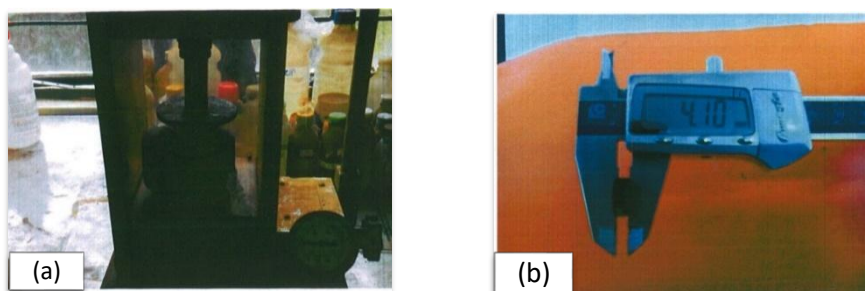


Figure 3 (a) Photograph of the SPECAC hydraulic press (b) Photograph of the thickness measurement of LiNiO_2 pellet

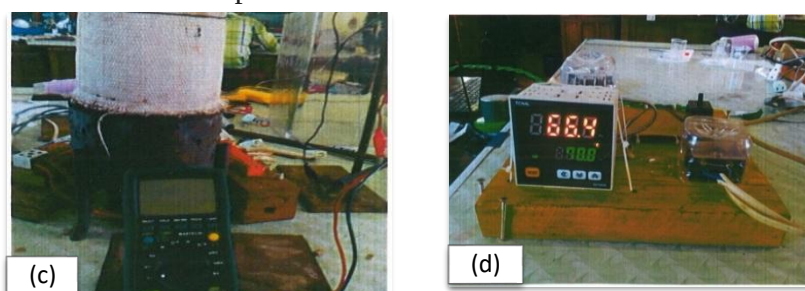


Figure 3(c) Photograph of the experimental setup of temperature dependent electrical conductivity measurement (d) the temperature controller Autronics TCN4L -24R

Results and Discussion

Temperature Dependent Electrical Conductivity Measurement

For the temperature dependent electrical conductivity measurement, firstly the as-prepared Lithium Nickel Oxide (LiNiO_2) sample was made pellet by SPECAC hydraulic press using 5 ton (~ 70 MPa). The silver paste (conductive pen) was made over the sample to ensure good electrical contacts. The electrical resistances of the samples were observed in the temperature range of 303 K - 723 K by the use of Autronics TCN4L - 24R Temperature Controller. Photographs of the SPECAC hydraulic press, thickness measurement and experimental setup of electrical conductivity measurement are shown in Fig 3.3(a - d) respectively. Thickness and area of the pellet are 4.10 mm and $1.14 \times 10^{-4} \text{ m}^2$ respectively.

The electrical resistances of the samples were measured by using MASTECH digital multi-meter. K-type thermocouple was placed near the sample to record real temperatures throughout the measurement. 300 W heater rods were used for heating elements. The electrical conductivity (σ) of the sample has been calculated by using the formula $\sigma = \frac{l}{RA}$ where l is the thickness of the sample, A is the cross-sectional area of the electrodes, and R is the resistance.

Structural Analysis by XRD

Powder X-ray diffraction pattern of Lithium Nickel Oxide (LiNiO_2) is shown in Fig 4.1. The collected XRD lines were compared to the JCPDS data file Cat. No. 89-3603 $\text{Li}_{0.524}\text{Ni}_{1.476}\text{O}_2$ - Lithium Nickel Oxide to identify the collected XRD lines. As shown in the observed XRD pattern, all of the diffraction lines were found to be agreed with standard JCPDS file. It indicated that the appearance of the diffraction peaks demonstrate that single phase LiNiO_2 solid electrolyte material. In the collected XRD pattern, three diffraction lines were appeared and well assigned by JCPDS data file. The appeared diffraction angles of 37.858° , 43.980° and 63.899° and their corresponding crystal planes were assigned as (012), (104) and (110) respectively.

The diffraction line of (104) planes in the XRD pattern is the strongest in intensity ($I = 100\%$) and this peak dominates others diffraction peaks. According to XRD patterns, single phase LiNiO_2 sample belongs to hexagonal structure at room temperature. The experimental data, the observed and the calculated lattice parameters are tabulated in Table 1. Julien C (2003) has reported that the lattice parameters of the $\text{Li}_{0.25}\text{Ni}_{0.75}\text{O}_2$ sample are $a = b = 2.9170\text{\AA}$ and $c = 14.096\text{ \AA}$ respectively. Thus, the obtained lattice parameters of the investigated LiNiO_2 are acceptable due to the compatible with the results of Julien C (2003).

To investigate the fine particle nature of the LiNiO_2 sample, in this work, the crystallite size of the sample was estimated by using the Scherrer formula, $D = \frac{0.9\lambda}{\beta \cos \theta}$, where D is the crystallite size (nm), λ is wavelength of incident X-ray ($\text{\AA}$), θ is diffraction angle of the peak under consideration at FWHM ($^\circ$) and β is the observed FWHM (radians). The calculated crystallite sizes are tabulated in Table 1. In the present work, the average crystallite size of the sample is obtained as 33.8475 nm. It is the acceptable nanosized materials size of the nanotechnology in the nanometer (sized) range of 1 - 100 nm. Also it indicates the as-prepared LiNiO_2 sample is a very fine material.

Table 1 Calculated crystallite sizes and lattice parameters of LiNiO_2

Sr No	2θ ($^\circ$)	FWHM ($^\circ$)	D (nm)	hkl	Observed lattice parameters $a = b, c$ ($\text{\AA}$)	Calculated lattice parameters $a = b, c$ ($\text{\AA}$)
1	37.858	0.249	33.7243	012	$a = b = 2.9076$, $c = 14.2680$	$a = b = 2.9076$, $c = 14.2675$
2	49.980	0.318	26.9393	104	$a = b = 2.9076$, $c = 14.2680$	$a = b = 2.9113$, $c = 14.2319$
3	63.899	0.229	40.8790	110	-	$a = b = 2.9113$, $c = 14.2680$
Average lattice parameters					$a = b = 2.9088$, $c = 14.2680$	$a = b = 2.9101$, $c = 14.2088$

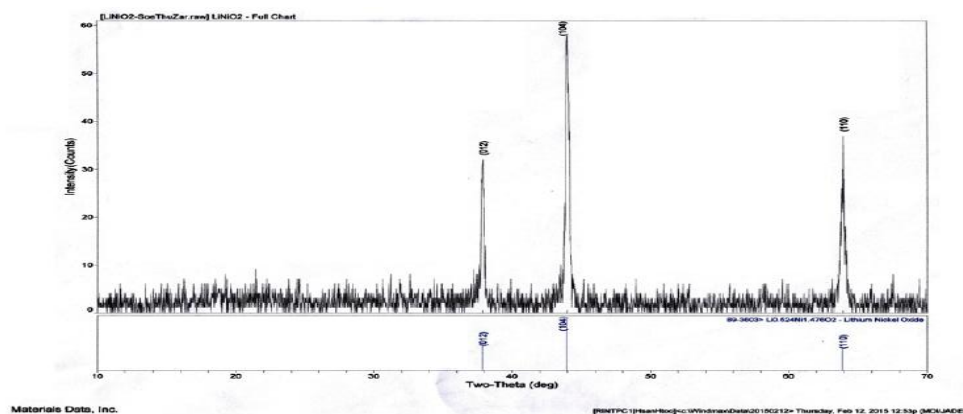
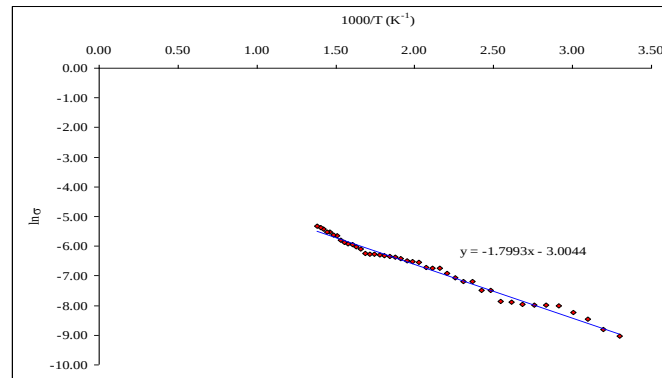


Figure 4 The XRD spectrum for LiNiO_2

Figure 5 Arrhenius plot of the temperature dependent electrical conductivity of LiNiO₂Table 2 Experimental data of electrical conductivity measurement of LiNiO₂

T (K)	1000/T (K ⁻¹)	R (Ω)	σ (S m ⁻¹)	ln σ	T (K)	1000/T (K ⁻¹)	R (Ω)	σ (S m ⁻¹)	ln σ
303	3.30	2.970E+05	1.21E-04	-9.02	573	1.75	1.920E+04	1.87E-03	-6.28
313	3.19	2.385E+05	1.51E-04	-8.80	583	1.72	1.880E+04	1.91E-03	-6.26
323	3.10	1.679E+05	2.14E-04	-8.45	593	1.69	1.870E+04	1.92E-03	-6.25
333	3.00	1.360E+05	2.64E-04	-8.24	603	1.66	1.590E+04	2.26E-03	-6.09
343	2.92	1.078E+05	3.34E-04	-8.01	613	1.63	1.470E+04	2.45E-03	-6.01
353	2.83	1.056E+05	3.41E-04	-7.98	623	1.61	1.370E+04	2.63E-03	-5.94
363	2.75	1.056E+05	3.41E-04	-7.98	633	1.58	1.340E+04	2.68E-03	-5.92
373	2.68	1.020E+05	3.53E-04	-7.95	643	1.56	1.260E+04	2.85E-03	-5.86
383	2.61	9.660E+04	3.72E-04	-7.90	653	1.53	1.171E+04	3.07E-03	-5.79
393	2.54	9.410E+04	3.82E-04	-7.87	663	1.51	1.030E+04	3.49E-03	-5.66
403	2.48	6.430E+04	5.59E-04	-7.49	673	1.49	1.000E+04	3.60E-03	-5.63
413	2.42	6.410E+04	5.61E-04	-7.49	683	1.46	9.100E+03	3.95E-03	-5.53
423	2.36	4.760E+04	7.56E-04	-7.19	693	1.44	9.000E+03	4.00E-03	-5.52
433	2.31	4.720E+04	7.62E-04	-7.18	703	1.42	8.200E+03	4.39E-03	-5.43
443	2.26	4.250E+04	8.46E-04	-7.07	713	1.40	7.800E+03	4.61E-03	-5.38
453	2.21	3.640E+04	9.88E-04	-6.92	723	1.38	7.300E+03	4.93E-03	-5.31
463	2.16	3.080E+04	1.17E-03	-6.75					
473	2.11	3.010E+04	1.19E-03	-6.73					
483	2.07	2.950E+04	1.22E-03	-6.71					
493	2.03	2.500E+04	1.44E-03	-6.54					
503	1.99	2.460E+04	1.46E-03	-6.53					
513	1.95	2.380E+04	1.51E-03	-6.49					
523	1.91	2.230E+04	1.61E-03	-6.43					
533	1.88	2.080E+04	1.73E-03	-6.36					
543	1.84	2.060E+04	1.75E-03	-6.35					
553	1.81	1.980E+04	1.82E-03	-6.31					
563	1.78	1.940E+04	1.85E-03	-6.29					

Electrical Conductivity Study

Electrical conductivity of the ceramic obeys an Arrhenius expression $\sigma = \sigma_0 \exp(-E_a / kT)$, where σ is the conductivity, σ_0 is the pre-exponential factor, E_a is the activation energy for ionic conduction, k is the Boltzmann constant and T is the absolute temperature.

In the present work, Arrhenius plot of the variation of electrical conductivity of Lithium Nickel Oxide (LiNiO_2) in the temperature range of 303 K- 723 K is shown in Figure 5. As shown in figure, temperature dependent electrical conductivity of the sample was increased with increase in temperature.

According to the theory of ionic conductivity, the slope of the electrical conductivity in each of the curves corresponding to the activation energy for creating of defect states due to the ionic motions of the sample due to thermal agitation. The electrical conductivity (σ) of the sample can be written in the form:

$$\sigma = \sigma_0 \exp (-E_a / kT)$$

$$\ln (\sigma) = -E_a / kT + \ln \sigma_0 = (-E_a / k) (1/T) + \ln \sigma_0$$

Comparing the above equation with the experimental linear equation, $y = mx + c$ where the value of slope will give the value of $(-E_a/k)$. For example, from Figure 5, the activation energy E_a can be obtained by using the slope of the $\ln (\sigma)$ versus $10^3/T$ graph.

$$E_a/k = 1.7993 \times 1000$$

$$E_a = 1.7993 \times 1000 \times k$$

$$E_a = 1.7993 \times 1000 \times 1.38\text{E-}23$$

$$E_a = 2.4830 \times 10^{-20} \text{ J}$$

$$E_a = 0.1552 \text{ eV}$$

Experimental data of electrical conductivity measurements of the samples are tabulated in Table 2. The obtained electrical conductivity values indicate that the sample is a superionic conductor in high temperature (463 K - 723 K) due to its electrical conductivity $\sigma > 1 \times 10^{-3} \text{ S m}^{-1}$.

It can be said that a few solids conduct electricity better by ion motion than by electron motion. These unusual materials are technologically important in making batteries. All batteries have two electrodes separated by an electrolyte, which is a material that conducts ions better than electrons.

Conclusion

Solid electrolyte material of Lithium Nickel Oxide (LiNiO_2) was prepared by solid-state reaction method. Structural analysis and temperature dependent electrical conductivity of the sample were reported in this work. XRD pattern indicated that as-prepared LiNiO_2 sample analogous to hexagonal structure and the lattice parameters were obtained as $a = b = 2.9088 \text{ \AA}$ and $c = 14.2680 \text{ \AA}$, respectively. The average crystallite size of the sample is obtained as 33.8475 nm. It indicated that the as-prepared sample was the very fine particle nature and the sample was the nanosized material.

Temperature dependent electrical conductivity of the disc shape pellet sample of LiNiO_2 was found to be increased with increase in temperature. The sample exhibited as a superionic conductor in the high temperature range 463 K - 723 K because its electrical conductivity was found to be greater than that of standard literature value $\sim 1 \times 10^{-3} \text{ Sm}^{-1}$. The activation energy was evaluated by using the slope of the $\ln \sigma$ versus $1000/T$ graph and obtained as 0.1552eV. According to experimental results, the sample can be used as the solid electrolyte materials due to the obtained experimental results are reliable with the standard values from the literature of solid electrolyte materials.

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We would like to express appreciation to Rector Dr Than Zaw Oo, Pro-Rector Dr Thanda, Pro-Rector Dr Thazin Lwin and Pro-Rector Dr Yin Yin Lwin, West Yangon University for their encouragement and kind permission to undertake the present research.

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APPLICATIONS OF CONIC SECTION IN REAL-LIFE

Sai Saw Khant Maung¹

Abstract

In this paper, the fact that any curve can be produced by the intersection of plane and right circular cone is first studied. Then properties of ellipse and parabola equations are demonstrated. Finally, this research conclude that mathematics is an essential subject for human society and presented with some real-life examples.

Keywords: parabola, ellipse, eccentricity, reflective

Introduction

In geometry, any curve can be produced by the intersections of a plane and a right circular cone. Depending on the angle of the plane relative to the cone, the intersection is a circle, an ellipse, a parabola and a hyperbola. In other words, the conic sections are the cross sections of a double cone.

Basic Concept of Conic Section

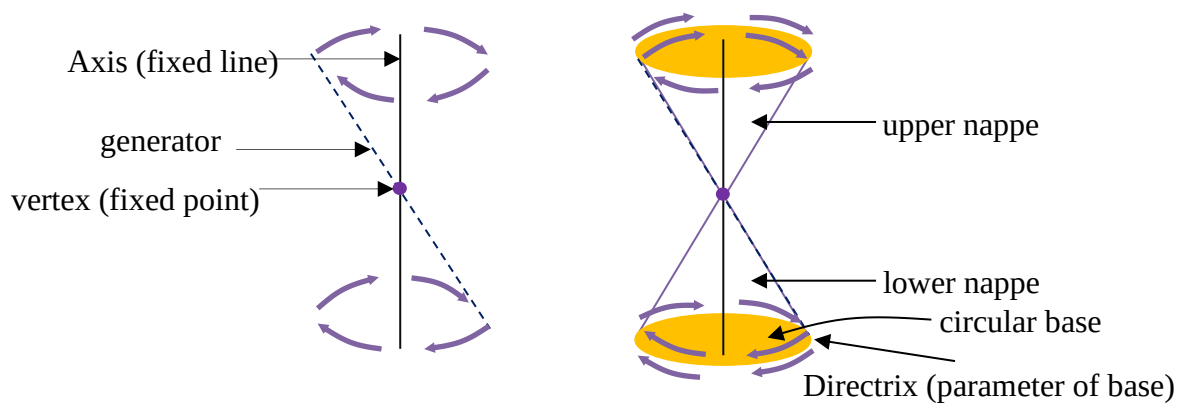


Figure 1

The fixed line is called the axis of cone. The vertex is the point shared by both cones. The lines that pass through the vertex and form the cones are the generators. The generators lie in the cone. The cone consists of two parts called the nappes. A conic section is a curve generated by intersection a right circular cone with a plane. There are four types of conic section which are ellipse, circle, parabola and hyperbola.

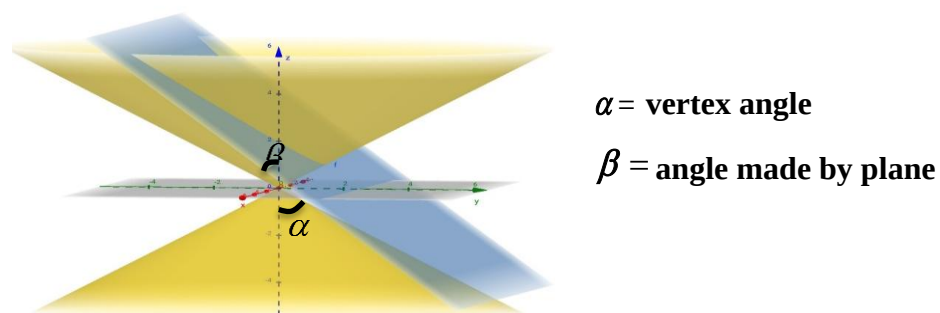


Figure 2

¹ Tutor, Department of Mathematics, Taunggyi University

When the double right circular cone is cut by the plane, the angle between the plane and the axis is greater than the vertex angle ($\beta > \alpha$), the ellipse is obtained. When the plane is perpendicular to the axis, the ellipse changes into a circle. When the angle between the plane and the axis is equal to the vertex angle ($\beta = \alpha$), the parabola is formed and the angle between the plane and the axis is less than the vertex angles ($\beta < \alpha$), the hyperbola is occurred.

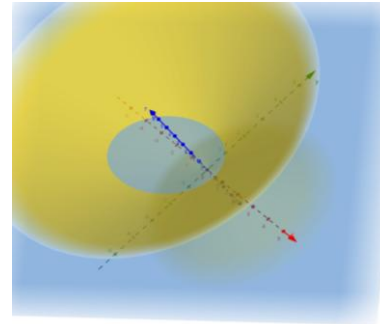
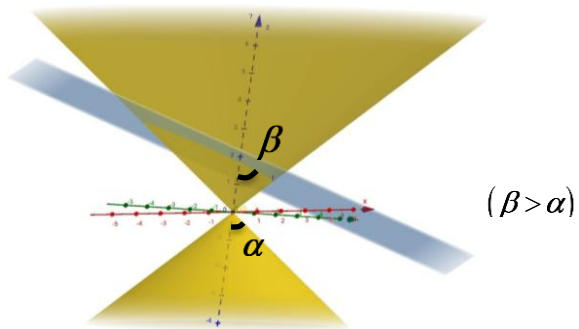


Figure 3

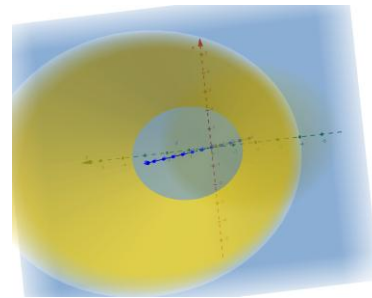
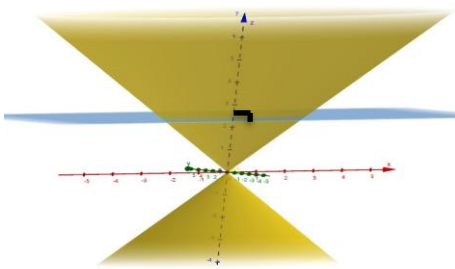


Figure 4

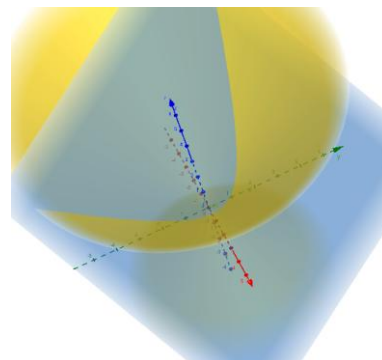
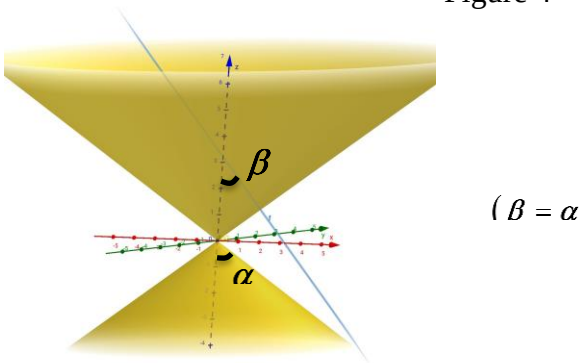


Figure 5

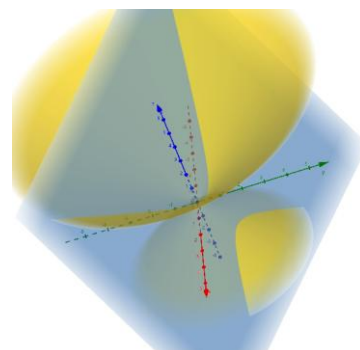
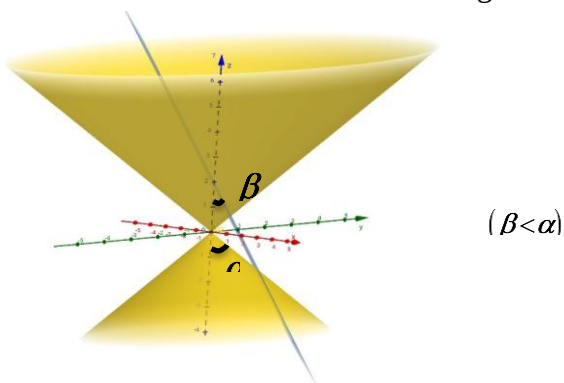


Figure 6

In section 2, we give the equations of parabola and ellipse. And we state the eccentricity of ellipse and the reflective properties of parabola and ellipse.

In section 3, we demonstrate some real-life examples: Orbit of Planets, A concrete bridge with parabola arch, A parabola car headlight and lithotripsy treatment for Kidney Stones.

Materials and Method

1. Definition of Parabola

Parabola is the set of all points that are equidistant between a focus and the directrix (fixed line).

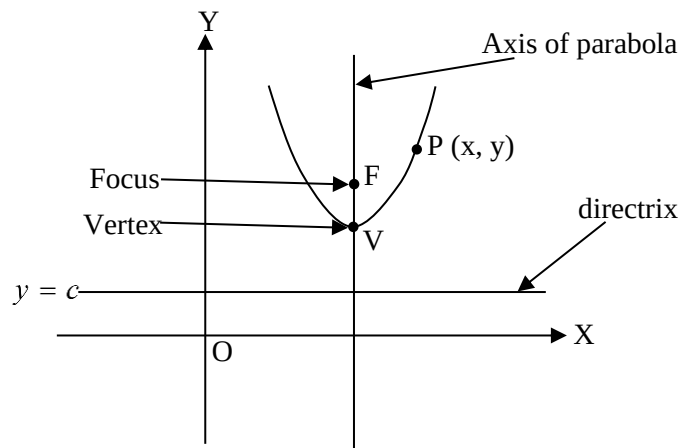


Figure 7

2. Equation of parabola

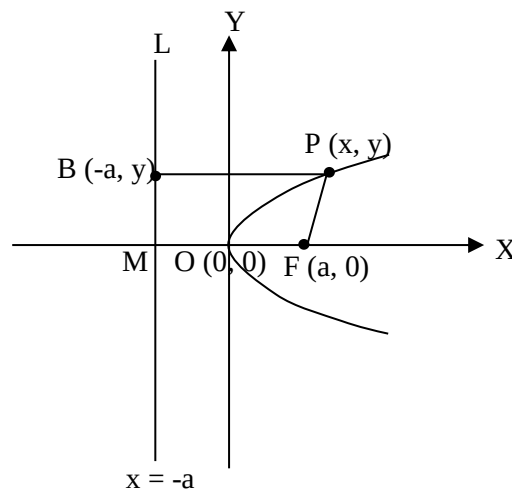


Figure 8

Let $P(x, y)$ lies on a parabola with a vertex $O(0,0)$ and its focus $F(a,0)$ and the directrix of this parabola $x = -a$. Any point of $P(x, y)$ is perpendicular to B on a directrix LM and then the coordinates of the point B is $B(-a, y)$.

By using the definition of parabola and distance formula are

$$PF = PB$$

$$\sqrt{(x-a)^2 + y^2} = \sqrt{(x+a)^2} \quad (1)$$

$$\text{So, } y^2 = 4ax \quad (2)$$

Now we consider the converse situation. If $P(x, y)$ is satisfying $y^2 = 4ax$, then $PF = PB$. So, we can conclude that the point $P(x, y)$ satisfying equation (2) lies on the parabola. Also, equation (1) and (2) prove the equation to the parabola with the vertex at the origin focus at $(a, 0)$ and directrix $x = -a$, is $y^2 = 4ax$.

Depending on symmetric axis the parabola equations can be classified with four types. If symmetric axis is X-axis the equations is $y^2 = 4ax$ and $y^2 = -4ax$. If symmetric axis is Y-axis the equations is $x^2 = 4ay$ and $x^2 = -4ay$.

3. Definition of Ellipse

An ellipse is a closed curve consisting of points whose distance from each of two fixed points (foci) all add up to the same value.

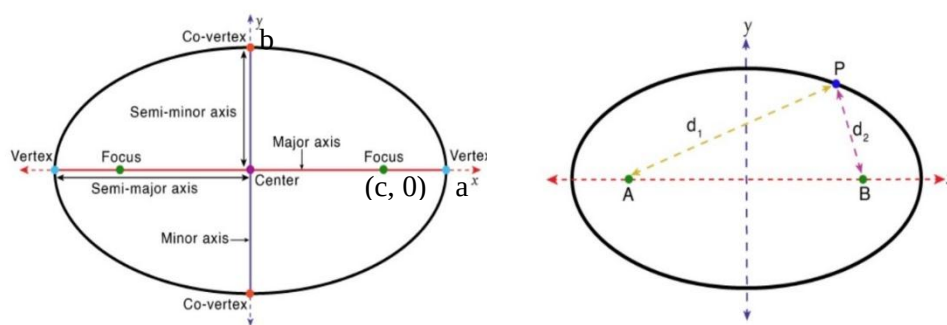


Figure 8

The length of the major axis by ' $2a$ '.

The length of the minor axis by ' $2b$ '.

The distance between the foci by ' $2c$ '.

4. Equation of Ellipse

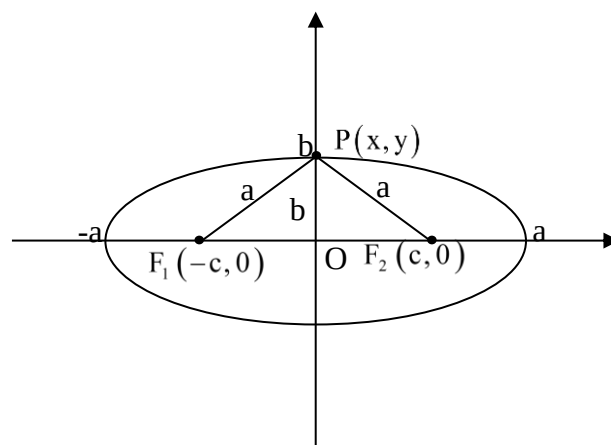


Figure 9

Let a, b be the lengths of semi-major and semi-minor axes.

Therefore, $c = \sqrt{a^2 - b^2}$

By definition of ellipse,

$$PF_1 + PF_2 = 2a$$

$$\sqrt{(x+c)^2 + (y-0)^2} + \sqrt{(x-c)^2 + (y-0)^2} = 2a$$

$$\sqrt{(x+c)^2 + y^2} = 2a - \sqrt{(x-c)^2 + y^2}$$

$$(x+c)^2 + y^2 = 4a^2 - 4a\sqrt{(x-c)^2 + y^2} + (x-c)^2 + y^2$$

$$4a\sqrt{(x-c)^2 + y^2} = 4a^2 + (x-c)^2 - (x+c)^2$$

$$= 4a^2 - 4cx$$

$$a^2((x+c)^2 + y^2) = a^4 - 2a^2cx + c^2x^2$$

$$a^2(x^2 - 2cx + c^2 + y^2) = a^4 - 2a^2cx + c^2x^2$$

$$ax^2 - c^2x^2 + a^2y^2 = a^4 - a^2c^2$$

$$(a^2 - c^2)x^2 + a^2y^2 = a^2(a^2 - c^2)$$

$$b^2x^2 + a^2y^2 = a^2b^2$$

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

Therefore, the equation of ellipse is $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$.

5. Eccentricity of Ellipse

Eccentricity of ellipse is the ratio of the distance from the center of the ellipse to one of the foci and one of the vertices of the ellipse. So, we can calculate the eccentricity of ellipse by $e = \frac{c}{a}$ and its value is between 0 and 1 ($0 < e < 1$). Eccentricity is a measure of how circular an ellipse is. If the eccentricity is near 0, then the ellipse is almost a circle and if the eccentricity is near 1, then the ellipse is almost a line.

6. Reflective properties of parabola and ellipse

The parabola has a very interesting reflexive property. The law of reflection which states that the angle of incidence is equal to the angle of reflection measured from the normal. Also, that the normal is perpendicular to the surface. The reflective property of the parabola has numerous practical applications. Since light is a wave, if a light source is placed at the focus of a **paraboloid**, the result will be a focused beam of light emerging outward along the direction of the axis.

The reflective property of an ellipse is simply; when a ray leaves one of the foci and meets a point on that ellipse, it will reflect off of the ellipse and pass through the other focus. Many real-world situations can be represented by ellipse, including orbits of planets, satellites, moons and comets, and shapes of boat keels, rudders and some airplane wings. A medical device called a '**Lithotripter**' uses elliptical reflectors to break up kidney stones by generating sound waves.

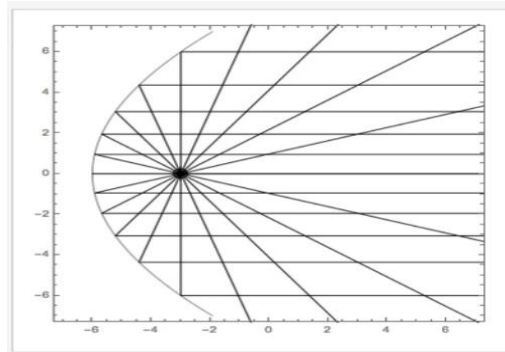


Figure 10

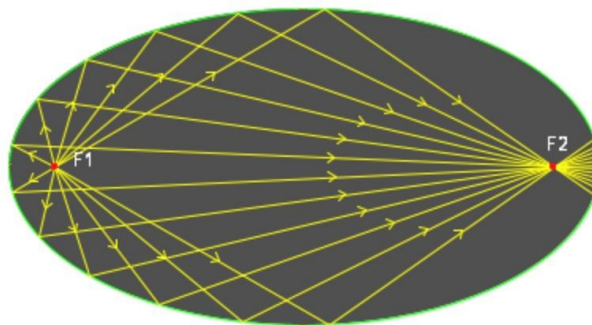


Figure 11

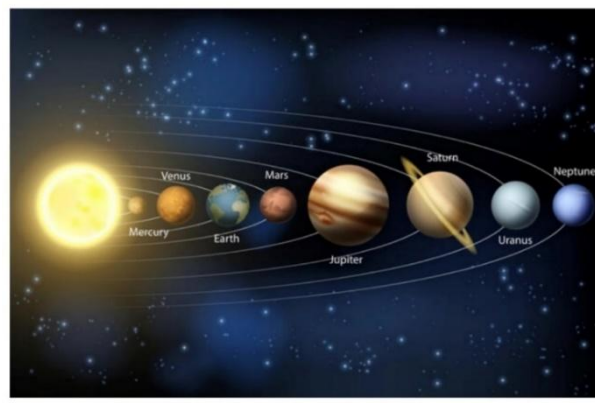


Figure 12

Results and Discussions

Illustrative Examples of Parabola and Ellipse

Example 1 Orbit of Planets

The planets orbit around the sun in an elliptical orbit which is located on one of its foci. So, the orbit of Earth has an eccentricity of about 0.0167 and the orbit of Mars has an eccentricity of about 0.0934. If an eccentricity above 1 it is not really an orbit as it does not loop back, meaning it is not part of our solar system.

Table I: The eccentricity of the planet's orbits

No	Planet	Eccentricity of Planet's Orbit	Remark	Time to Complete an Orbit
1.	Mercury	0.21	Nearest the Sun	88 Days
2.	Venus	0.007		243 Days
3.	Earth	Low 0.0034; Up to 0.058		365.256 Days
4.	Mars	0.0934		687 Days
5.	Jupiter	0.048775		4333 Days
6.	Saturn	0.05555		10756 Days
7.	Uranus	0.0469		30687 Days
8.	Neptune	0.0097	Farthest from the Sun	60182 Days
9.	Pluto	0.25		248 Years

For example, Asteroid 11/2017 U1 namely '**Oumuamua**' was discovered by '**Robert J. Weryk**' on October 19, 2017 by the **NASA-FUNDED PAN-STARRS 1** telescope in Hawaii. From its trajectory and speed, scientists believe it was not inside the solar system but came from outside. It may be about 800 meters or so long and very narrow and skinny in width, only about 40 meters. It is reddish in color which indicates it has been possibly in space for a long time. In '**Hawaiian**' language, '**Oumuamua**' means '**a messenger from afar arriving first**'. On October 14, 2017, it came across within about 0.16AU of the '**Earth**', which is equivalent to about 24 million kilometer (15 million miles). The interstellar asteroid '**Oumuamua**' has an eccentricity of about **1.2** in its path around the Sun, meaning it is not part of the **Solar System**.

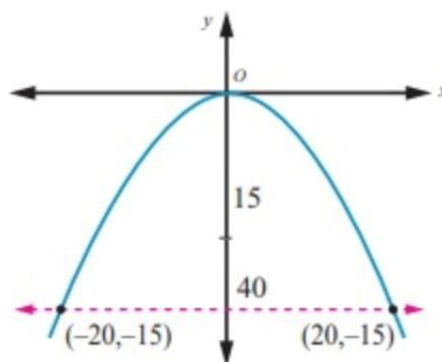


Figure 13

Example 2. A Concrete Bridge with parabola arch

A concrete bridge is designed as a parabola arch. The road over bridge is 40 m long and the maximum height of arch is 15m. Now we will find the equation for the parabola arch.

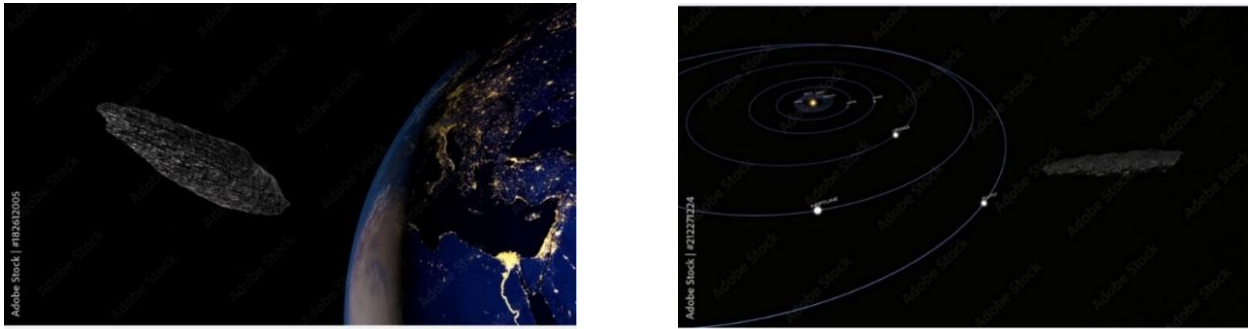


Figure 14

From the graph the vertex is at (0,0) and the parabola is open down.

Equation of parabola is $x^2 = -4ay$

$(-20, -15)$ and $(20, -15)$ lie on the parabola.

$$20^2 = -4a(-15)$$

$$400 = -4a(-15)$$

$$4a = \frac{400}{15} = \frac{80}{3}$$

$$x^2 = -\frac{80}{3}y$$

The required equation for parabola arch is $3x^2 = -80y$.

Example 3. A parabola car headlight

A car headlight has a parabolic reflector. The parabolic bowl is 40cm wide from rim to rim and 30cm deep. The bulb is located at the focus. Now we will find the equation of parabola used for reflector and how far the bulb from the vertex.

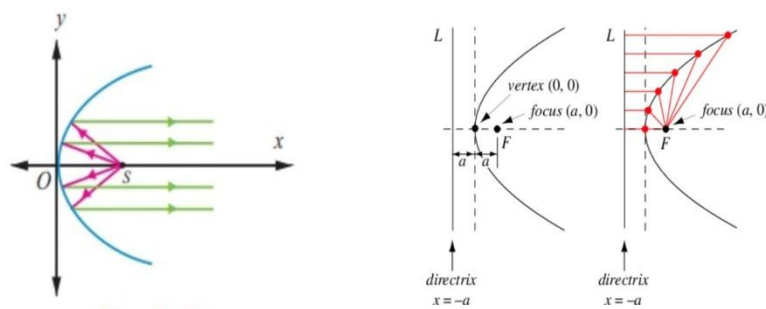


Figure 15

Equation of parabola is $y^2 = 4ax$

Since the diameter is 40cm and the depth is 30cm.

The point $(30, 20)$ lies on the parabola.

$$20^2 = 4a(30)$$

$$4a = \frac{400}{30} = \frac{40}{3}$$

$$a = \frac{10}{3}$$

The required equation for parabola used for reflector is $3y^2 = 40x$ and the bulb is $\frac{10}{3}$ cm far from vertex.

Example 4. Lithotripsy treatment for Kidney Stones

Lithotripsy is a noninvasive procedure used to treat ‘**kidney stones**’ that are too large to pass through the urinary tract. Lithotripsy treats kidney stones by sending focused ultrasonic energy or shock waves directly to the stone. The shock waves break a large stone into smaller stones that will pass through the urinary system. The shock waves, which are generated by a machine called a ‘**Lithotripter**’. In a lithotripter, a high frequency sound wave is emitted from a source that is located at one of the foci. The patient is placed so that the kidney stone is located at the other foci of the ellipse. Now we will find where to the nearest centimeter should the kidney’s stone be placed.

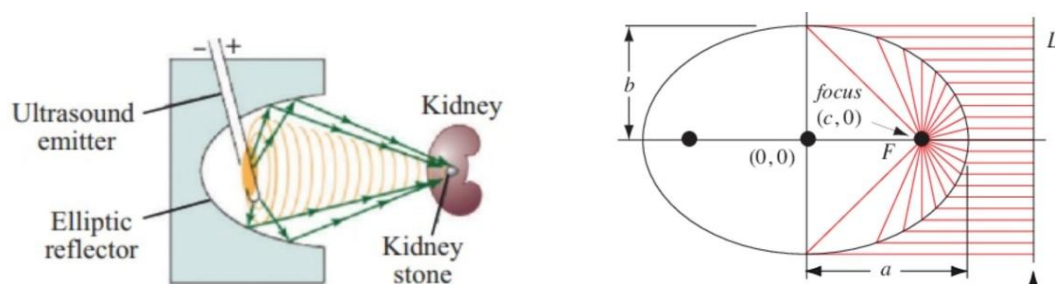


Figure 16

The equation of ellipse is $\frac{(x-11)^2}{484} + \frac{y^2}{64} = 1$.

The origin of the sound wave and the kidney’s stone should be placed at the foci to crush the stones.

$$a^2 = 484 \text{ and } b^2 = 64$$

$$\begin{aligned} c^2 &= a^2 - b^2 \\ &= 484 - 64 \\ &= 420 \end{aligned}$$

$$c \approx 20.5$$

Therefore, the patient’s kidney stone should be placed about 20.5cm from the center of the ellipse.

The advantages of ‘**Lithotripsy**’ is maximizing the breakage of a patient’s kidney stone while minimizing injury that the shock waves can cause to the kidney and surrounding organs.

Conclusion

We have presented very useful results in human society. The properties and equations in mathematics are closely relative to human society and thus very important. The result of this research shows the usefulness and importance of mathematical concept in medical fields and other fields.

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SOLVING SOME INTEGRAL EQUATIONS BY USING SERIES SOLUTION METHOD

Khin Ma Ma Moe¹

Abstract

In this paper, firstly, the basic concept of the series solution method is described. Then, its usages are indicated. After that, the definitions of the analytic function and the power series are stated. Furthermore, the series solutions of the second order homogeneous and non-homogeneous ordinary differential equations are worked out for some examples. Moreover, the definition of the integral equation is denoted, and also, classified the integral equations, and continuing described them. And then, these equations are solved with some examples. Finally, Volterra-Fredholm integral equation is described as well as solved by using the series solution method.

Key words: Analytic function, power series, series solution, Taylor series

Introduction

The series solution method is used for solving different types of equations, such as Volterra integral equations, Fredholm integral equations, Volterra-Fredholm integral equations, Volterra integro-differential equations, Fredholm integro-differential equations, Volterra-Fredholm integro-differential equations, the mixed Volterra-Fredholm integral equations and the mixed Volterra-Fredholm integro-differential equations, etc.

Among them, Volterra integral equations, Fredholm integral equations, and Volterra-Fredholm integral equations are solved by using the series solution method in this paper.

The rest of this paper is organized as follows: the basic concept of the series solution method is expressed, and finding the series solutions of ordinary differential equations; the definition of the integral equation is stated, and classify the integral equations. Continuing, Volterra linear integral equations, Fredholm linear integral equations, and Volterra-Fredholm linear integral equations are described; Volterra linear integral equations, Fredholm linear integral equations and Volterra-Fredholm linear integral equations are solved with some examples by using the series solution method.

1 Analytic Function

A real function $u(x)$ is called **analytic** if it has derivatives of all orders such that the Taylor series at any point x_0 in its domain

$$u(x) = \sum_{n=0}^{\infty} \frac{f^{(n)}(x_0)}{n!} (x - x_0)^n \quad (1)$$

converges to $f(x)$ in a neighborhood of x_0 . For simplicity, the generic form of Taylor series at $x_0 = 0$ can be written as

$$u(x) = \sum_{n=0}^{\infty} a_n x^n. \quad (2)$$

2. Power Series

The real **power series** of the form

$$\sum_{n=0}^{\infty} a_n (x - x_0)^n, \quad (3)$$

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where x is real and, x_0 and all a_n are real constants. We shall deal in the most part with the case $x_0 = 0$ for simplicity of exposition, with the case of power series

$$\sum_{n=0}^{\infty} a_n x^n \quad (4)$$

about $x_0 = 0$.

Materials and Method

1 Basic Concept of Series Solution Method

The series solution method can be used to determine the series solution of the differential equations of any order, with constant coefficients or with variable coefficients, with x is an ordinary point. If such a closed form solution exists, the obtained series solution may converge the exact solution. A truncated number of terms of the obtained series may be used for numerical purposes if an exact solution is not obtainable.

The series solution method assumes that the solution near an ordinary point $x = 0$ is given by

$$u(x) = \sum_{n=0}^{\infty} a_n x^n, \quad (5)$$

or by using few terms of the series

$$u(x) = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + a_4 x^4 + a_5 x^5 + a_6 x^6 + \dots \quad (6)$$

Differentiating term by term gives

$$\left. \begin{aligned} u'(x) &= a_1 + 2a_2 x + 3a_3 x^2 + 4a_4 x^3 + 5a_5 x^4 + 6a_6 x^5 + \dots, \\ u''(x) &= 2a_2 + 6a_3 x + 12a_4 x^2 + 20a_5 x^3 + 30a_6 x^4 + \dots, \\ u'''(x) &= 6a_3 + 24a_4 x + 60a_5 x^2 + 120a_6 x^3 + \dots, \end{aligned} \right\} \quad (7)$$

and so on.

Substituting $u(x)$ and its derivatives in the given differential equation, and equating coefficients of like powers of x gives a recurrence relation that can be solved to determine the coefficients a_n , $n \geq 0$. Substituting the obtained values of a_n , $n \geq 0$ in the series assumption (5) gives the series solution. That series may converge to the exact solution. Otherwise, the obtained series can be used to any finite number of terms by truncating for numerical calculations. The more terms we use will enhance the level of accuracy of the numerical approximation.

The series solution method can be used for homogeneous and nonhomogeneous equations as well when $x = 0$ is an ordinary point. However, if $x = 0$ is a regular singular point of an ordinary differential equation, then a solution can be obtained by the Frobenius method (see reference). Furthermore, the Taylor series of any elementary function involved in the differential equation should be used for equating the coefficients.

2 Solving Ordinary Differential Equations

Although the series solution can be used for equations with constant coefficients or with variable coefficients, where $x = 0$ is an ordinary point, but this method is commonly used for ordinary differential equations (ODE) with variable coefficients where $x = 0$ is an ordinary point.

The series solution method will be illustrated by examining the following ordinary differential equations where $x = 0$ is an ordinary point. Some examples will give exact solutions and others will provide series solutions that can be used for numerical purposes.

3 Integral Equation

An equation in which the unknown function $u(x)$ appears under an integral sign is called an **integral equation**. A standard integral equation form in $u(x)$ is

$$u(x) = f(x) + \lambda \int_{g(x)}^{h(x)} K(x, t) u(t) dt, \quad (8)$$

where $g(x)$ and $h(x)$, the limits of integration, which may be both variables, constants, or mixed; and λ is a constant parameter; and $K(x, t)$ is called the kernel or the nucleus of the integral equation, which is a function of two variables x and t .

4 Classification of Integral Equations

Integral equations appear in many forms. The most frequently used linear integral equations may be classified into two distinct ways that depend on the limits of integration are used to characterize integral equations, namely as Fredholm and Volterra integral equations.

5 Volterra linear integral equations

The standard form of **Volterra linear integral equations**, where the limits of integration are functions of x rather than constants, are of the form

$$\phi(x)u(x) = f(x) + \lambda \int_a^x K(x, t) u(t) dt, \quad (9)$$

where the unknown function $u(x)$ under the integral sign occurs linearly. It is worth noting that (9) can be viewed as a special case of Fredholm integral equation when the kernel $K(x, t)$ vanishes for $t > x$, x is in the range of integration $[a, b]$.

Depending on the value of $\phi(x)$, Volterra integral equations fall under two kinds, namely:

(i) When $\phi(x) = 0$, (9) becomes

$$f(x) + \lambda \int_a^x K(x, t) u(t) dt = 0, \quad (10)$$

and this integral equation is called **Volterra integral equation of the first kind**.

(ii) When $\phi(x) = 1$, (9) becomes

$$u(x) = f(x) + \lambda \int_a^x K(x, t) u(t) dt, \quad (11)$$

and in this case the integral equation is called **Volterra integral equation of the second kind**.

In summary, if the unknown function $u(x)$ appears only under the integral sign, the Volterra integral equation is of the first kinds. However, if the unknown function $u(x)$ appears inside and outside the integral sign, the Volterra integral equation is of the second kind.

6 Fredholm linear integral equations

The standard form of **Fredholm linear integral equations** is given by the form

$$\phi(x)u(x) = f(x) + \lambda \int_a^b K(x,t)u(t)dt, \quad a \leq x, t \leq b, \quad (12)$$

where the limits of integration a and b are constants, and λ is a parameter. The kernel of the integral equation $K(x,t)$ and the function $f(x)$ are given in advance. The equation (12) is called **linear** because the unknown function $u(x)$ under the integral sign occurs linearly, i.e., the power of $u(x)$ is one.

The value of $\phi(x)$ will give the following kinds of Fredholm linear integral equations:

(i) When $\phi(x) = 0$, (12) becomes

$$f(x) + \lambda \int_a^b K(x,t)u(t)dt = 0, \quad (13)$$

and the integral equation is called **Fredholm integral equation of the first kind**.

(ii) When $\phi(x) = 1$, (12) becomes

$$u(x) = f(x) + \lambda \int_a^b K(x,t)u(t)dt, \quad (14)$$

and this integral equation is called **the second kind Fredholm integral equation**. In fact, that the equation (10) can be obtained from (12) by dividing both sides of (12) by $\phi(x)$ provided that $\phi(x) \neq 0$.

In summary, if the unknown function $u(x)$ appears only under the integral sign, the Fredholm integral equation is of the first kinds. However, if the unknown function $u(x)$ appears inside and outside the integral sign, the Fredholm integral equation is of the second kind.

7 Homogeneous integral equations

In all Volterra or Fredholm integral equations stated before, if $f(x)$ is identically zero, the resulting equation:

$$u(x) = \lambda \int_a^x K(x,t)u(t)dt \quad (15)$$

or

$$u(x) = \lambda \int_a^b K(x,t)u(t)dt \quad (16)$$

is called the **homogeneous Volterra integral equation** or **homogeneous Fredholm integral equation**, respectively.

8 Solving Volterra integral equations

We will assume that the solution $u(x)$ of (11) is analytic, and therefore possesses a Taylor series of the form given in

$$u(x) = \sum_{n=0}^{\infty} a_n x^n, \quad (17)$$

where the coefficients a_n will be determined recurrently. Substituting (17) into both sides of (11), we get

$$\sum_{n=0}^{\infty} a_n x^n = T(f(x)) + \lambda \int_0^x K(x, t) \left(\sum_{n=0}^{\infty} a_n t^n \right) dt, \quad (18)$$

or for simplicity we use

$$a_0 + a_1 x + a_2 x^2 + \dots = T(f(x)) + \lambda \int_0^x K(x, t) (a_0 + a_1 t + a_2 t^2 + \dots) dt, \quad (19)$$

where $T(f(x))$ is the Taylor series for $f(x)$. We are seeking series solution, then if $f(x)$ includes elementary functions such as trigonometric functions, exponential functions, etc., then Taylor expansions of functions involved in $f(x)$ should be used.

Firstly, the right side of the integral in (18) or (19) are integrated, and the coefficients of like powers of x are collected. Then, a recurrence relation in a_j , $j \geq 0$ is obtained by equating the coefficients of like powers of x in both sides of the resulting equation.

The recurrence relations are solved to get a complete determination of the coefficients a_j , $j \geq 0$. The coefficients a_j , $j \geq 0$ are determined, and substituted into (17), then the series solution follows immediately. If an exact solution exists, the exact solution may be obtained. If an exact solution is not obtainable, the obtained series can be used for numerical purposes. In this case, the more terms are evaluated, the higher accuracy level is achieved.

9 Solving Fredholm integral equations

The series solution method that stems mainly from the Taylor series for analytic functions will be used to solve Fredholm integral equations. The solution $u(x)$ of the Fredholm integral equations of the second kind will be assumed as

$$u(x) = f(x) + \lambda \int_a^b K(x, t) u(t) dt \quad (20)$$

is analytic, and thus a Taylor series of the form given (5) is possessed, where the coefficients a_n will be determined recurrently.

Using the series solution method for solving Fredholm integral equations gives exact solutions if the solution $u(x)$ is a polynomial. However, the series solution method gives the exact solution after rounding few of the coefficients a_j , $j \geq 0$, if the solution is any other elementary function such as $\sin x$, e^x , etc. Calculating processes are almost identically as the Volterra integral equations.

10 Volterra-Fredholm Integral Equations

The Volterra-Fredholm integral equations arise from parabolic boundary value problems, from the mathematical modelling of the spatiotemporal development of an epidemic, and from various physical and biological models. The Volterra-Fredholm integral equations can be seen in two forms, namely

$$u(x) = f(x) + \lambda_1 \int_0^x K_1(x, t) u(t) dt + \lambda_2 \int_a^b K_2(x, t) u(t) dt, \quad (21)$$

and the mixed form

$$u(x) = f(x) + \lambda \int_0^x \int_a^b K(r, t) u(t) dt dr, \quad (22)$$

where $f(x)$ and $K(x, t)$ are analytic functions.

It is noted that (21) contains disjoint Volterra and Fredholm integrals, whereas (22) contains mixed Volterra and Fredholm integrals. Moreover, a characteristic feature of a second kind integral equation is the unknown function $u(x)$ appears inside and outside the integral signs. The resulting equations are of first kind, if the unknown functions appear only inside the integral signs.

Results and Discussions

1 Example. Consider the second order homogeneous ODE

$$u'' + xu' + u = 0, \quad (23)$$

to find a series solution.

Substituting the series assumption for $u(x)$, $u'(x)$ and $u''(x)$ gives

$$\begin{aligned} & 2a_2 + 6a_3x + 12a_4x^2 + 20a_5x^3 + 30a_6x^4 + 42a_7x^5 + \dots \\ & + x(a_1 + 2a_2x + 3a_3x^2 + 4a_4x^3 + 5a_5x^4 + 6a_6x^5 + \dots) \\ & + a_0 + a_1x + a_2x^2 + a_3x^3 + a_4x^4 + a_5x^5 + \dots = 0, \end{aligned}$$

that can be rewritten by

$$\begin{aligned} & (a_0 + 2a_2) + (2a_1 + 6a_3)x + (3a_2 + 12a_4)x^2 + (4a_3 + 20a_5)x^3 \\ & + (5a_4 + 30a_6)x^4 + (6a_5 + 42a_7)x^5 + \dots = 0. \end{aligned}$$

This equation is satisfied only if the coefficient of each power of x be zero. This gives the recurrence relation

$$\begin{aligned} & a_0 + 2a_2 = 0, \quad 2a_1 + 6a_3 = 0, \quad 3a_2 + 12a_4 = 0, \\ & 4a_3 + 20a_5 = 0, \quad 5a_4 + 30a_6 = 0, \quad 6a_5 + 42a_7 = 0, \dots \end{aligned}$$

where by solving this recurrence relation, we obtain

$$\begin{aligned} & a_2 = -\frac{1}{2}a_0, \quad a_3 = -\frac{1}{3}a_1, \quad a_4 = \frac{1}{8}a_0, \\ & a_5 = \frac{1}{15}a_1, \quad a_6 = -\frac{1}{48}a_0, \quad a_7 = -\frac{1}{105}a_1, \dots \end{aligned}$$

The solution in a series form is

$$u(x) = a_0 \left(1 - \frac{1}{2}x^2 + \frac{1}{8}x^4 - \frac{1}{48}x^6 + \dots \right) + a_1 \left(x - \frac{1}{3}x^3 + \frac{1}{15}x^5 - \frac{1}{105}x^7 + \dots \right),$$

where a_0 and a_1 are constants, where $a_0 = u(0)$ and $a_1 = u'(0)$.

2 Example. Consider the second order nonhomogeneous ODE

$$u'' - xu' + u = -x \cos x, \quad (24)$$

to find a series solution.

Substituting the series assumption for $u(x)$, $u'(x)$, and $u''(x)$, and using the Taylor series for $\cos x$, we get

$$\begin{aligned}
& (a_0 + 2a_2) + 6a_3x + (-a_2 + 12a_4)x^2 + (-2a_3 + 20a_5)x^3 \\
& + (-3a_4 + 30a_6)x^4 + (-4a_5 + 42a_7)x^5 + \dots \\
& = -x + \frac{1}{2!}x^3 - \frac{1}{4!}x^5 + \frac{1}{6!}x^7 - \dots
\end{aligned}$$

Equating the coefficient of each power of x be zero and solving the recurrence relation, we obtain

$$\begin{aligned}
a_2 &= -\frac{1}{2}a_0, & a_3 &= -\frac{1}{6} = -\frac{1}{3!}, \\
a_4 &= \frac{1}{12}a_2 = -\frac{1}{24}a_0, & a_5 &= \frac{1}{10}a_3 + \frac{1}{40} = \frac{1}{120} = \frac{1}{5!}, \\
a_6 &= \frac{1}{10}a_4 = -\frac{1}{240}a_0, & a_7 &= \frac{2}{21}a_5 - \frac{1}{1008} = -\frac{1}{5040} = -\frac{1}{7!}, \dots
\end{aligned}$$

The solution in a series form is

$$u(x) = a_0 \left(1 - \frac{1}{2}x^2 - \frac{1}{24}x^4 - \frac{1}{240}x^6 + \dots \right) + a_1x + \left(-\frac{1}{3!}x^3 + \frac{1}{5!}x^5 - \frac{1}{7!}x^7 + \dots \right),$$

that can be rewritten as

$$u(x) = a_0 \left(1 - \frac{1}{2}x^2 - \frac{1}{24}x^4 - \frac{1}{240}x^6 + \dots \right) + Bx + \left(x - \frac{1}{3!}x^3 + \frac{1}{5!}x^5 - \frac{1}{7!}x^7 + \dots \right),$$

by setting $B = a_1 - 1$. Consequently, the solution is

$$u(x) = a_0 \left(1 - \frac{1}{2}x^2 - \frac{1}{24}x^4 - \frac{1}{240}x^6 + \dots \right) + Bx + \sin x.$$

Notice that $\sin x$ gives the particular solution that arises as an effect of the inhomogeneous part.

3 Example. Consider the Volterra integral equation of the first kind

$$\sin x - x \cos x = \int_0^x t u(t) dt, \quad (25)$$

by using the series solution method.

We will use only few terms of the Taylor series for $\sin x - x \cos x$ and for the solution $u(x)$, we get

$$x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \dots - x \left(1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \dots \right) = \int_0^x t (a_0 + a_1t + a_2t^2 + a_3t^3 + \dots) dt,$$

or equivalently

$$\frac{1}{3}x^3 - \frac{1}{30}x^5 + \frac{1}{840}x^7 + \dots = \int_0^x t (a_0 + a_1t + a_2t^2 + a_3t^3 + \dots) dt.$$

Integrating the right side, we obtain

$$\frac{1}{3}x^3 - \frac{1}{30}x^5 + \frac{1}{840}x^7 + \dots = \frac{1}{2}a_0x^2 + \frac{1}{3}a_1x^3 + \frac{1}{4}a_2x^4 + \frac{1}{5}a_3x^5 + \frac{1}{6}a_4x^6 + \frac{1}{7}a_5x^7 + \dots$$

Equating the coefficients of like powers of x yields

$$\begin{aligned}
a_0 &= 0, & a_1 &= 1, & a_2 &= 0, \\
a_3 &= -\frac{1}{6} = -\frac{1}{3!}, & a_4 &= 0, & a_5 &= \frac{1}{120} = \frac{1}{5!}, \dots
\end{aligned}$$

The solution in a series form is

$$u(x) = x - \frac{1}{3!}x^3 + \frac{1}{5!}x^5 - \frac{1}{7!}x^7 + \dots,$$

that converges to the exact solution

$$u(x) = \sin x.$$

4 Example. Consider the Volterra integral equation of the second kind

$$u(x) = x^2 - \frac{1}{2}x^3 + x^3 \ln(1+x) - \int_0^x 2xu(t) dt, \quad (26)$$

by using the series solution method.

We will use few terms of the Taylor series for $\ln(1+x)$ and for the solution $u(x)$ in (26), we get

$$\begin{aligned} a_0 + a_1x + a_2x^2 + a_3x^3 + a_4x^4 + \dots &= x^2 - \frac{1}{2}x^3 + x^3 \left(x - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4} + \dots \right) \\ &\quad - \int_0^x 2x(a_0 + a_1t + a_2t^2 + a_3t^3 + a_4t^4 + \dots) dt. \end{aligned}$$

Integrating the right side, and collecting the like terms of x , we obtain

$$\begin{aligned} &a_0 + a_1x + a_2x^2 + a_3x^3 + a_4x^4 + \dots \\ &= (1 - 2a_0)x^2 + \left(-\frac{1}{2} - a_1\right)x^3 + \left(1 - \frac{2}{3}a_2\right)x^4 + \left(-\frac{1}{2} - \frac{1}{2}a_3\right)x^5 + \dots \end{aligned}$$

Equating the coefficients of like powers of x yields

$$a_0 = 0, \quad a_1 = 0, \quad a_2 = 1 - 2a_0 = 1, \quad a_3 = -\frac{1}{2} - a_1 = -\frac{1}{2}, \quad a_4 = 1 - \frac{2}{3}a_2 = \frac{1}{3}, \quad \dots$$

The solution in a series form is

$$u(x) = x^2 - \frac{1}{2}x^3 + \frac{1}{3}x^4 - \frac{1}{4}x^5 + \dots,$$

that can be rewritten as

$$u(x) = x \left(x - \frac{1}{2}x^2 + \frac{1}{3}x^3 - \frac{1}{4}x^4 + \dots \right),$$

that converges to the exact solution

$$u(x) = x \ln(1+x).$$

5 Example. Consider the Fredholm integral equation

$$u(x) = -x^4 + \int_{-1}^1 (xt^2 - x^2t) u(t) dt, \quad (27)$$

by using the series solution method.

Substituting $u(x)$ into both sides of (27) leads to

$$\begin{aligned} \sum_{n=0}^{\infty} a_n x^n &= -x^4 + \int_{-1}^1 \left((xt^2 - x^2t) \sum_{n=0}^{\infty} (a_n t^n) \right) dt, \\ &a_0 + a_1x + a_2x^2 + a_3x^3 + a_4x^4 + a_5x^5 + a_6x^6 + \dots \\ &= -x^4 + \int_{-1}^1 \left((xt^2 - x^2t)(a_0 + a_1t + a_2t^2 + a_3t^3 + a_4t^4 + a_5t^5 + a_6t^6 + \dots) \right) dt. \end{aligned}$$

Evaluating the integral at the right side, we obtain

$$\begin{aligned} & a_0 + a_1x + a_2x^2 + a_3x^3 + a_4x^4 + a_5x^5 + a_6x^6 + \dots \\ &= \left(\frac{2}{3}a_0 + \frac{2}{5}a_2 + \frac{2}{7}a_4 + \frac{2}{9}a_6 + \dots \right)x + \left(-\frac{2}{3}a_1 - \frac{2}{5}a_3 - \frac{2}{7}a_5 + \dots \right)x^2 - x^4, \end{aligned}$$

and equating the coefficients of like powers of x in both sides of the resulting equation, we obtain

$$\begin{aligned} a_0 &= 0, & a_1 &= \frac{2}{5}a_2 - \frac{2}{7} = -\frac{30}{133}, & a_2 &= -\frac{2}{3}a_1 = \frac{20}{133}, \\ a_3 &= 0, & a_4 &= -1, & a_n &= 0, \quad n \geq 5. \end{aligned}$$

Consequently, the exact solution is

$$u(x) = -\frac{30}{133}x + \frac{20}{133}x^2 - x^4.$$

6 Example. Consider the Volterra-Fredholm integral equation

$$u(x) = e^x - xe^x + x - 1 + \int_0^x xu(t)dt + \int_0^1 tu(t)dt, \quad (28)$$

by using the series solution method.

Using the Taylor polynomial for e^x and substituting $u(x)$ by the Taylor polynomial into both sides of (28) leads to

$$\begin{aligned} \sum_{n=0}^{\infty} a_n x^n &= e^x - xe^x + x - 1 + \int_0^x \left(x \sum_{n=0}^{\infty} a_n t^n \right) dt + \int_0^1 \left(t \sum_{n=0}^{\infty} a_n t^n \right) dt, \\ a_0 + a_1x + a_2x^2 + a_3x^3 + \dots &= \left(1 + x + \frac{1}{2!}x^2 + \frac{1}{3!}x^3 + \frac{1}{4!}x^4 + \dots \right) \\ &\quad - x \left(1 + x + \frac{1}{2!}x^2 + \frac{1}{3!}x^3 + \frac{1}{4!}x^4 + \dots \right) + x - 1 \\ &\quad + \int_0^x \left(x(a_0 + a_1t + a_2t^2 + a_3t^3 + a_4t^4 + \dots) \right) dt \\ &\quad + \int_0^1 \left(t(a_0 + a_1t + a_2t^2 + a_3t^3 + a_4t^4 + \dots) \right) dt. \end{aligned} \quad (29)$$

Evaluating the integrals at the right side, using few terms from both sides of (29), we get

$$\begin{aligned} a_0 + a_1x + a_2x^2 + a_3x^3 + \dots &= 1 + x + \frac{1}{2!}x^2 + \frac{1}{3!}x^3 + \frac{1}{4!}x^4 + \dots \\ &\quad - x - x^2 - \frac{1}{2!}x^3 - \frac{1}{3!}x^4 - \frac{1}{4!}x^5 - \dots + x - 1 \\ &\quad + x \left(a_0x + \frac{1}{2}a_1x^2 + \frac{1}{3}a_2x^3 + \frac{1}{4}a_3x^4 + \frac{1}{5}a_4x^5 + \dots \right) \\ &\quad + \frac{1}{2}a_0 + \frac{1}{3}a_1 + \frac{1}{4}a_2 + \frac{1}{5}a_3 + \frac{1}{6}a_4 + \dots, \end{aligned}$$

and collecting the coefficients of like powers of x , we get

$$\begin{aligned}
a_0 + a_1x + a_2x^2 + a_3x^3 + a_4x^4 + \dots &= \frac{1}{2}a_0 + \frac{1}{3}a_1 + \frac{1}{4}a_2 + \frac{1}{5}a_3 + \frac{1}{6}a_4 + \dots \\
&+ x + \left(\frac{1}{2!} - 1 + a_0\right)x^2 + \left(\frac{1}{3!} - \frac{1}{2!} + \frac{1}{2}a_1\right)x^3 \\
&+ \left(\frac{1}{4!} - \frac{1}{3!} + \frac{1}{3}a_2\right)x^4 + \left(\frac{1}{5!} - \frac{1}{4!} + \frac{1}{4}a_3\right)x^5 + \dots
\end{aligned}$$

Equating the coefficients of like powers of x in both sides, and solving the resulting system of equations, we obtain

$$a_0 = 1, \quad a_1 = 1, \quad a_2 = \frac{1}{2!}, \quad a_3 = \frac{1}{3!}, \quad a_4 = \frac{1}{4!}, \quad a_5 = \frac{1}{5!}.$$

The solution in a series form is

$$u(x) = 1 + x + \frac{1}{2!}x^2 + \frac{1}{3!}x^3 + \frac{1}{4!}x^4 + \frac{1}{5!}x^5 + \dots$$

We obtain the exact solution

$$u(x) = e^x.$$

7 Example. Consider the Volterra-Fredholm integral equation

$$u(x) = 2 - x - x^2 - 6x^3 + x^5 + \int_0^x tu(t)dt + \int_{-1}^1 (x+t)u(t)dt, \quad (30)$$

by using the series solution method.

Substituting $u(x)$ by the series

$$u(x) = \sum_{n=0}^{\infty} a_n x^n,$$

into both sides of (30) leads to

$$\sum_{n=0}^{\infty} a_n x^n = 2 - x - x^2 - 6x^3 + x^5 + \int_0^x \left(t \sum_{n=0}^{\infty} a_n t^n \right) dt + \int_{-1}^1 \left((x+t) \sum_{n=0}^{\infty} a_n t^n \right) dt,$$

that can be rewritten as

$$\begin{aligned}
a_0 + a_1x + a_2x^2 + a_3x^3 + a_4x^4 + \dots &= 2 - x - x^2 - 6x^3 + x^5 \\
&+ \int_0^x \left(t(a_0 + a_1t + a_2t^2 + a_3t^3 + \dots) \right) dt \\
&+ \int_{-1}^1 \left((x+t)(a_0 + a_1t + a_2t^2 + a_3t^3 + \dots) \right) dt.
\end{aligned}$$

Evaluating the integrals at the right side, using few terms from both sides,

$$\begin{aligned}
a_0 + a_1x + a_2x^2 + a_3x^3 + a_4x^4 + \dots &= 2 - x - x^2 - 6x^3 + x^5 \\
&+ \frac{1}{2}a_0x^2 + \frac{1}{3}a_1x^3 + \frac{1}{4}a_2x^4 + \frac{1}{5}a_3x^5 + \dots \\
&+ \left(2a_0 + \frac{2}{3}a_2 + \frac{2}{5}a_4 + \dots \right) x \\
&+ \frac{2}{3}a_1 + \frac{2}{5}a_3 + \frac{2}{7}a_5 + \dots,
\end{aligned}$$

and collecting the coefficients of like powers of x , we get

$$\begin{aligned}
& a_0 + a_1x + a_2x^2 + a_3x^3 + a_4x^4 + \dots \\
& = 2 + \frac{2}{3}a_1 + \frac{2}{5}a_3 \\
& \quad + \left(-1 + 2a_0 + \frac{2}{3}a_2 + \frac{2}{5}a_4\right)x \\
& \quad + \left(-1 + \frac{1}{2}a_0\right)x^2 + \left(-6 + \frac{1}{3}a_1\right)x^3 + \frac{1}{4}a_2x^4 + \left(1 + \frac{1}{5}a_3\right)x^5 + \dots.
\end{aligned} \tag{31}$$

Equating the coefficients of like powers of x in both sides of (31), and solving the resulting system of equations, we obtain

$$a_0 = 2, \quad a_1 = 3, \quad a_2 = 0, \quad a_3 = -5, \quad a_4 = a_5 = \dots = 0.$$

The exact solution is

$$u(x) = 2 + 3x - 5x^3.$$

Conclusion

In this paper, the differential equations are solved based on the Taylor series expansion, and its properties are used for finding the series solution of different types of linear integral equations. By doing so, it allows us to overcome the difficulty caused by integrals. Furthermore, it has more precise and rapidly converge solution to the exact form. Some examples are considered to show the accuracy and efficiency of the series solution method in this paper.

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EFFECT OF DIFFERENT DIETS ON THE GROWTH AND SURVIVAL RATE OF SWORDTAIL, *XIPHOPHORUS HELLERI* HECKEL, 1848

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Abstract

The study period lasted from April 2022 to March 2023. Eight months of feeding experiment was conducted to ornamental fish; *Xiphophorus helleri* fry fed with three types of diet. Diet D1 was ready - made pellet (Tokyu) as a control experiment. Diet D2 was Artemia and the diet D3 was Bloodworm. Ten fries were stocked in each aquarium (60 x 30 x 30 cm³) and fed two times a day (10:00 and 16:00 h). The fry fed with diet D2 showed a significantly ($p < 0.01$) the highest body weight (2.85 ± 0.96 g) than those fed with diet D1 (1.76 ± 0.14 g) and diet D3 (1.15 ± 0.24 g). The length increment of fry fed with diet D2, D1 and D3 were 6.12 ± 0.85 cm 5.22 ± 0.61 cm and 4.53 ± 0.23 cm respectively. The correlation coefficient 'r' was significant in all diets. The final stage of correlation coefficient between length and weight of studied fish fed with different diets were highly significant at $p < 0.05$ level. Higher survival rate was recorded in diet D2 (90%) compared to experimental diets D1 and D3. The FCR value of fry fed with diet D2 (0.06) was better than diet D1 (0.15) and diet D3 (0.31). Fry fed with diet D2 also showed the best Specific Growth Rate (SGR) value (1.41%) followed by diet D1 (0.6%) and diet D3 (0.29%). Diet D2 was better for the growth of the fish and diet D3 was less the effect on the fish growth. Thus, based on the results of growth performance and FCR, the fish meal diet Artemia was an excellent feed for *X. helleri* fry in terms of growth, weight gain, and survival rate.

Key words: Growth and survival rate, Feed Conversion Ratio (FCR), Specific Growth Rate (SGR)

Introduction

Ornamental fishes are attractive colourful fishes of various characteristics, which are kept as pets in the confined space of an aquarium or a garden pool for recreation and economy. Keeping aquarium fish as a hobby gives a peaceful effect for the people. Watching fish swimming in an aquarium is extremely calming and peaceful, especially after a stressful day (Goodwin, 2001).

Swordtail (*Xiphophorus helleri*) is one of the most important ornamental fishes in aquaculture production. It is a live bearing species from the family Poeciliidae. Swordtails get their name from the distinctive sword-like extension on the male's tail fin, which can sometimes grow almost as long as their bodies. It is widely reared in the aquarium and is considered as one of the commercially important ornamental fishes after goldfish due to its aesthetic values, food habit, and reproductive traits (Ghosh *et al.*, 2008). The food habit of swordtail includes omnivorous in nature and feeds on both live and artificial feeds (James and Sampath, 2003).

Fish food consists of natural food and artificial feeds. Fishes have various diets according to their feeding habits. Correct and suitable amount of diet produces healthy, colorful and disease-resistant fish. Healthy fishes are more colorful than unhealthy one. Knowledge of feeding is very essential from the economical point of view (Lovell, 1987).

Artemia is a widely accepted live feed for fish larvae and juveniles but due to its availability and higher price fish breeders are looking forward to alternative options, especially in developing countries (Evangelista *et al.*, 2005). Decapsulation of artemia cysts provides

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numerous benefits, including disinfection, improved hatchability and easy storage. As a feed source, decapsulated cysts have a higher energy and nutritional value than live *Artemia nauplii* (Anonymous. 2022).

Bloodworms are readily accepted as a natural food by 99% of carnivorous fish and are suitable for both freshwater and marine specimens. Bloodworms are the bright red larva of a little midge insect developed in freshwater lakes. Frozen bloodworm is often used by advanced hobbyists and fish breeders as a component of maturation diets. It is less expensive than purchasing live food, it is more nutritious than a freeze-dried bloodworm and is easy to store and prepare (Anonymous. 2022).

To our knowledge, there is no study comparing the effect of feed Artemia, Bloodworm and commercial feeds on the growth performance and survival of swordtail. It was hypothesized that swordtail juveniles fed different dietary treatments would have similar growth performance. The main objective of the present study was to study the nutritional efficacy of three formulated feeds prepared with protein levels on growth rate and feeds conversion ratio. The present study works are conducted with the following objectives;

- to access the content of crude protein, fat, ash and moisture
- to compare the effect of different diets on the growth rate of fish species
- to analyze the survival rate, feed conversion ratio and specific growth rate of studied fish species

Materials and Methods

Study site and study period

The study site is in the Laboratory of Zoology Department, Dawei University. Study period lasts from April 2022 to March 2023 (Plate 1).

Selection of ornamental fishes

Ornamental fish species *Xiphoporus helleri* (Swordtail) was selected from families Poeciliidae. Two – months - old swordtails were used for the experiment. The fishes were collected from the breeding pond of Ko Aung Phyo aquarium shop in Dawei Township.

Duration of experiments

Two experiments for selected fish species were conducted by feeding them with two types of foods and one control food. Each experiment lasted for four months. The first experiment commenced from April 2022 to August 2022 and the second experiment was from September 2022 to January 2023.

Preparation of diets

Three types of diets designated as (D1 to D3) were used in this experiment. Diet D1 was ready made pellet (Tokyu) as a control experiment. Diet D2 was Artemia and the diet D3 was Bloodworm food. Artemia is the newly hatched in size which hatched from canned artemia cyst sold commercially in market. Artemia and frozen bloodworms were taken from Moe Kaung Kin aquarium shop in Yangon Division (Plate 2).

Experimental set up

The experiment was done in two glass aquaria. The dimension of each aquarium was 60 x 30 x 30 cm³. The first experiment was conducted in Aquarium 1 and 2. Each aquarium was stocked with ten fingerlings. Aquarium 1 was given diet D1 and those of Aquarium 2 with diet D2. Prior to stocking, fishes were also weighed and measured individually. Glass aquaria which have been cleaned with salt for nearly two days were used to avoid the presence of toxic substances. During the experiment, every three days, three quarters of water of the aquarium was siphoned out and refilled with tap water if the pH and dissolved oxygen level were in poor condition or when the fishes showed stressful behavior. The excess feed and feces at the bottom aquarium was siphoned out every day. Aquariums were covered with plastic mosquito-net lids to prevent unnecessary disturbance and escape of fishes.

The second experiment was Aquarium 3 and 4. Each aquarium was stocked with ten fingerlings. Fish in Aquarium 3 was fed with diet D1, those in Aquarium 4 with diet D3. All aquaria were maintained the same procedures and monitored as in experiment I. Fish of each tank was fed with 2% of body weight for two times daily in the morning and evening.

Recording of water parameters

The water temperature of aquaria was noted twice a day with the use of common thermometer. The range of water temperature was recorded between 28 - 31°C during the study period.

Water pH was examined once a week using color matching method. In order to maintain stable water conditions, Dissolved Oxygen and pH in each aquarium was monitored by changing the water daily and by using an air pump (Table 1).

Table 1 Water parameters

Parameter	Unit	Tube well	Standard value
pH		7.3	6.5 - 9
Total Alkalinity	mg/l	80	100-250
Total Hardness	mg/l	100	40 - 150
Dissolved Oxygen	mg/l	4.5	>5

Source for standard values; for water (1998) from U.S Environmental Protection Agency (EPA) Quality Criteria

Data recording

The morphometric characteristic i.e. body weight and total length were recorded to observe their growth performance. Standard length and body weight of ornamental fishes of each aquarium were measured to the nearest centimeter and gram. Measurements were taken monthly by using a scaled ruler and a weighing digital balance. The mean standard length and weight were calculated. The amount of consumed feed for each aquarium was subsequently calculated. Dead fish were removed and recorded. The total amount of feed fed the fish was recorded to calculate survival rate, feed conversion ratio (FCR) and specific growth rate (SGR).

Analytical procedure

The composition of protein, fat, moisture and ash in each diet were examined at Analytical Laboratory Section, Department of Fisheries. Water quality was assessed in the Laboratory of Freshwater Aquaculture Research Unit, Department of Fisheries, Thaketa Township, Yangon Region (Table 1).

Comparison among two different diets in each experiment was done by paired sample T- test. The relationships between the length and weight of fishes were calculated by the program of Microsoft Excel 2010 and Pearson Correlation Coefficient Test of SPSS version 22. Growth rate, survival rate, feed conversion ratio (FCR) and specific growth rate (SGR) were calculated as follows.

The fish survival rate was calculated as the number of fishes harvested as percentage of the number of fish stocked.

$$\text{Survival rate} = \frac{\text{final fish number}}{\text{initial fish number}} \times 100 \quad (\text{Booth and Alquezar, 2002})$$

$$\text{Feed conversion ratio FCR} = \frac{P}{(W_k - W_p)}$$

Where P = Amount of food offered (g)

W_k = Final weight of fish in a aquarium (g)

W_p = Initial weight of fish in a aquarium (g) (Sadowski *et al.*, 1998)

$$\text{Specific growth rate SGR} = \frac{W_f - W_i}{T} \times 100 \text{ (Vasagam *et al.*, 2007)}$$

Where W_f = mean final weight
 W_i = mean initial weight
 T = total experiment days

Identification of species

Each species was identified according to Petrovicky` (1989).

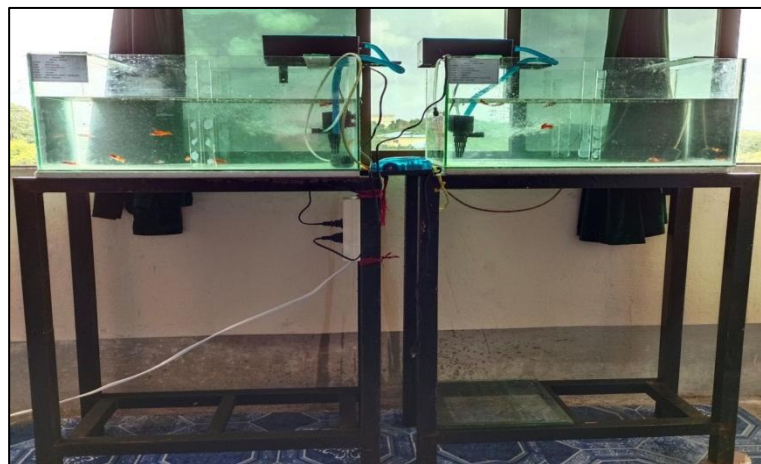


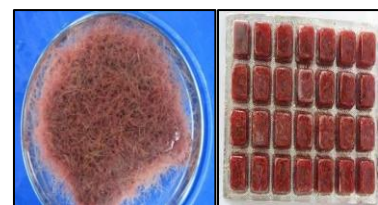
Plate 1 Aquarium in Zoology Department



Tokyu pellet (Diet 1)



Artemia (Diet 2)



Bloodworm (Diet 3)

Plate 2 Different types of food

Results

Systematic position

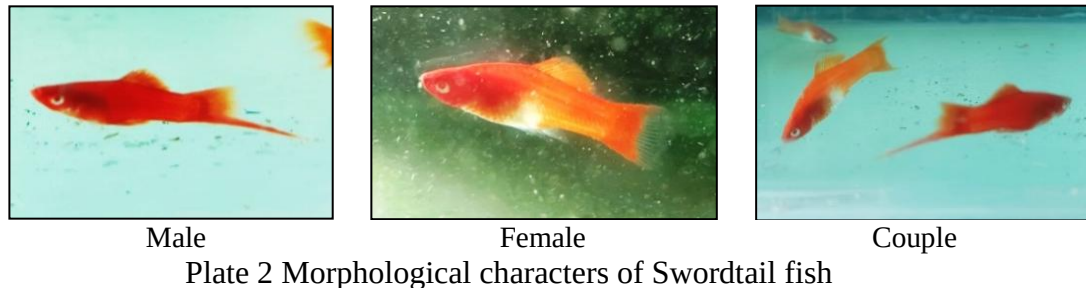
According to Petrovicky` (1989), the systematic position of the studied fish species was

- Phylum - Chordata
- Class - Actinopterygii
- Order - Cyprinodontiformes
- Family - Poeciliidae
- Genus - *Xiphophorus*
- Species - *Xiphophorus helleri* Heckel, 1848
- Common name - Swordtail
- Local name - So - tail

Morphological characters

Swordtail is moderate in size with a sturdy, elongated body. Females are larger, reaching up to 6.3 inches (16 cm) in length while the males are somewhat smaller and slimmer at 5.5

inches (14 cm) and have a "sword" on the caudal fin (tail fin). The swordtail gets its name from the shape of its tail fin. The lower part of the fin sticks out like a sword and often measures up to a third of its total body length. As the male fish matures, the middle rays of its anal fin modify into a narrow copulatory organ called a gonopodium. They reach sexual maturity at around three months old. The females are able to give birth to fry every 28 days. Females produce 50-100 fry on average (Plate 2).



Nutrient values of Artemia and Bloodworm

Nutrient values of Tokyu pellet diet D1 contained crude protein 32%, fat 4%, ash 10%, moisture 9% and Artemia diet D2 contained crude protein 60%, fat 24%, ash 4.4%, moisture 8.5% and in D3 Bloodworm contained crude protein 8.3%, fat 1.2%, ash 1.5%, moisture 81.7% were analyzed (Table 2).

Growth performance of Swordtail fish fed with Diet D1

Initial length and weight of Swordtail fish fed with D1 were 4.25 ± 0.60 cm and 1.04 ± 0.43 g, respectively which increased to 4.74 ± 0.5 cm and 1.29 ± 0.47 g at the end of the first month. Then the length and weight of fish increased regularly to 4.94 ± 0.22 cm and 1.46 ± 0.34 g at the end of the second month and 5.05 ± 0.22 cm and 1.56 ± 0.28 g at the end of the third month and 5.22 ± 0.61 cm and 1.76 ± 0.14 g at the end of the fourth month (Table 3, Fig.1 and 2).

Growth performance of Swordtail fish fed with Diet D2

Initially the size of fish fed with D2 was 4.25 ± 0.46 cm in length and 1.16 ± 0.36 g in weight. After one month of feeding, the mean length and weight of fish was found to be 4.82 ± 0.77 cm and 1.61 ± 0.34 g, respectively. It increased to 5.29 ± 0.85 cm and 1.96 ± 0.82 g at the end of the second month and 5.66 ± 0.94 cm and 2.31 ± 0.99 g at the end of the third month and 6.12 ± 0.85 cm and 2.85 ± 0.80 g at the end of the fourth month (Table 3, Fig. 1 and 2).

Growth performance of Swordtail fish fed with Diet D3

Initially, length and weight of fish fed with D3 was 4.02 ± 0.33 cm and 0.80 ± 0.25 g, respectively. After one month of feeding, the fish grew to 4.1 ± 0.41 cm in length and 0.83 ± 0.27 g in weight. At the end of the second month, it grew to 4.21 ± 0.43 cm in length and 0.99 ± 0.35 g in weight and 4.59 ± 0.27 cm and 1.03 ± 0.22 g at the end of the third month. At the end of the experiment, the fish increased to 4.53 ± 0.23 cm and 1.15 ± 0.33 g (Table 3, Fig.1 and 2).

Growth performance of Swordtail fish fed with three different diets

Growth performance of Swordtail fry fed with selected diets was presented in Fig. 3 and Fig. 4. The weight gain (g) of fish in the all treatment shows positive growth. The fry fed with Artemia showed a significantly ($p < 0.05$). The higher weight gain (1.69 g) than those fed with Tokyu pellet (0.72 g) and Bloodworm (0.35 g). The length gain of fry fed with Artemia, Tokyu pellet and Bloodworm was 1.87 cm, 0.97 cm, and 0.51 cm respectively.

Comparison of the effect of the three diets on the growth of fish

The length and weight of fish at the beginning of the experiment were not significantly different with diet D1 and diet D2 ($p > 0.05$). Similar results were observed between diet D1 and diet D3 ($p > 0.05$). The length of fish different between diet D2 and diet D3 was not

significant ($p>0.05$) and the weight was significantly different ($p<0.05$) (Table 4). At the end of the experiment, the difference between growth of fish fed with diet D1 and diet D2 was significant ($p<0.05$). The difference between the length of fish fed with diet D1 and diet D3 was significant ($p<0.05$) and the weight was significant ($p<0.01$). However, those were significantly different between diet D2 and diet D3 ($p<0.01$) (Table 5).

Correlation between the length and weight of Swordtail fed with different diets

The initial stage of correlation coefficient between the length and weight of Swordtail fed with diet D1 was $r = 0.49$, feeding with diet D2 was $r = 0.76$, and feeding with diet D3 was $r = 0.89$ (Table 6). The relationship diet D3 was highly significant at $p<0.01$ level. The relationship in diet D2 was significant at $p<0.05$ level, a positive relationship between weight and length. (Fig. 5).

At the end of the experiment, the correlation coefficient between the length and weight of Swordtail fed with D1 was $r = 0.89$, feeding with diet D2 was $r = 0.87$, and feeding with diet D3 was $r = 0.79$ (Table 7). Significant positive relationship between the length and weight of Swordtail was observed in all three diets. The coefficient of determination reveals that (R^2) 79 % of the change in the weight is explained by change in length in diet D1, 77 % in diet D2 and 63 % in diet D3 (Fig. 6).

Survival rate, feed conversion ratio and specific growth rate

Survival rate, feed conversion ratio and specific growth rate of Swordtail fish receiving three different types of diets are found to differ from each other.

At the end of the experiment (4 months), survival rate of Swordtail fed on diet D1 was 80 %, diet D2 was 90 % and diet D3 was 70 %. The diet D2 was the highest percentage and the smaller percentage result was observed in the experiment of diet D3.

Feed conversion ratio (FCR) of Swordtail fed on diet D1 was 0.15, diet D2 was 0.06, and diet D3 was 0.31. The value of FCR was lower (better) in diet D2 than those of diet D1 and diet D3.

Specific growth rate of Swordtail fed on diet D1 was 0.6, diet D2 was 1.41 and diet D3 was 0.29. The specific growth rate shows that fingerlings of Swordtail fed with diet D2 was the best, followed by diet D1 and D3 (Table 8).

Table 2 The composition of food ingredients

Ingredients	Crude protein (%)	Crude fat (%)	Moisture (%)	Ash (%)
Diet D1 Tokyu pellet	32	4	9	10
Diet D2 Artemia	60	24	8.5	4.4
Diet D3 Bloodworm	8.3	1.2	81.7	1.5

(Analytical Laboratory Section, Department of Fisheries)

Table 3 Monthly growth performance of Swordtail using three different diets

	Initial state		First month		Second month		Third month		Fourth month	
	Length (cm)	Weight (g)	Length (cm)	Weight (g)	Length (cm)	Weight (g)	Length (cm)	Weight (g)	Length (cm)	Weight (g)
Diet (1)	4.25 ± 0.60	1.04 ± 0.43	4.74 ± 0.5	1.29 ± 0.47	4.94 ± 0.22	1.46 ± 0.34	5.05 ± 0.22	1.56 ± 0.28	5.22 ± 0.61	1.76 ± 0.14
Diet (2)	4.25 ± 0.46	1.16 ± 0.36	4.82 ± 0.77	1.61 ± 0.34	5.29 ± 0.85	1.96 ± 0.82	5.66 ± 0.94	2.31 ± 0.99	6.12 ± 0.85	2.85 ± 0.80
Diet (3)	4.02 ± 0.33	0.80 ± 0.25	4.1 ± 0.41	0.83 ± 0.27	4.21 ± 0.43	0.99 ± 0.35	4.59 ± 0.27	1.03 ± 0.22	4.53 ± 0.23	1.15 ± 0.33

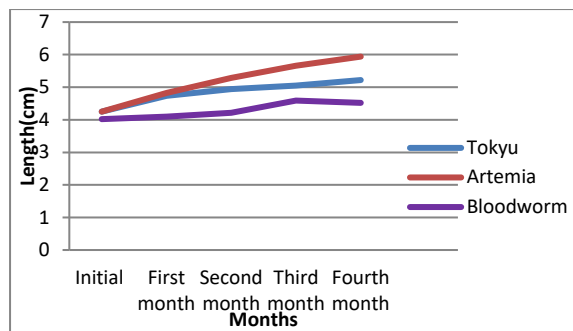


Fig. 1 Monthly growth (length) performance of Swordtail fish using three different diets

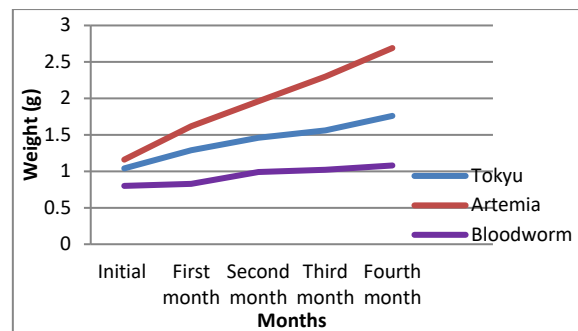


Fig. 2 Monthly growth (weight) performance of Swordtail fish using three different diets

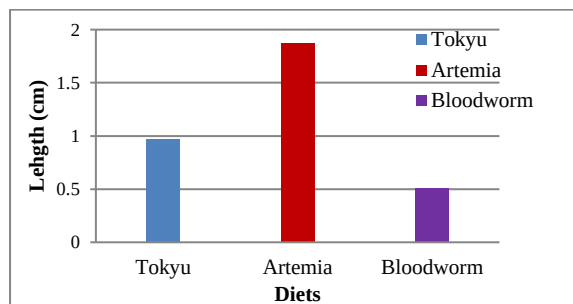


Fig. 3 Length gain of Swordtail fed with three different diets

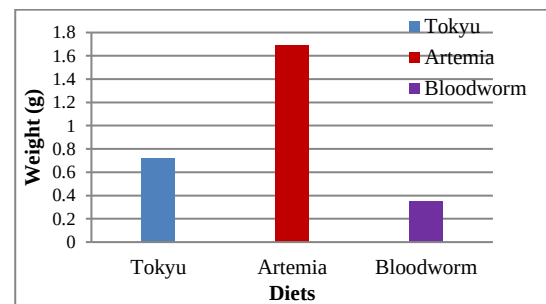


Fig. 4 Weight gain of Swordtail fed with three different diets

Table 4 Comparison of initial standard length and body weight of Swordtail fish fed on three different feeds

Condition	Growth	P. value	Remark
Diet (1) vs Diet (2)	Length	0.83	NS
	Weight	0.53	NS
Diet (1) vs Diet (3)	Length	0.35	NS
	Weight	0.17	NS
Diet (2) vs Diet (3)	Length	0.34	NS
	Weight	0.02*	S

Significant level **p<0.01 *p<0.05 (Paired sample T-test)

Table 5 Comparison of final standard length and body weight of Swordtail fish fed on three different feeds

Condition	Growth	P. value	Remark
Diet (1) vs Diet (2)	Length	0.03*	S
	Weight	0.02*	S
Diet (1) vs Diet (3)	Length	0.02*	S
	Weight	0.00**	S
Diet (2) vs Diet (3)	Length	0.00**	S
	Weight	0.00**	S

Significant level **p<0.01 *p<0.05 (Paired sample T-test)

Table 6 Correlations of initial body length and weight of Swordtail

	Length (cm) Mean $\pm$ SD	Weight (g) Mean $\pm$ SD	Correlation Coefficient (r)	P value
Diet (1)	4.25 $\pm$ 0.60	1.04 $\pm$ 0.43	R ² = 0.2475 r = 0.4974	0.14
Diet (2)	4.25 $\pm$ 0.46	1.16 $\pm$ 0.43	R ² = 0.5831 r = 0.7635	0.01*
Diet (3)	4.02 $\pm$ 0.33	0.80 $\pm$ 0.25	R ² = 0.7922 r = 0.8900	0.00**

Table 7 Correlations of final body length and weight of Swordtail

	Length (cm) Mean $\pm$ SD	Weight (g) Mean $\pm$ SD	Correlation Coefficient (r)	P value
Diet (1)	5.22 $\pm$ 0.61	1.76 $\pm$ 0.14	R ² = 0.798 r = 0.8933	0.00**
Diet (2)	6.12 $\pm$ 0.85	2.85 $\pm$ 0.96	R ² = 0.7740 r = 0.8797	0.00**
Diet (3)	4.52 $\pm$ 0.23	1.15 $\pm$ 0.24	R ² = 0.6315 r = 0.7946	0.03*

Table 8 Survival rate, feed conversion ratio and specific growth rate of Swordtail fish

	Survival rate %	Feed conversion ratio (FCR)	SGR %
Diet (1)	80	0.15	0.6
Diet (2)	90	0.06	1.41
Diet (3)	70	0.31	0.29

Discussion

Ornamental fish keeping is one of the most popular hobbies in the world today. With the expansion of global ornamental fish trade, increased attention is being paid to the nutritional requirements of ornamental fish (Jagtap and Kulkarni, 2013). The present study was undertaken to evaluate the effect of Artemia and bloodworm on Swordtail fish species.

Growth performance of Swordtail fish species fed with three different types of diets was found to differ from each other. At the end of the experiment, the body weight of Swordtail feeding with diet D1 was 1.76 g whereas feeding with Diet D2 was 2.85 g and diet D3 was 1.15 g. It was clearly observed that Swordtail was well accepting the Artemia diet D2. The highest weight gain 1.69 g was recorded in D2 and the lowest weight gain 0.35 g was recorded in D3. It was assumed that D2 is the best food for the rearing of Swordtail fingerlings.

Atar and Secer (2003) stated that the length-weight relationships are important prerequisites to know the variations in weight from the known length indicating feeding, growth and breeding. In the present study, the linear plot based calculated values suggested that there is a direct relationship in length-weight relationships. The logarithmic relation between weight and length indicated a linear relationship signifying the increase in weight with increase in length. The correlation coefficient 'r' was significant in all diets. At the end of the experiment, the correlation between the length and weight of studied species fed with different diets was highly significant at $p < 0.05$ level. Hansen (1997) described that the correlation coefficient 'r' can range from -1.0 to +1.0, with 0.0 indicating no linear relationship whatever. The present study has been found that correlations coefficient of final body weight and length of Swordtail fed with Diet D1 was ($r = 0.89$), diet D2 was ($r = 0.87$) and diet D3 was ($r = 0.79$).

Thus, the result supported to Hansen (1997) and linear relationships were observed in studied fish species. In the present study, the highest values of growth in length, length gain, body weight, weight gain of studied fish species were recorded in D2. But the lowest values were occurred in D3.

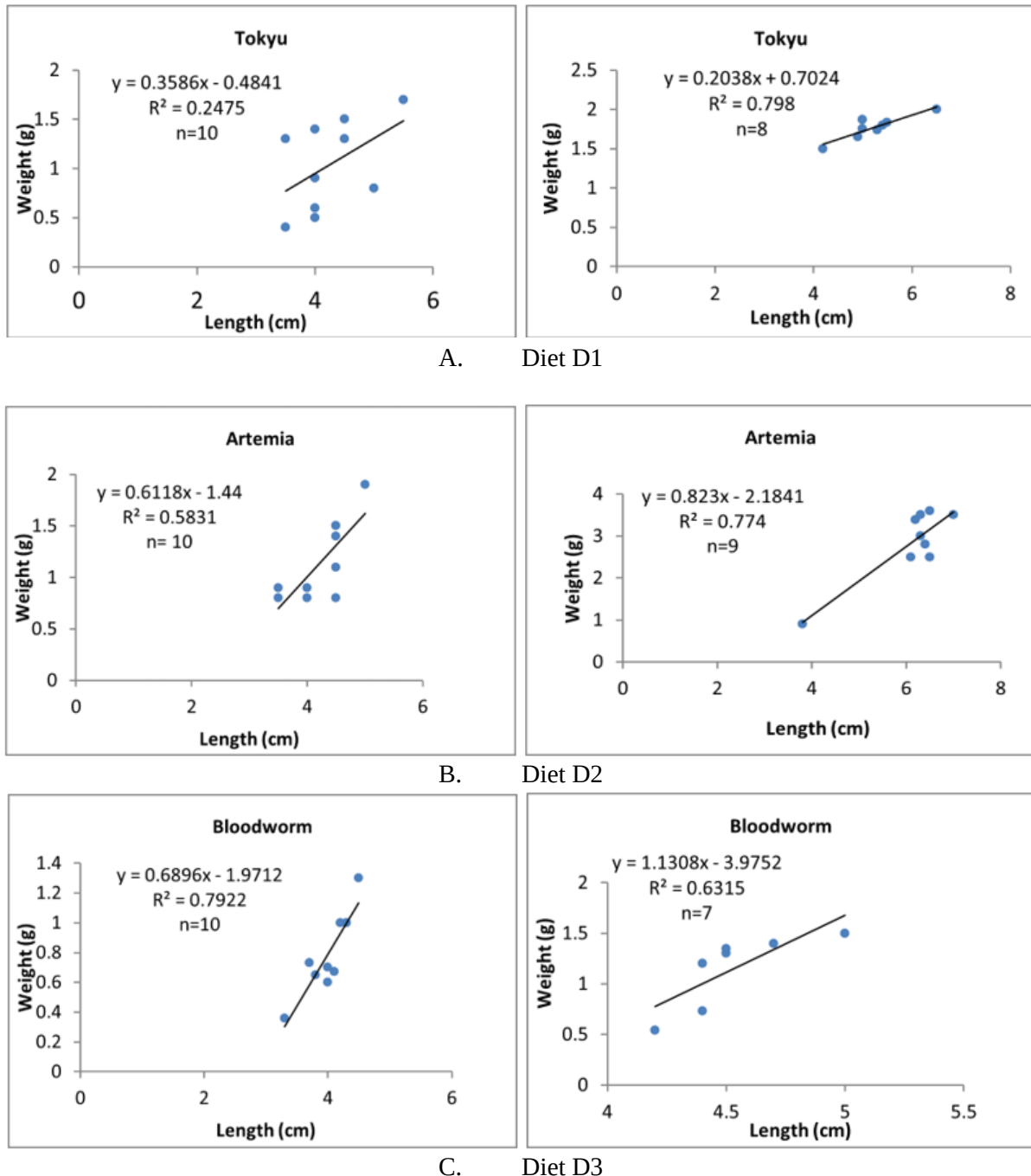


Fig. 5 Initial body length and weight relationship in Swordtail feeding with different diets

Fig. 6 Final body length and weight relationship in Swordtail feeding with different diets

Food conversion ratio (FCR) is calculated as the weight of the feed fed to the fish divided by the weight of fish growth. As far as the value of FCR is concerned, the better (lower) feed conversion ratio of Swordtail was observed for Artemia, followed Bloodworm. Ali and Salim (2004) noted higher FCR value for rice polish (5.27), followed by fish meal (3.026) and

sunflower meal (3.021). The FCR value of sunflower was comparatively higher than the value of present results. In the present study, the FCR value of D2 (0.06) was better than D1 and D3. Thus, it agreed with the previous author. This indicated that Artemia D2 is more acceptable fish feed for rearing in fingerlings of studied species. The value of FCR and SGR showed good condition in diet D2 than in diet D1 and D3. Significantly higher percent of survival rate was recorded in D2 than in D3. Steffens (1981) and Jauncy (1982) reported that best FCR recorded at certain protein level after which it increases. This is due to wider gap between protein and energy content of feed. FCR value decreased gradually with the increased protein level of the feed indicating better utilization of feed by juveniles at higher protein level. This is confirmed for the higher digestibility diet D2 at 60% crude protein in feed. Bureau (1997) stated that protein by products can be very useful complementary protein source in fish diets and it is important to use highly digestible products. Present findings agreed with the previous author.

In the present study, specific growth rate was the best in diet D2. According to the result, diet D2 could be considered as the valuable food for studied fish species and it seems to be tastier than other diets because of the protein source. Moreover, ingredients of Diet D2 could attract the fish and these compounds seem to convert the food energy into increase in growth performance. Based on the results of the present study, it was concluded that Artemia food should be fed in the rearing of hybrid fingerlings of Swordtail fish species.

Conclusion

The effect of food on the growth rate of *Xiphophorus helleri* (Swordtail) was investigated in the aquaria of Zoology Department, Dawei University. Of the three experimental diets, diet D2 had been given growth performance than the commercial pellet diet and bloodworm diet. The experiment revealed that diet D2 gave the best growth and survival rate. The value of FCR and SGR showed the good condition in diet D2. Moreover, significantly higher percentage of survival rate was recorded in the experimental diets D2 than in the diet D3. *Xiphophorus helleri* fry fed by Artemia showed the best result compared to others diet because Artemia possesses the high content of protein. It was encouraged to use in *Xiphophorus helleri* fry rearing because Artemia was easily ingested. The size was also compatible to the fry mouth. It could be concluded that Artemia was an excellent feed for *X. helleri* fry in terms of growth, weight gain and survival rate. The finding of this study could provide effective information for hobbyists and aquarium fishery biologists. Fishkeeping hobbyists need to understand the feeding of fish to increase growth rate, promote health and facilitate reproduction.

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A STUDY ON MORPHOMETRIC MEASUREMENT, SEASONAL ABUNDANCE AND SEX RATIO OF *AMBLYPHARYNGODON MOLA* (HAMILTON, 1822), YANGON REGION

May Moe Tun¹, Myint Myint Khine², Cho Cho Mar³

Abstract

Totally 123787 individuals of *Amblypharyngodon mola* were recorded in this study site. It was most abundance in the hot season, 357.27 kg in the numbers of 62592 individuals (RA = 50.6%) wet season was second most abundance, 257.33 kg in the numbers of 45668 individuals (RA = 36.9%) and cool season was least abundance, 76.43 kg numbering in 15527 individuals (RA = 12.5%). *Amblypharyngodon mola* is a commercially important naturally occurring auto-stocked cyprinid fish. A total of 677 individuals of *A. mola* were examined the variation of sex ratio during the study period. Overall sex ratio of male and female was 1: 1.33 *A. mola* with the monthly average 1.39. In *A. mola*, the female population was larger than that of male population throughout the study period. The highest value of sex ratio was recorded in June 1:2.5. But overall sex ratios were not significantly difference from the expected value 1:1 among the sexes in both studied fish species ($P>0.05$).

Introduction

The fisheries sector plays a vital role in the culture and socio-economic life as well as employment to a large number of communities and rural dwellers. Fish constitutes almost half of the total number of vertebrates in the world. At the global scale, the freshwater fishes belong to 207 families, 2,513 genera and estimated up to 32,500 species, in which the 11,952 species are strictly to freshwater environment, and using freshwater 12,457 species (Nelson, 2006).

Studies on sex ratio and the size and age at sexual maturity are fundamental parameters used in stock assessment and useful in management to calculate the reproductive potential of fish population. Sex ratio is important in predicting the population structure and reproductive performance (Wang *et al.*, 2003).

Amblypharyngodon mola is a commercially important naturally occurring auto-stocked cyprinid fish. It is distributed in Pakistan: Indus plain and the adjoining hills; India: throughout the country (except perhaps Kerala); Bangladesh; and Burma and belonging to the family Cyprinidae, is among the badly affected small indigenous species (Jayaram, 1999). Earlier the fish was considered as weed fish in the fish culture ponds but in advent of time the fish is now highly demanded, economically valuable and costly fish in the market. It is considered to be nutritional value, taste, income source, availability, family chosen fish and to alleviate poverty (International Collective in Support of Fishworkers ICSF, 2010). The objectives of the present study were as follows;

- to identify and examine their morphometric characters of species
- to record the seasonal abundance of studied species
- to analyze the sex ratio of studied species

Materials and methods

Study area

The present study was conducted for sample collection Khun-na-eain-tan Inn, Htantabin Township, south of Yangon-Pathein Highway Road locating between 17°0'0"N to

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17 ° 3'0" and 95 ° 50'0"E to 96 ° 0'0"E. It occupies the area including the part of three villages, Sattan, Htoenayee, and Mawthawt (Fig. 1, Plate 1).

Study period

The study was lasted from June, 2021 to November, 2022.

Specimens collection and identification

Field survey and interview of local fisherman from the chosen study area was conducted two times per month. Two species belonging to family Cyprinidae viz. *Osteobrama belangeri* and *Amblypharyngodon mola* were collected from landing at fishery depot in Mawthawt village and local fishermen in this study area and identified by Inland Fishes, Talwar and Jhingran (1991).

Morphometric study

The meristic and morphometric characters were measured and taken the scaled photographs with digital camera immediately after the collections. A total of 30 individuals of *Amblypharyngodon mola* was monthly collected to access the morphometric measurements data taken. Examination on fin formulae, morphological and taxonomic characters were recorded for each fresh specimen. Technical terms and measurements of the studied species are followed after Rainboth (1996). The samples were transferred into ice box and brought back to laboratory and preserved in 10% formalin for detail studies.

Relative abundance

Abundance of fish species was calculated seasonally based on the total catch-weight and catch-numbers for each species during 2021-2022. The calculation was as follows;

$$\text{RA of individual species} = \frac{\text{Number of specimens of particular species}}{\text{Total number of specimens of all species}} \times 100$$

Sex ratio

The fishes were sexed by morphologically and dissecting out the gonads. The female fishes were found to be larger size than the male in all the seasons. Difference was also observed in the body depth as because the gravid female had enlarged belly during the breeding seasons. In the present study, totally 360 fishes of 677 samples was randomly collected to access the sex ratio of certain species. The calculation on sex-ratio of both species was done after differentiation of sex.



Fig. 1 Location map of fish sampling area at Khun-na-eain-tan Inn, Htantabin Township, Yangon Region (Source: Department of Geography, West Yangon University)



Plate. 1 View of study site: Khun-na-eain-tan Inn in Htantabin Township, Yangon Region



A. Digital caliper for measuring fish length



A. Digital balance for measuring fish weight
Plate. 2 Length and weight measuring equipments



A. Male and female of *Amblypharyngodon mola* (Hamilton, 1822)

Plate. 3 Studied fish species of *O.balengeri* and *A. mola* in Khun-na-eain-tan Inn, Htantabin Township, Yangon Region

Results

Amblypharyngodon mola were identified follow after Inland Fishes, Talwar and Jhingran (1991).

Systematic positions of studied fish species

Phylum	-	Chordata
Class	-	Actinopterygii
Order	-	Cypriniformes
Family	-	Cyprinidae
Genus	-	<i>Amblypharyngodon</i>
Species	-	<i>Amblypharyngodon mola</i> (Hamilton, 1822)

Distinguishing character and morphometric measurement of *Amblypharyngodon mola*

Fin formula: D ii-iii 7; A ii- iii 5-6; P i 13-15; V i 8

Body elongated its depth 3.5 to 3.8 times in standard length. Eyes large, its diameter 3.5 to 4 times in head length. Scales small; lateral line incomplete, ceases after 9 to 18 scales; 65 to 91 scales; 9 or 10 scale- rows between lateral line pelvic fin bases. Color in life shows golden yellow with a broad silvery lateral band on body. Dorsal, anal and caudal fins usually with dark markings; pectoral and pelvic fins hyaline.

Relative abundance of studied fish species in the study area

During the present study period, totally 123787 individuals of *Amblypharyngodon mola* were recorded in this study site. It was most abundance in the hot season, 357.27 kg in the numbers of 62592 individuals (RA = 50.6%) wet season was second most abundance, 257.33 kg in the numbers of 45668 individuals (RA = 36.9%) and cool season was least abundance, 76.43 kg numbering in 15527 individuals (RA = 12.5%).

Distribution of sex ratio of studied fish species

A total of 677 individuals of *A. mola* were examined the variation of sex ratio during the study period. Overall sex ratio of male and female was 1: 1.33 *A. mola* with the monthly average 1.39.

In *A. mola*, the female population was larger than that of male population throughout the study period. The highest value of sex ratio was recorded in June 1:2.5. But overall sex ratios were not significantly difference from the expected value 1:1 among the sexes in both studied fish species.



A. Horizontal cylinder trap



B. Set gill net



C. Trammel net



D. Encircling seine net



E. Beach seine net



F. Push net



G. Cash net

Plate. 4 Fishing gears used in the study area

Table. 1 Morphometric measurement of *Amblypharyngodon mola*

Morphometric measurements (n=360)	Mean± SD	Min	Max
Preorbital length (mm)	4.51± 0.42	3.9	5.19
Eye diameter (mm)	5.316± 0.66	4.32	6.19
Postorbital length (mm)	2.781± 0.59	2.03	4.15
Head length (mm)	17.255± 2.38	12.64	20.79
Dorsal fin base (mm)	8.731± 1.24	6.99	10.87
Length of caudal peduncle (mm)	13.603± 1.68	9.89	16.41
Depth of caudal peduncle (mm)	8.254± 1.30	5.7	10.73
Anal fin base (mm)	9.696± 1.88	6.39	13.32
Length of pectoral fin (mm)	11.483± 1.54	9.16	13.29
Depth of body (mm)	20.847± 3.75	14.03	28.16
Branchioostegal rays	3.000± 0.00	3.00	3.00
Standard length (mm)	64.548± 8.04	49.42	79.44
Total length (mm)	77.56± 11.90	45.00	115.00
Body weight (g)	5.90± 1.96	2.12	13.49

Table. 2 Seasonal abundance of *A. mola* in the study area

Sr. no	Season	<i>A.mola</i> (kg/numbers)	RA %
1	Hot season	357.27 / 62592	50.6
2	Wet season	257.33 / 45668	36.9
3	Cool season	76.43 / 15527	12.5
4	TOTAL	691.03 / 123787	100

Discussion

The present study indicated the morphometric characteristics, abundance and sex ratio of *Amblypharyngodon mola* collecting from landing at fishery depot and local fisherman at Khun-na-eain-tan Inn, Htantabin Township Mawthawt village, Yangon Region.

The monthly individual numbers of *A. mola* was ranged from 1556 individuals to 7212 and monthly average number was 3065 individuals. This finding data was defined as common in this study site.

Jahan *et al.*, (2014) reported that the highest small indigenous fish (SIS) species number was found in October and the lowest in February. The maximum yield of SIS was found in (September to December) period and the least availability of SIS found during (January to April). In the present study, the maximum number of *A. mola* was observed in October to January and minimum number in February to September.

Table. 3 Monthly distribution of sex ratio of studied fishes

Months	<i>A. mola</i> (n =30 individuals/month)		
	Male	Female	Sex ratio (M:F)
March	14	19	1: 1.36
April	13	18	1: 1.38
May	20	22	1: 1.10
June	10	25	1: 2.50
July	23	37	1: 1.61
August	31	41	1: 1.32
September	29	41	1: 1.41
October	33	40	1: 1.21
November	35	40	1: 1.14
December	20	21	1: 1.05
January	33	41	1: 1.24
February	30	41	1: 1.37
Total	291	386	1: 1.33

In *A. mola*, the most abundance in hot season 357.27 kg (50.6%) followed by wet season and cool season were 257.33 kg (36.9%) and 76.43 kg (12.5%) respectively. This finding was contrast to the finding Myint Myint Khine (2007) stated that the catch of *A. mola* was highest in wet season 425 kg and lowest in cool season 41 kg in Moyingyi Inn.

From the study of sex ratio of *A.mola*, it was found that the numbers of female was more than that of male, (Gogio and Goswami, 2014). However, (Ahamed *et al*, 2017) reported that sex ratio of *A.mola* showed no significant difference from the expected value of 1:1. In the present studies, a total of 416 specimens of *A. mola* were collected in this study with 173 (40.79%) males and 243 (59.20%) females. The monthly mean sex ratio was 1:2 (1:1.48). This finding was similar to (Gogio and Goswami, 2014).

Conclusion

In the present study, the most seasonal abundance of *Amblypharyngodon mola* was observed in hot season (357.27kg, 62592 individuals) and least abundance in cool season (76.43 kg numbering in 15527 individuals). The overall male and female sex ratio of *A. mola* was not significant difference. In this study, female numbers were slightly large in male numbers.

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MINERAL CONTENTS OF THE PRODUCTS FROM ITALIAN HONEYBEE, *APIS MELLIFERA LIGUSTICA* SPINOLA, 1806 IN MYANMAR

Zin Win Mar¹, Myint Sandar Win²Myint Myat Thu²

Abstract

New modern apiculture are working the world Israel, America, England, France and Australia of several honey and honey products. Beekeeping technique with Italian breeds of bees was firstly introduced to Myanmar in 1979 (Morse, 1982). The three study areas were Magway, Mandalay and Bago Regions. Beekeeping in the areas was based on short and long transference. Bee hives were placed among field crops, orchards and vegetable plantations. Usually bee hives with one bee hive has seven or eight frames. One frame was produced two pounds or 2.4 liters of honey. The constituents of honey, propolis, beeswax and royal jelly were determined with the aid of Energy Dispersive X-Ray Fluorescence Spectrometer (Model EDXR-700) at the University Research Centre (URC). Occurrence of potassium (K) was highest in all the honey samples and product of *A. mellifera ligustica*, Spinola, 1806. In soil samples of Manganese (Mn), Copper (Cu), Zinc (Zn) were recorded with moderate amount of 0- 4 percent. Calcium was absent in all the soil samples of Bago Region.

Keywords: Emtomology

Introduction

Honeybees are worldwide in their distribution. Honeybee are domesticated and employed as pollinator and production of bee products. Honeybees provide honey, propolis, beeswax and royal jelly and pollen. Propolis is a sticky dark- coloured beeswax and resinous material produced by honeybees (*Apis mellifera ligustica*) from plant material. Beeswax is a large variety of substances of plant and animal origin, as well as man made products which are mostly petroleum derivatives. Natural waxes are not single substances, but a mixture of various long chain fatty acids and a variety of other constituents. Eight wax glands on the underside the abdomens of young bees secrete small wax platelets. Together with propolis, wax is also employed for sealing cracks and covering foreign objects in the hive. The wax collected by the beekeeper from the cap and top part of the honey cells (Alford, 1975). The chemical constituents of pure beeswax was found to consist hydrocarbons, monohydric alcohols, acids and other substances (Hepburn, 1986). hypopharyngeal glands of worker bees normally 5-15 days of age. Royal jelly can be described as a creamy, milky white, strongly acid, highly nitrogenous substance with a slightly pungent odor and a somewhat bitter taste. Which is not surprising since royal jelly would otherwise be growth (Gulikers, 1955; Bee World, 1962 and Hadhanyi, 1965). In medicine-like formulations royal jelly is generally included for its stimulator effects. The chemical composition of royal jelly consists of moisture, proteins, lipids, total reducing substances, asantibiotic activity against many bacteria and fungi.

Aim and Objectives

- to analyze the mineral contents of honeybee product from upper and lower Myanmar.
- to find out the mineral contents of the soil samples from the three studied Regions.

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Materials and Methods

Study area

Pho lay lone township, Magway Region N-20° 11' and 35.7' E-10° 95' and 11.445'. Pyin Oo Lwin Township, Mandalay Region N-23° 1' E-96° 27' Yeni Township, Bago Region N-17° 47' E-96° 40' (Figure .1), The study was lasted from 2021-2022 choice to conduct the present research. Honeybees products transport from the beekeeping sites of upper and lower Myanmar.

Study period

The study period was lasted from 2021 to 2022

Materials

Glass ware, steel pot, Bee veli (plate 1)

Methods

Data collection

Honey products transport from the beekeeping sites of upper and lower Myanmar. All samples were saved in glass flasks in a place and analyzed within two weeks from sampling.

Analysis for mineral content of honeybees products

Content of minerals in honeybees products were determined with the aid of Energy Dispersive X-Ray Fluorescence Spectrometer (Model EDXR-700) at University Research Centre (URC).

Analysis for mineral content of soil samples

Content of minerals in soil samples were determined with the aid of Energy Dispersive X-Ray Fluorescence Spectrometer (Model EDXR-700) at University Research Centre (URC).

Statistical analysis

Data obtained were presented in tables and graphs

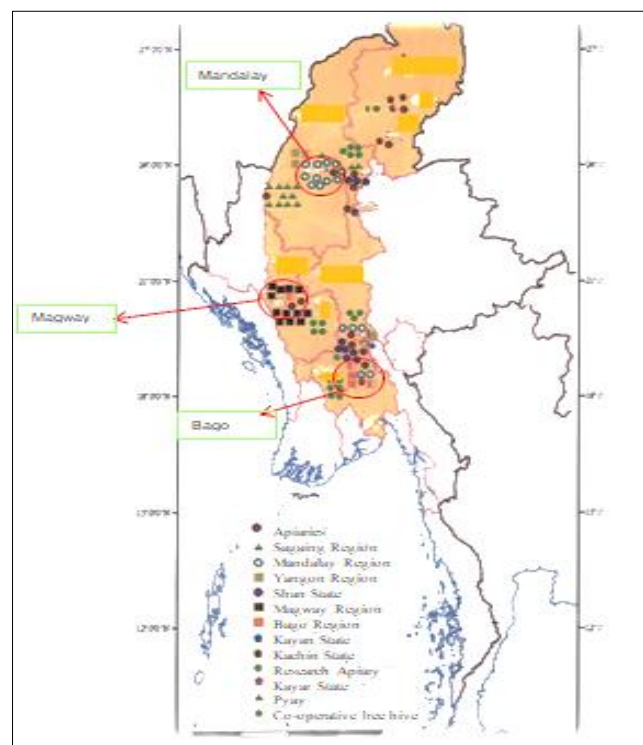


Fig. 1 Map of the study area
Source: Apiculture of Myanmar



A. Products using with honey

B. Export honey

Plate. 1 Honey products and equipments

Results and Discussion

The study was found on Italian honey bee Genus *Apis* belonging to the family Apidae were identified and tested honeybees products.

Diagnostic characters of studied species

Italian honeybee species was collected and belong to the family Apidae were identified. Systematic position of studied species

Phylum - Arthropoda
Class - Insecta

Order - Hymenoptera
 Family - Apidae
 Subfamily - Apinae
 Genus - *Apis*
 Subspecies- *Apis mellifera ligustica*
 (Italian honeybee)



(A) Beewax



(B) Propolis

Plate .2 Beewax and Propolis

❖ Collection of royal jelly

- Doolittle method
- 120 Queen cell cups



A. young larva remove



B. queen cell



C. wax-cell cup



D. grafting tool

Production of royal jelly from queen cells

Plate. 3 Production of royal jelly from queen cells

Constituents of honey

Mineral content of Water and sugar contents of Sunflower and Niger Mandalay and Bago Region

The Sunflower and Niger honey in Magway Region, were found to contain 23.19 ± 2.47 and 23.44 ± 1.95 per cent respectively. Water content in the honey of Sunflower and Niger were recorded as 23.78 ± 1.69 per cent and 23.67 ± 2.01 per cent from Mandalay Region and 25.01 ± 1.41 and 25.33 ± 1.76 per cent from Bago Region. Three kinds of sugar sucrose, glucose and fructose were detected in the honey samples of different Regions. In Niger honey from Magway Region, content of fructose at 39.89 ± 4.25 per cent was higher than in honey from other Regions. Content of glucose in the Sunflower honey of Bago Region was lowest at 30.99 ± 1.53 per cent. Sucrose was recorded at low values in Sunflower honey of Mandalay and Bago Regions at 2.27 ± 1.48 and 1.44 ± 0.32 per cent respectively. The reducing sugars of Niger

honey were detected at maximum value of 73.50 ± 17.07 per cent in Mandalay Region. (Table .1, Fig. 2)

Mineral contents of Sunflower and Niger honey samples from Magway, Mandalay and Bago Regions Potassium (K), calcium (Ca), copper (Cu), iron (Fe), manganese (Mn) and chromium (Cr) were recorded. Potassium in the Sunflower and Niger honey of Magway Region was higher than the other minerals at 37.56 ± 69.53 mg/L and 34.17 ± 23.18 mg/L respectively. It was followed by Mandalay Region at 29.19 ± 27.36 mg/L and 15.08 ± 21.67 mg/L and minimum at 23.65 ± 22.70 mg/L and 14.02 ± 22.72 mg/L in Bago Region. In Sunflower and Niger honey, Ca, Cu and Fe were recorded at moderate amounts of 20.13 ± 3.65 mg/L and 57.47 ± 15.45 mg/L respectively. The presence of manganese (Mn) and chromium (Cr) were detected in Sunflower honey of Magway Region. (Table .2, Fig.3)

Constituents of propolis

Mineral contents of propolis from Magway, Mandalay and Bago Regions

Potassium (K), Calcium (Ca), Iron (Fe), Copper (Cu), Zinc (Zn), Phosphorus (P), Sulphur (S) Manganese (Mn), Titanium (Ti), Nickel (Ni) and Chromium (Cr) were found to occur only in the propolis of Magway Region. Content of potassium (K) was maximum with 65.95 ± 13.71 from the propolis of Magway Region. The differences in chemical composition can be attributed to environmental, botanical and bee species factors. (Table. 3, Fig. 4)

Constituents of beeswax

Mineral contents of beeswax from Magway, Mandalay and Bago Regions

Potassium (K), iron (Fe), Calcium (Ca), Copper (Cu) and Sulphur (S) were commonly present in the beeswax. Content of K was maximum at 46.81 ± 0.67 per cent in the beeswax of Pyin Oo Lwin township and minimum at 13.71 ± 0.12 per cent in the beeswax of Ye ni township of Bago Region. Fe was maximum at 7.31 ± 0.02 per cent in Ye ni township which was followed by minimum of 2.56 ± 0.06 per cent from beeswax in pyo lay lone town ship of Magway Region. Trace mineral chlorine (Cl) and phosphorus (P) were not detected in the beeswax form all Regions. Khin San Nwe (2007) stated that the maximum content of potassium(K) at 46.81 per cent was observed in the beeswax of *A dorsata* from Myikyina Township of Kachin state. (Table.4, Fig. 5)

Constituents of royal jelly

Mineral contents of royal jelly samples from Magway, Mandalay and Bago Regions

The minerals recorded common to all samples were potassium (K), Phosphorus (P), Sulphur (S), Chlorine (CL), Calcium (Ca), Iron (Fe), Zinc (Zn), Copper (Cu) and Chromium (Cr). Content of K was higher than the other minerals with the maximum content of 71.05 ± 52.34 mg/L in the royal jelly of Magway Region. It was followed by 37.97 ± 22.27 mg/L and minimum of 33.49 ± 21.35 mg/L in samples from Bago Region. Bromine (Br), Chlorine (Cl), and manganese (Mn) were detected only in royal jelly from Mandalay and Bago Regions. (Table.5, Fig,6)

Mineral contents of soil samples

The soil samples were collected from Magway, Mandalay and Bago Regions. Potassium K. Calcium (Ca), manganese (Mn) , copper (Cu) and zinc (Zn) were commonly present. Content of K and Ca were maximum with 16.57 per cent and 15.70 per cent in the soil samples of pholaylone township of Magway Region. In soil samples of manganese (Mn), copper (Cu) and zinc (Zn) were recorded with moderate amount of 0- 4 per cent. Calcium was absent in all the soil samples of Bago Region. (Table. 6, Fig. 7)

Table 1. Water and sugar contents (per cent) of honey samples produced in Magway, Mandalay and Bago Regions

Region	Honey samples	Sugar				Water content
		Sucrose	Glucose	Fructose	Reducing sugars	
Magway	Sunflower	-	31.35 ± 2.14	39.26 ± 4.41	68.60 ± 13.48	23.19 ± 2.47
	Niger	-	31.66 ± 2.08	39.89* ± 4.25	69.85 ± 14.47	23.44 ± 1.95
Mandalay	Sunflower	2.27 ± 1.48	31.38 ± 2.01	39.54 ± 3.86	71.68 ± 13.41	23.78 ± 1.69
	Niger	-	34.68* ± 4.87	38.76 ± 3.72	73.50* ± 17.07	23.67 ± 2.01
Bago	Sunflower	1.44 ± 0.32	30.99 ± 1.53	38.00 ± 3.61	69.30 ± 14.02	25.01 ± 1.41
	Niger	-	31.05 ± 2.09	37.78 ± 3.85	69.38 ± 14.07	25.33* ± 1.76

* = maximum

- = not detected

n = 10

Table 2. Mineral contents (mg/L) of honey samples produced in Magway, Mandalay and Bago Regions

Region	Honey samples	Mineral					
		Potassium (K)	Calcium (Ca)	Copper (Cu)	Iron (Fe)	Manganese (Mn)	Chromium (Cr)
Magway	Sunflower	37.56* ± 69.53	47.95* ± 13.43	20.13 ± 3.65	31.52 ± 9.12	47.01 ± 13.9	32.58 ± 9.12
	Niger	34.17 ± 23.18	31.15 ± 8.50	32.82 ± 9.48	44.85 ± 11.76	-	-
Mandalay	Sunflower	29.19 ± 27.36	47.23 ± 14.68	45.20 ± 11.73	57.47* ± 15.45	-	-
	Niger	15.08 ± 21.67	23.32 ± 5.21	52.38* ± 12.04	46.50 ± 11.52	-	-
Bago	Sunflower	23.65 ± 22.72	36.87 ± 10.71	22.81 ± 4.63	31.20 ± 9.50	-	-
	Niger	13.02 ± 22.72	32.90 ± 9.71	26.47 ± 7.63	27.07 ± 7.86	-	-

* = maximum

- = not detected

n = 10

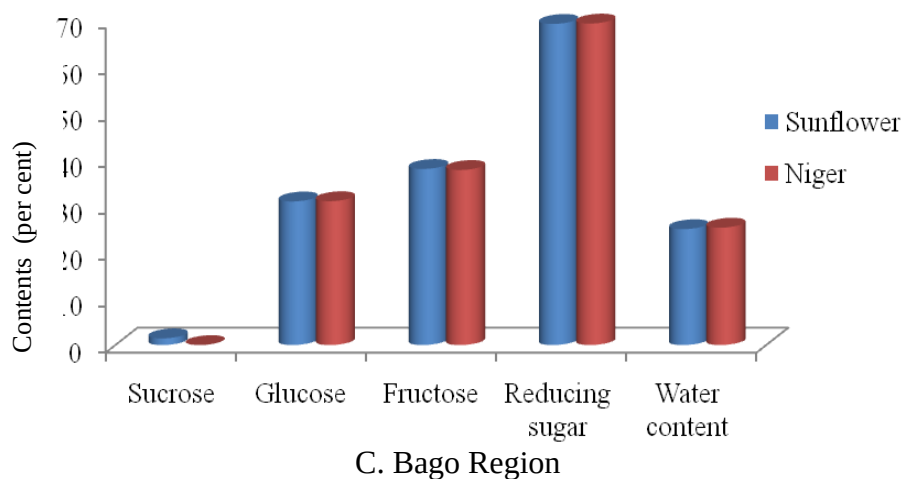
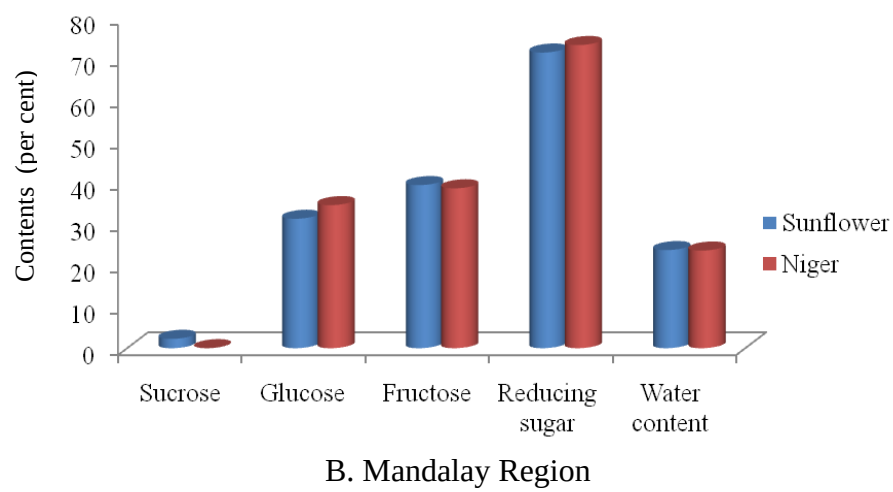
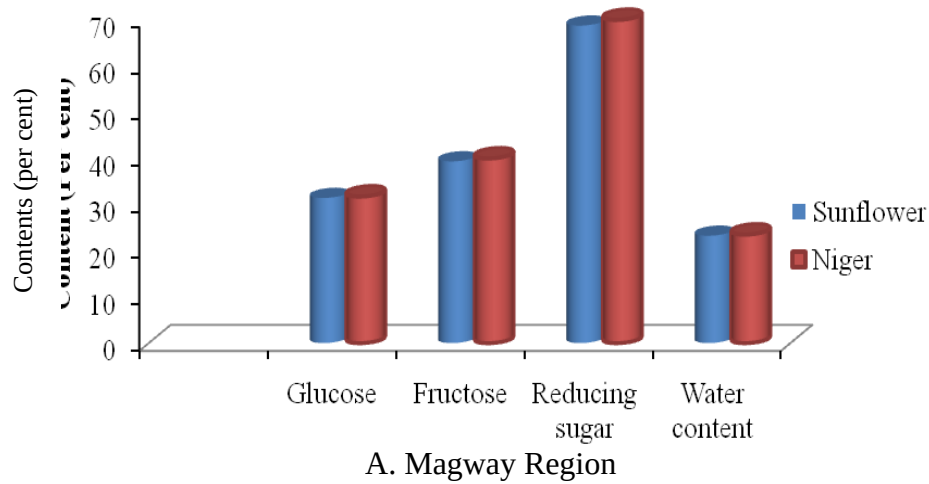
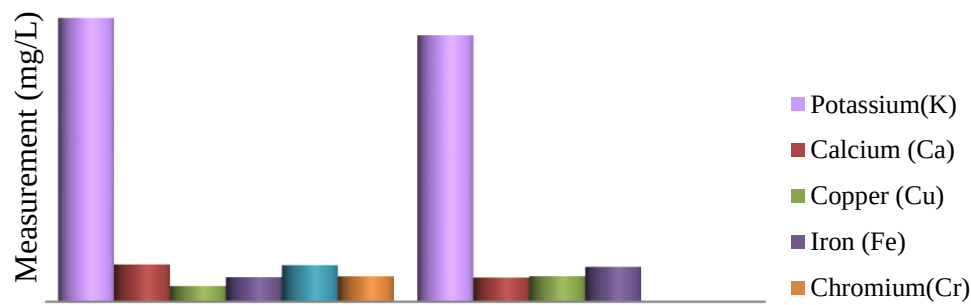
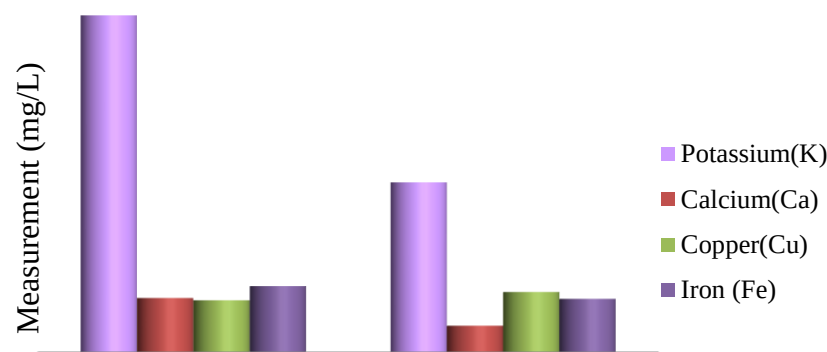


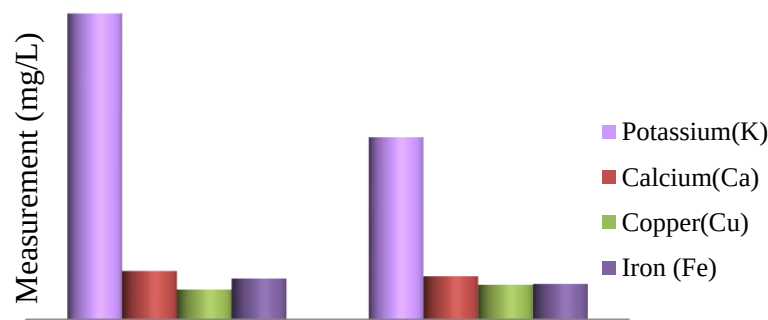
Fig. 2 Water and sugar contents (per cent) in the honey samples of three Regions



A. Magway Region



B. Mandalay Region



C. Bago Region

Fig. 3 Mineral contents (mg/L) in the honey samples of three Regions

Discussion

In the present study honey samples were collected from aparies using Sunflower and Niger plant sources in Magway, Mandalay and Bago Regions. The success of migratory beekeeping depends on appropriate colony manipulation before, during and after each flowering season. Preparations need to begin in the minor nectar flow season in October when sufficient surplus honey is deliberately left in the hive as food for the coming dearth flowering

period during the wet weather of November and December (Akratanakul,1984). The maximum content of potassium at 16.57 per cent was observed from the soil of Magway Region.

Table 3. Mineral contents of propolis (per cent) in three Regions

Mineral	Magway Mean $\pm$ SD	Mandalay Mean $\pm$ SD	Bago Mean $\pm$ SD
Potassium (K)	65.95 $\pm$ 13.71	42.60 $\pm$ 11.23	33.12 $\pm$ 10.12
Calcium (Ca)	36.46 $\pm$ 10.24	23.22 $\pm$ 9.02	13.10 $\pm$ 7.61
Copper (Cu)	54.50 $\pm$ 3.50	51.37 $\pm$ 2.96	29.90 $\pm$ 0.07
Magnese (Mn)	32.31 $\pm$ 1.02	31.34 $\pm$ 1.01	23.37 $\pm$ 1.01
Zinc (Zn)	30.14 $\pm$ 1.21	26.65 $\pm$ 0.02	23.05 $\pm$ 0.05
Iron (Fe)	32.15 $\pm$ 1.82	16.87 $\pm$ 0.00	17.95 $\pm$ 0.00
Phosphorus (P)	52.36 $\pm$ 2.18	-	-
Sulphur (S)	38.73 $\pm$ 0.19	-	-
Nickel (Ni)	92.39 $\pm$ 4.72	-	-
Krypton (Kr)	33.53 $\pm$ 1.02	-	-
Titanium (Ti)	27.96 $\pm$ 0.02	-	-
Chromium (Cr)	18.87 $\pm$ 0.01	0.84 $\pm$ 0.01	16.78 $\pm$ 1.05
Strontium (Sr)	-	1.07 $\pm$ 0.05	-
Silicon (Si)	-	-	-
Barium (Ba)	-	-	16.78 $\pm$ 0.05

Fig. 4 Contents (per cent) of minerals common to propolis samples in three regions

Table 4. Mineral contents of beeswax in three Regions (mg/L)

Mineral	Magway Mean $\pm$ SD	Mandalay Mean $\pm$ SD	Bago Mean $\pm$ SD
Potassium (K)	42.70 $\pm$ 8.29	46.81 $\pm$ 0.67	13.71 $\pm$ 0.12
Iron (Fe)	2.60 $\pm$ 0.06	5.29 $\pm$ 0.02	7.31 $\pm$ 0.02
Calcium (Ca)	6.51 $\pm$ 0.30	5.72 $\pm$ 0.40	3.02 $\pm$ 0.01
Sulphur (S)	4.12 $\pm$ 0.33	5.17 $\pm$ 0.21	1.51 $\pm$ 0.00
Copper (Cu)	2.91 $\pm$ 0.60	0.58 $\pm$ 0.02	2.18 $\pm$ 0.05

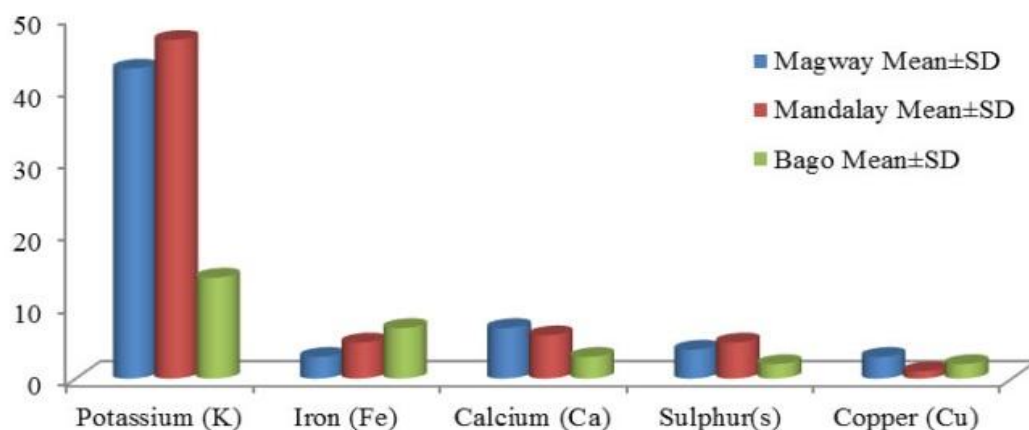


Fig. 5 Mineral contents of beeswax in three Regions (mg/L)

Table 4. Mineral contents of Royal jelly in three Regions (mg/L)

Mineral	Magway Mean $\pm$ SD	Mandalay Mean $\pm$ SD	Bago Mean $\pm$ SD
Potassium (K)	71.05 $\pm$ 52.34	37.97 $\pm$ 22.27	33.49 $\pm$ 21.35
Phosphorus (P)	12.01 $\pm$ 10.93	23.49 $\pm$ 20.76	15.96 $\pm$ 11.48
Sulphur (S)	17.76 $\pm$ 12.50	32.66 $\pm$ 21.00	24.94 $\pm$ 22.11
Chlorine (Cl)	-	22.08 $\pm$ 19.87	36.89 $\pm$ 22.58
Calcium (Ca)	16.99 $\pm$ 13.71	37.81 $\pm$ 24.54	27.28 $\pm$ 23.26
Iron (Fe)	12.37 $\pm$ 9.19	14.51 $\pm$ 11.91	13.10 $\pm$ 10.75
Lead (Pb)	-	15.96 $\pm$ 12.36	-
Zinc (Zn)	25.97 $\pm$ 3.83	60.09 $\pm$ 5.59	99.29 $\pm$ 8.28
Copper (Cu)	43.52 $\pm$ 4.63	53.34 $\pm$ 5.90	45.11 $\pm$ 4.67
Bromine (Br)	-	29.86 $\pm$ 3.70	85.62 $\pm$ 7.07
Magnese (Mn)	-	-	29.92 $\pm$ 2.74
Chromium (Cr)	25.29 $\pm$ 3.62	35.98 $\pm$ 4.63	20.38 $\pm$ 1.02

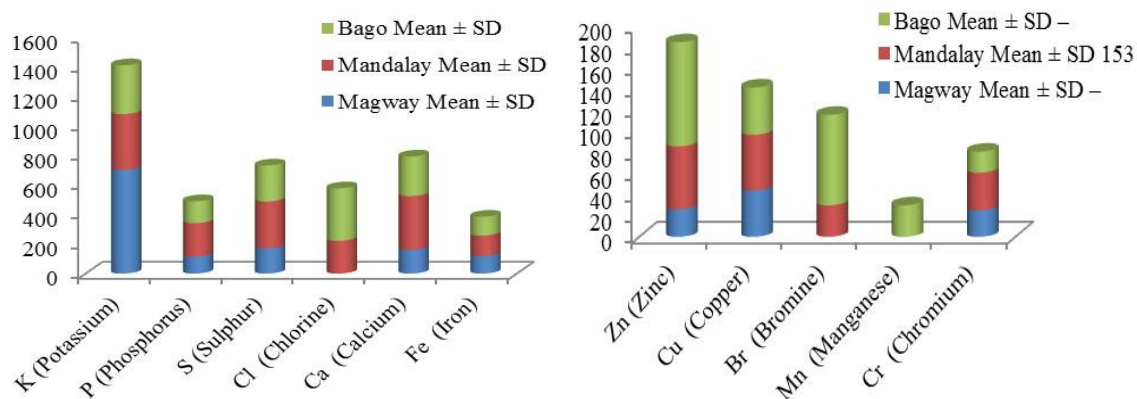


Fig. 6 Mineral contents of Royal jelly in Magway, Mandalay, an Bago Regions (mg/L)

Table 6. Mineral constituents per cent of soil samples from Magway, Mandalay, and Bago Regions

Mineral	Magway	Mandalay	Bago
Potassium (K)	16.57	4.56	3.75
Calcium (Ca)	15.70	7.42	-
Mangnese (Mn)	2.29	0.28	0.17
Copper (Cu)	2.06	0.12	0.08
Zinc (Zn)	2.49	0.02	0.14

In the present study, water content in the Niger and Sunflower honey samples from Bago Region was higher than from the other Regions. In all the honey samples tested, water content ranged from 23.19 to 25.33 per cent. Tin Tin Mar (1996) described that the water content was 25.6 per cent to 26.6 per cent in honey. Khin San Nwe (2007) reported that water content of honey ranged from 21.5 per cent to 21.8 per cent.

House (1961) described that the differences in chemical composition of beeswax could be attributed to environmental, botanical and bee species factors. Benfenati *et al* , (1986) stated that the mineral salts in royal jelly were K, Ca, Fe, Zn, S, Cr, Cu, and Mn with a strong prevalence of potassium.

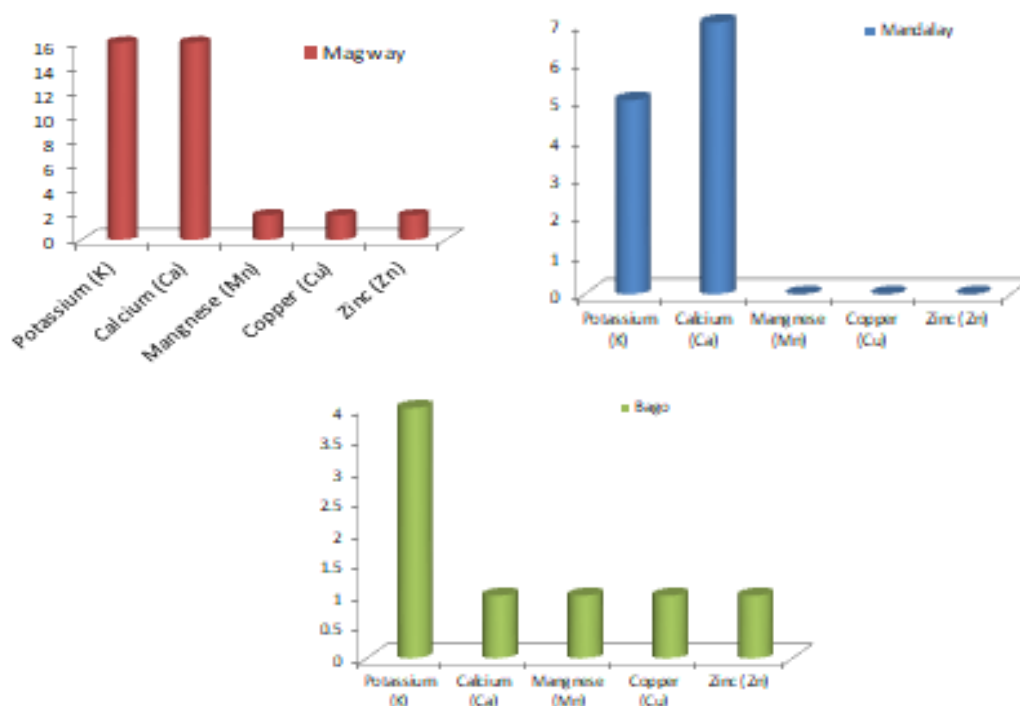


Fig. 7 Mineral constituents per cent of soil samples from Magway, Mandalay and Bago Regions

Okada and Obata (1962) described that to produce royal jelly on a small scale, a beekeeper might simply queen a colony, and harvest jelly from the emergency queen cells the bees construct but colony population and honey production will decline. Brown *et. al* (2002) described that royal jelly is 67 per cent moisture, 8 per cent fat, 12.9 per cent proteins and 11.2 per cent ash. This percentages vary slightly in different seasons. This finding agrees with in the present result. In the present study, occurrence of potassium (k) was higher than the other minerals in all beeswax and royal jelly. The differences in potassium concentration can be attributed to environmental, botanical and bee species factors.

It may probably be due to chemical contents of honey sources plants that are mainly absorbed from the soil along with water by the roots of plants and used in flowering and formation of fruit. Potassium is the higher concentrations of mineral in the soil and the environment around the production area (Mohammad, 2005). Italian honey bee of *A. mellifera ligustica* should be domesticated for the purpose of good quality honeybee products, pollination of cultivated crops and health of human.

Conclusion

Honey bees are very important animals. People also eat honey and use wax from honey comb to make candles and other. Potassium is a mineral salt that is essential for maintaining the balance of PH levels in our body fluids. Low levels of potassium can cause potassium deficiency and bring on a whole host of health problems. People with a potassium deficiency are suffering from Hypokalemia. The presence of flavonoids and reducing sugars in great quantity of honey, propolis, beeswax and royal jelly could be used in various industries, therapeutic, pharmaceutical.

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SEASONAL OCCURRENCE AND NUTRITIONAL ANALYSIS OF EDIBLE INSECT, *LETHOCERUS INDICUS* (LEPELETIER & SERVILLE, 1825) IN MAUBIN ENVIRONS, AYARWADDY REGION

Aye Thida¹, Soe Myint Khine², Lwin Lwin Htet²

Abstract

A study on seasonal occurrence of giant water bug *Lethocerus indicus* (Lepeletier & Serville, 1825) was conducted from April 2021 to March 2022 in Ayarwaddy Region. The study area was conducted in three study sites; War Taw village (Maubin Township), Nyawt Pyaw Kune village (Nyaungdon Township) and Imma village (Pantanaw Township) in Ayarwaddy Region. A total of 3204 individuals were collected in all study sites. Population size of giant water bugs changed with the season. Sex ratio of the studied species was also observed to change with the season. The highest numbers of *L. indicus* are found in March and April. In August and September, giant water bug was not found. Generally, edible insects are representing significant biological resources that are rich in protein, amino acids, fat, carbohydrates, various vitamins and trace elements. Insect consumption has played an important role as part of human nutrition in many regions around the world. Edible insects (*L. indicus*) are provided essential nutrients, such as energy, protein, carbohydrates, fat and fiber that could help to daily diets. According to this study, the protein content of *L. indicus* was 21.42%, carbohydrates 2.99%, fat 8.26%, fiber 4.99% and moisture 61.21% respectively. The proportion of population size were related to study sites and monthly occurrence were discussed.

Introduction

Human insect-eating is common in the world especially in China and Thailand. Some companies are trying to introduce insects as food into Western diets. The member of this family has been reported to occur in all over the world. *Lethocerus* species is distributed through the South Europe to South East Asia, including Myanmar (Nattawut et al. 2019). They can be found in freshwater habitat such as rice field, marches, ponds, lakes and river (Cullen 1969, Menk 1979, Mukai *et al.* 2005). Many species of insects are served as traditional foods among indigenous peoples and they play an important role in human nutrition. With an increase in global population comes an increase in consumer demand for protein, making sustainable meat productions are a serious challenge for the future. In this regard, insects are one of the best alternative protein sources with a low environmental impact. Insects are not only an alternative source of energy, but also an important source of fiber that may help to prevent cardiovascular diseases (Nielsen, S. S. 2010).

Generally, edible insects are representing significant biological resources that are rich in protein, amino acids, fat, carbohydrates, various vitamins, and trace elements (Xiaoming et al. 2010). Insect consumption has played an important role as part of human nutrition in many regions around the world, including Latin America and Asia, since ancient time. Giant water bug: *Lethocerus indicus* is one of the edible aquatic insects. They are common in light bug because people can catch easily by light trap at night on shore of creek. The adults of *lethocerus indicus* are considered as delicacy in Asia especially in Thailand. They are eaten both fresh and cooked (Choate, 2003). The male *lethocerus* secretes a fragrant liquid from two abdominal glands, which is important to flavor the sauce. Bug paste is also a famous food of the people from Thailand due to its particular flavor. (Sungpuag and Puwastein, 1983; Wantanabe and Satrawaha, 1984). In Myanmar, the bug species is considered as one of the insect species which provide additional income for rural people. Phyu Phyu Sein (2008) conducted the ecology and economic importance of *Lethocerus americanus* in Pegu Region.

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Objective

- to record the population abundance in three study sites
- to observe the size and sex ratio of study species
- to investigate the nutritional values of study species

Materials and Methods

Study sites

Study sites were chosen by three study sites in Ayeyarwady Region

Site I: War Taw village, Maubin Township (16° 41' 14" N, 95° 40' 42" E)

Site II: Nyawt Pyaw Kune village, Nyaungdon Township (17° 02' 36" N, 95° 38' 18" E) Site

III: Inma village, Pantanaw Township (16° 59' 02" N, 95° 40' 42" E)

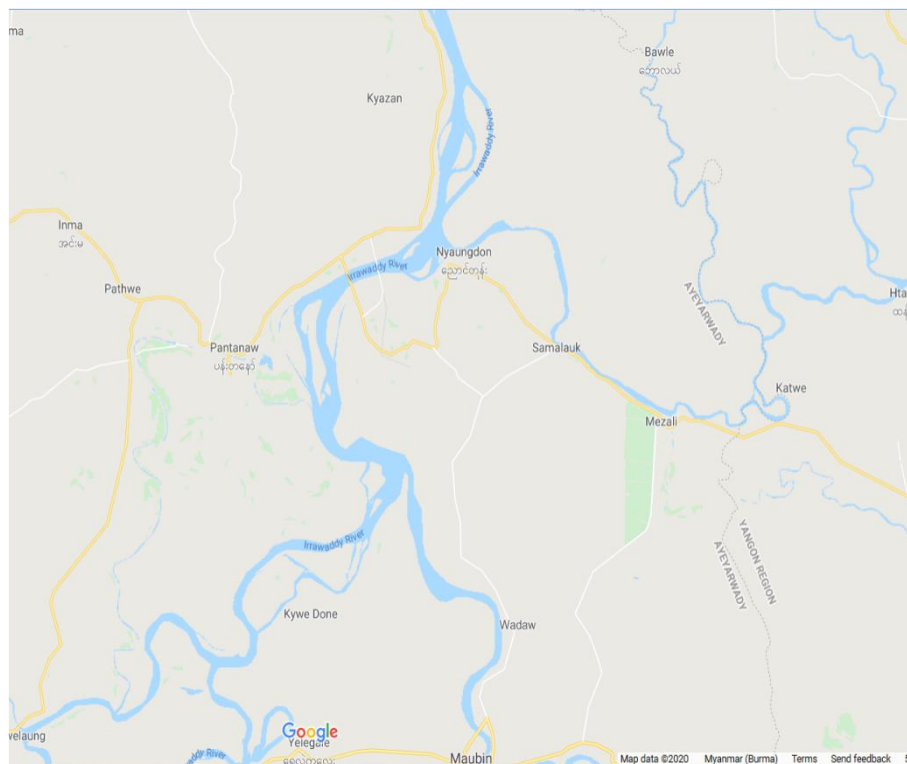


Fig. 1 Map of Study Sites
Source: google map (2020)

Study period

Study period lasted from April 2021 to March 2022.

Specimens and data collection

Specimens were collected near the paddy field, irrigation ditches and streams by using violet- color light trap. Specimens collecting in all study sites by twice a month for population abundance. Total of six times per month in all study sites. Sets of light trap containing 12 voltage batteries, bamboo stick light stand and plastic container were used during the period from 6:00 pm to 9:00 pm. 10 specimens were randomly collected from each study sites during data collecting period for recording the measurement of study species. Measure the total length, width and wing spans of 30 samples of males and 30sample of females from three study sites by using the clipper. Collected insects were put into various sizes of plastic boxes . The boxes were labeled with date of collection and locality. The plastic boxes that contain the specimens

were placed into the ice and brought back to the laboratory for identification and nutritional analysis. Nutritive values of *L. indicus* were analyzed in the Union of Myanmar Federation of Chambers of Commerce and Industry (UMFCCI) Yangon. Identification follow after Charles & Norman (2005) and Nattawut *et al.*, 2019.



A. Camera



B. 12 Voltage battery



C. Rubber glove



D. Plastic container



E. Clipper



F. Violet-color light lamp

Plate1 Equipments for specimens collection



Plate. 2 Measure the body length and width

Plate. 3 Measure the length wing-spans of *L. indicus*

Results

Systematic position of giant water bug.

Phylum	-	Arthropoda
Class	-	Insecta
Order	-	Hemiptera
Suborder	-	Heteroptera
Family	-	Belostomatidae
Genus	-	<i>Lethocerus</i>
Species	-	<i>Lethocerus indicus</i> (Lepeletier & Serville, 1825)
Common name	-	Giant water bug
Local name	-	Belar / Palima

A Total of 3204 individuals were collected in all study sites. In wet season, a total number is 405 individuals. In cool season, a total number is 707 individuals. In dry season, a total number is 2092 individuals were collected. The highest number of *L. indicus* are collected in dry season, while the lowest in wet season. During the study period, the highest numbers of *L. indicus* are found in March and April. In August and September, giant water bug was not found by using light trap. During the study period, the highest content of protein is 21.95% and highest content of lipids is 9.95% were observed in male *L. indicus*. The highest content of carbohydrate is 3.59% were observed in female *L. indicus*. Regarding energy, the maximum amount were found 191.39kcal in male and 174.31Kcal in female *L. indicus*. This study also investigated the other extracts such as fiber, moisture and ash content of edible insect, *L. indicus*.

Table 1 Monthly data of *lethocerus indicus* in all study sites

Sites Month	Site I		Site II		Site III		Total
	Male	Female	Male	Female	Male	Female	
January	33	35	25	27	39	55	214
February	49	56	40	51	53	70	319
March	90	119	72	85	117	130	613
April	98	110	79	90	122	135	634
May	86	99	61	70	100	110	526
June	42	50	35	40	56	73	296
July	15	15	16	21	20	22	109
August	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0
October	19	23	10	14	35	36	137
November	31	32	18	22	38	38	179
December	29	32	19	19	37	41	177
	492	571	375	439	617	710	3204
Total	1063		814		1327		3204

Table 2 Seasonally data of *lethocerus indicus* in all study sites

Location		Wet Season				Cool Season			Dry Season					Total
		Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
Site I	Male	42	15	-	-	19	31	29	33	49	90	98	86	492
	Female	50	15	-	-	23	32	32	35	56	119	110	99	571
Site II	Male	35	16	-	-	10	18	19	25	40	72	79	61	375
	Female	40	21	-	-	14	22	19	27	51	85	90	70	439
Site III	Male	56	20	-	-	35	38	37	39	53	117	122	100	617
	Female	72	22	-	-	36	38	41	55	70	130	135	110	710
Total		296	109	-	-	137	179	177	214	319	613	634	526	3204
		405				707			2092					3204

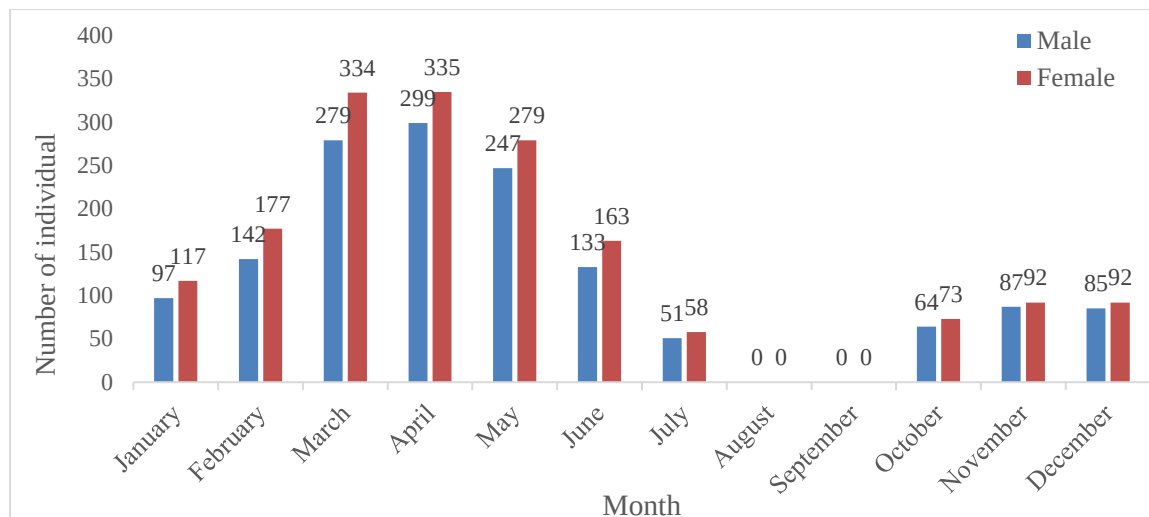


Fig. 2 Monthly comparison of collected number of *L. indicus* (Male and Female)

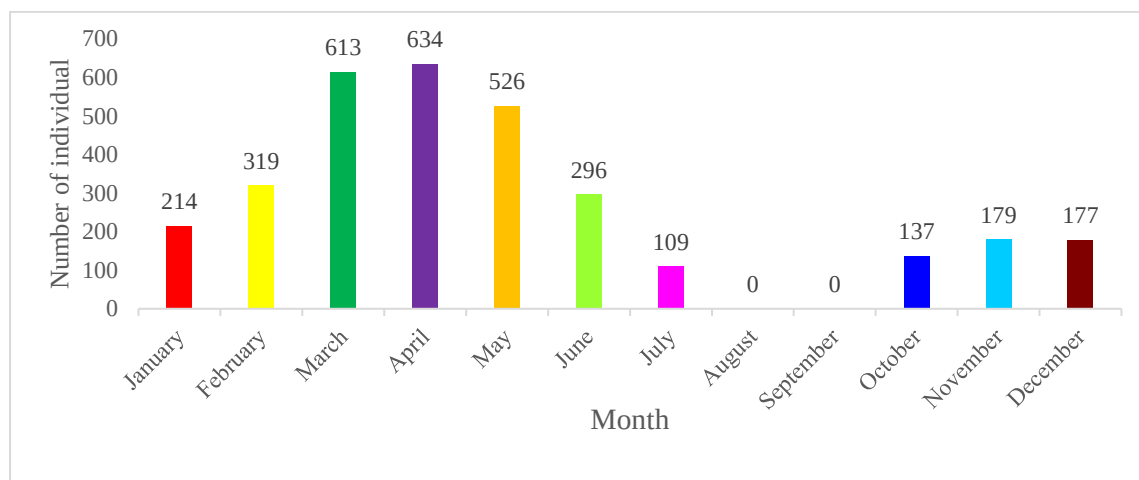


Fig. 3 Monthly comparison of total number of *L. indicus*

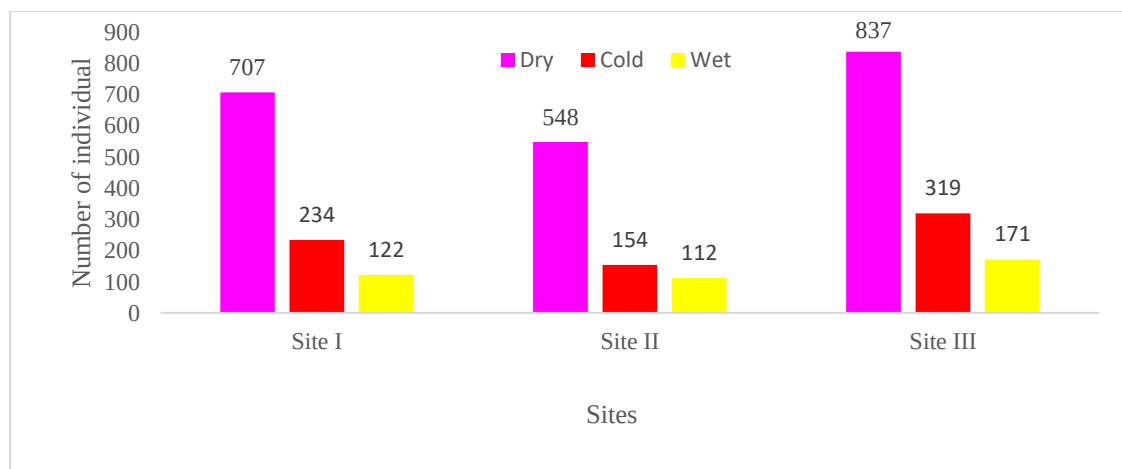


Fig. 4 Seasonally comparison of total number of *L. indicus* between three study sites

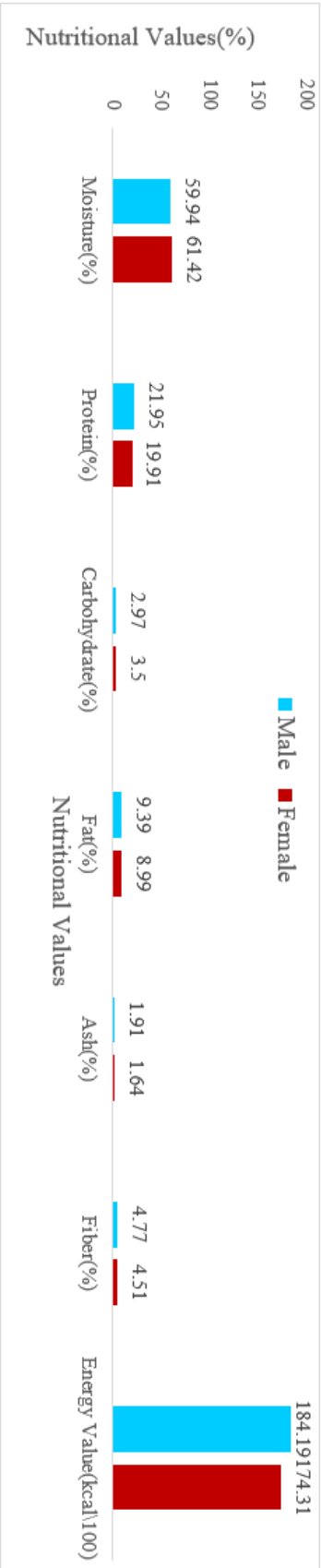


Fig.8 Mean variation of nutritional value of *L. indicus* in three study sites for cool season

Table 7 Mean variation of nutritional Values of *L. indicus* in three study sites for three seasons.

	Moisture (%)		Protein (%)		Carbohydrate (%)		Fat (%)		Ash (%)		Fiber (%)		Energy Value (kcal/100)	
Gender	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Summer	57.9	62.85	22.62	19.78	2.84	3.59	9.95	8.19	1.77	1.17	4.89	4.28	191.39	167.59
Rainy	60.95	64.18	21.83	19.56	2.95	2.98	6.77	6.29	1.58	1.38	5.91	5.6	160.05	146.75
Winter	59.94	61.42	21.95	19.91	2.97	3.5	9.39	8.99	1.91	1.64	4.77	4.51	184.19	174.31

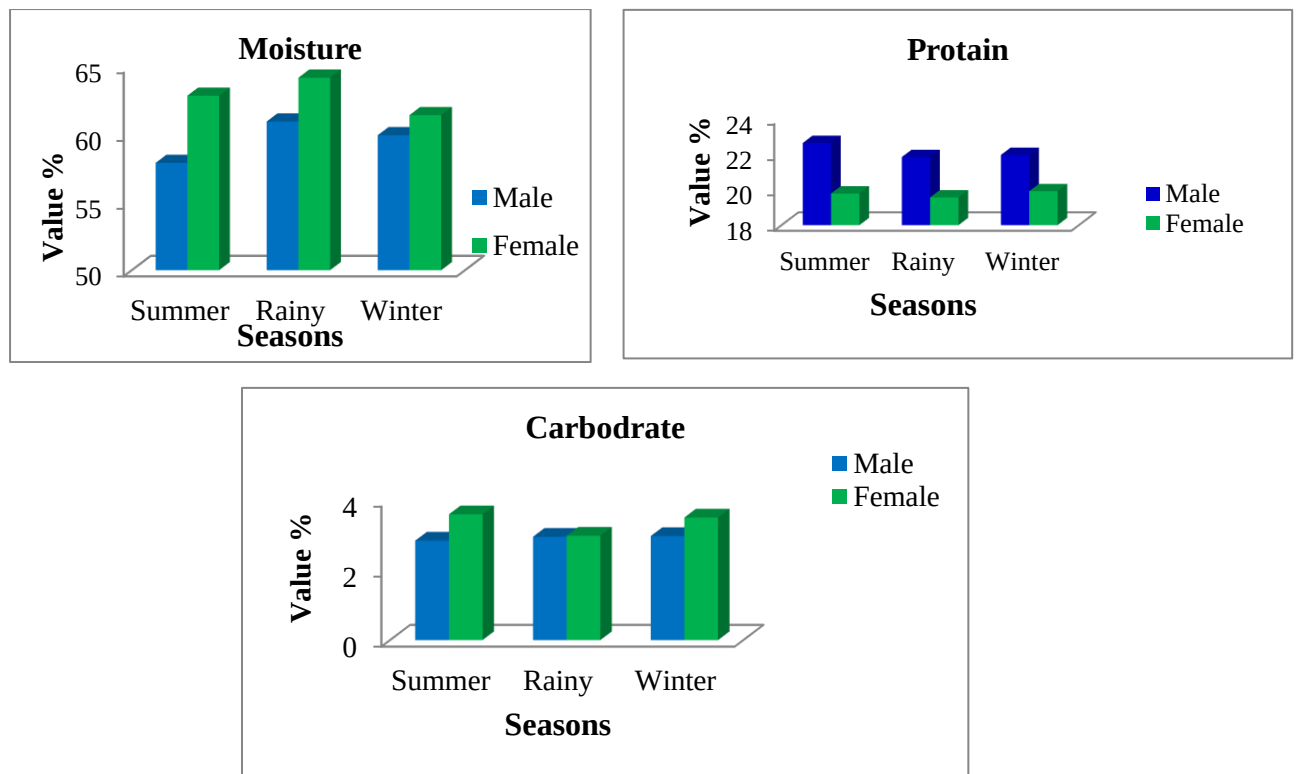


Fig.9 Mean variation of Moisture, Protein and Carbohydrate values of *L. indicus* in three study sites for three seasons

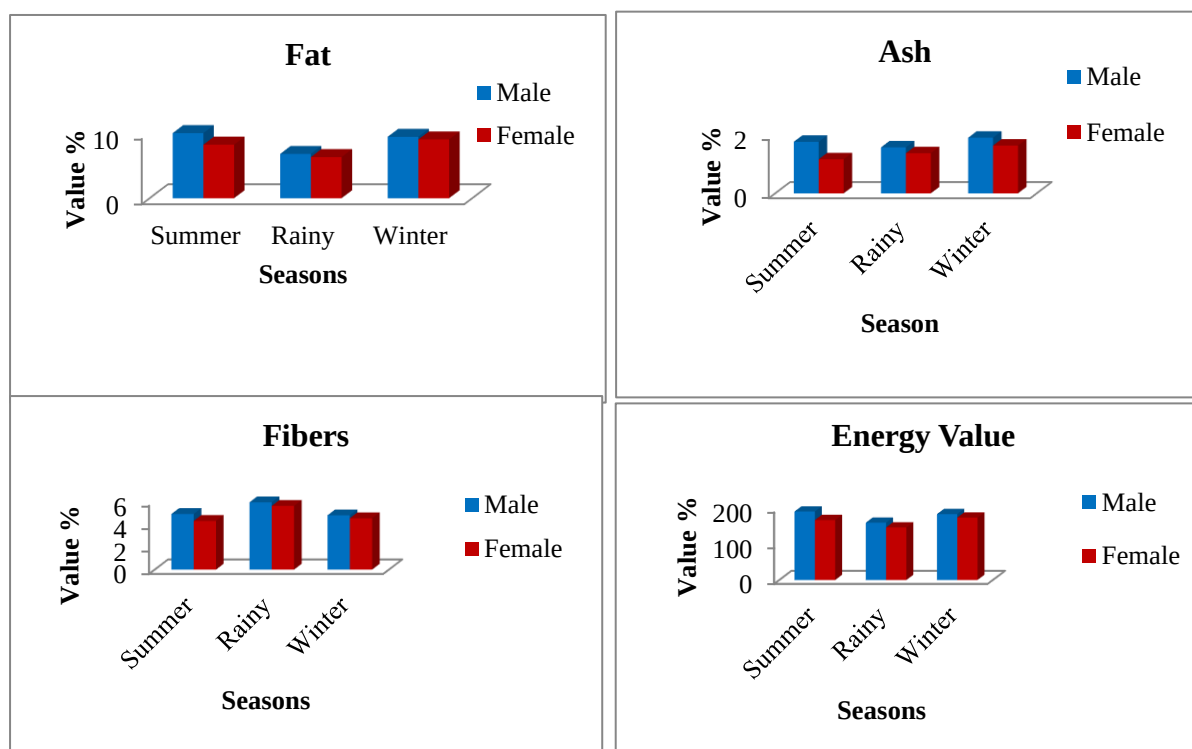


Fig.10 Mean variation of Fat, Ash, Fibers and Energy Values of *L. indicus* in three study sites for three seasons

Discussion

In the present study, a total of 3204 individuals were collected in all study sites. The study species is the largest bug species and they active at night under electric light. Females is larger than males, body length is 73.085 ± 2.435 mm, body width is 28.655 ± 0.715 mm and wing span is 158.14 ± 2.09 mm in males. Female's body length is 89.48 ± 0.44 mm, 32.095 ± 0.065 mm in body width and 167.795 ± 1.845 mm in wing span. Charles & Norman (2005) stated that the species under family *Belostomatidae*, genus *Lethocerus* are true giant water bug and body size range from 65 mm of body length in United States and 100 mm long in South America. Subfamily Lethocerinae contain the giant water bug and some of the world's largest aquatic insects, the body length was 60-110 mm. (Polhemus 2013 and Tran *et al.* 2015). During the study period, female population are higher than male populations in all study sites. Total populations are highest in dry season and lowest in wet season in all study sites. Phyu Phyu Sein, 2008 mentioned the similar finding, in July, August and September, the total population sizes are lowest in all study sites. Nattawut *et al.*, 2019 stated that *L. americanus* and *L. indicus* are migrant species and this behavior occur in early rainy season. According to local people, the female left their laying eggs and fly away during early rainy season. Based on the present study of the nutritive values of insect species, *L. indicus* was highly nutritious as a food source. Edible insects are provided essential nutrients, such as energy, protein, carbohydrates, fat and fiber that could help to daily diets (Bodenheimer, 1951; Paoletti, 2005). Many insect species contained as much or more protein as meat or fish. Protein are not only necessary for hormonal and enzyme development (Wilsom, 1986), but are also an important source of energy (Halver and Hardy, 2002). Ni Ni Khin, 2016 mentioned that the content of protein in edible insects more than in pork. She was stated that the amount of protein is 21.69% in pork, while the amount of protein in edible insect species, *L. indicus* is 21.88%. In the present study, the protein content of *L. indicus* is 19.56% - 22.62%. In the present study, the average amount of protein is 21.42%, carbohydrates is 2.99, fat is 8.26%, fiber is 4.99%, ash is 1.57% and moisture is 61.21% in *L. indicus* species. The finding of the present study is agreement with Ni Ni Khin, 2016. She was stated that the amount of protein is 21.88%, carbohydrates is 2.65%, fat is 8.22%, fiber is 4.97%, ash is 1.03% and moisture is 61.25% in *L. indicus* species. Aside from their nutritional and environmental benefits, expect considerable opportunity for study species to provide income and jobs for rural people.

Conclusion

The population of the species were recorded largest in study site III and follow by site I and site II. The population of the species were recorded largest in dry season and follow by cool season and wet season. Most of the insects are consumed in rural areas but this species does not eat as part of regular diet, which might be due to lack of knowledge about the nutritional benefits of *L. indicus*. The study species, *L. indicus* has high nutritional values as a food source. Giant water bug, *L. indicus* species are one of the natural resources for income of the local people in the study areas.

Acknowledgements

I am greatly thankful to Dr. Than Zaw Oo (Rector), Dr. Thanda, Dr. Thazin Lwin, Dr. Yin Yin Lwin, Pro-rectors West Yangon University for their encouragement, valuable suggestion and permission to conduct this manuscript. My special thanks to Professor Dr. Yi Yi Cho, Head of Zoology Department, West Yangon University for her advice and suggestions throughout my study period. I am grateful to Professor Dr. Htar Htar Kyi Department of Zoology, West Yangon University for permitting us to conduct the present study.

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PETROGRAPHICAL AND GEOCHEMICAL ANALYSIS OF LATERITE AND LATERITIC SOIL IN THANLYIN AREA, YANGON REGION, MYANMAR

Hlaing Myo Nwe¹

Abstract

The research is carried out to explore the lateritization process and its controlling factors of laterite and lateritic soil exposed in the Thanlyin Area, Yangon Region, Myanmar. The investigated area is situated at the southernmost part of Central Basin and the rocks composed in this area are Upper Pegu Group, Irrawaddy Formation, laterite and lateritic soil of Older Alluvium and recent sediments of Younger Alluvium. This study is based on the morphological, petrographical and geochemical analyses of laterite and lateritic soils. Laterite exposed in the southern part displays reddish coloured with wormlike texture. Lateritic soil layers in the middle and northern parts of the area comprise loosely cemented yellowish or reddish coloured soils which covered sandy clay or clayey recent soil layer. According to petrographically analysis, quartz and iron oxides in laterite are transformed from sandstone and shale of the Upper Pegu Group and Irrawaddy Formation. Moreover, iron nodules are not found, pisoliths formed in soil are homogeneous. Therefore, laterite and lateritic soil in study area occurred in soil environments. The composition of Fe_2O_3 percent is the highest in the southern part of the study area and SiO_2 percent is lesser in this area based on the geochemical analysis. Consequently, the SiO_2 percent is higher than Fe_2O_3 percent in the northern part. Therefore, two of these oxides, iron and silica are inversely proportioned in each outcrop. In the correlation between iron and other oxides, Fe_2O_3 increases when SiO_2 , Al_2O_3 , K_2O , MgO , CaO and TiO_2 decrease because the relationship between Fe_2O_3 and the other oxide variables is a negative relationship. Besides, laterite from the southern part of the study area can be assumed as true laterite by Molar ratio. Lateritization stage analysis by Ternary diagram displays moderate and strong lateritization stages in there. Therefore, the laterite and lateritic soil in this area can be more suitable for sculpture and building stones.

Keywords: Laterite, lateritic soil, lateritization process, geochemical analysis, Ternary diagram

Introduction

The research is carried out to explore the lateritization process and its controlling factors in the Thanlyin Area. Laterite and lateritic soils are well exposed in Lower Myanmar which are extensively cropped out in Thanlyin Area and also extend southeastward in the Sittaung-Mokepalin, Chaungzon to Yay Areas. They are derived from weathering of igneous, metamorphic and sedimentary rocks.

Location

The investigated area is located in Thanlyin Township which is very close to Yangon City. It is bounded between north latitude $16^\circ 37'$ to $16^\circ 47'$ and east longitude $96^\circ 13'$ to $96^\circ 19'$. It is included in the UTM map no. 1969-05 and 06. This area is situated at the western part of Thongwa and Khayan Townships, in the eastern part of Yangon River, in the northern part of Kyauktan Township and in the southern part of Bago River. The total coverage of the study area is approximately 176 km^2 which is illustrated in figure (1). This can be accessible conveniently by car, train and waterway because it has located just about 6.4 km from southeast of Yangon City.

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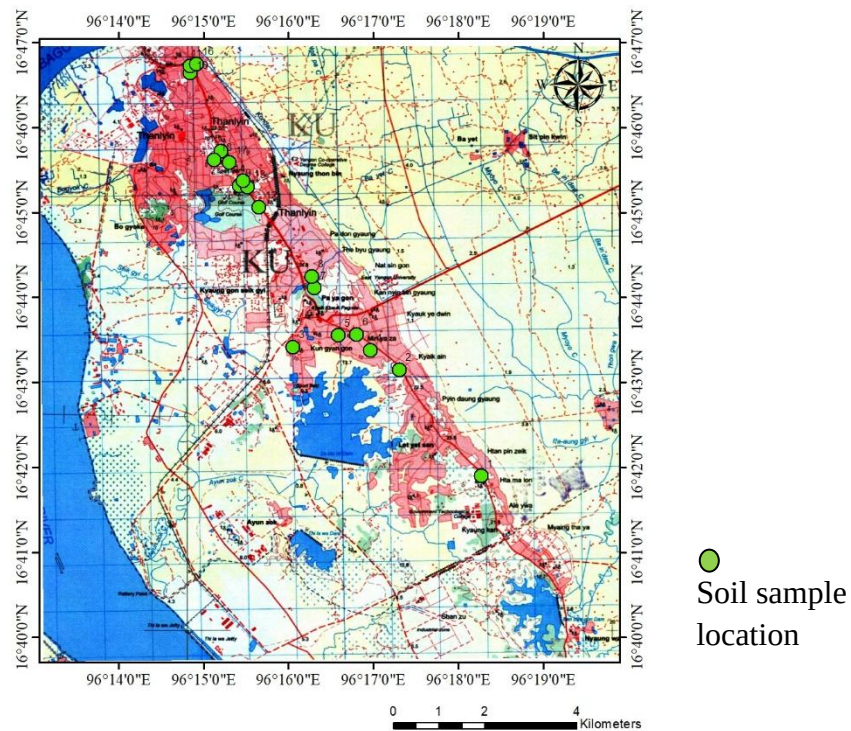


Figure (1) Location map of the research area

Physiography and Drainage

In this research area, hilly terrain occurred along the Thanlyin-Kyauktan area which seems to be extension of Bago Yoma. The rolling hill topography is found along the central part of the study which is trending in northwest- southeast direction as shown in figure (2). The other areas are generally flat plains.

Yangon River flow from north to south at the western part of the study area and its tributaries flow from south to north surging into the Yangon River. The prominent drainage pattern especially dendritic pattern is governed with medium to coarse texture in this area which is displayed in figure (3). Therefore, the arenaceous rocks can be comprised in the area.

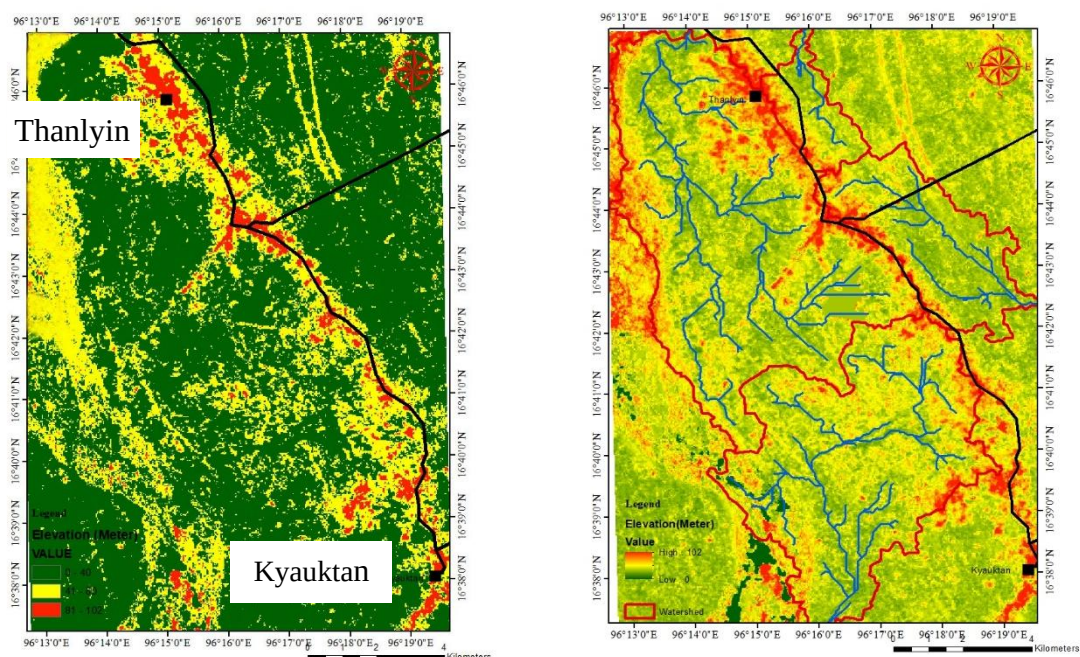


Figure (2) Physiographic map of the study area Figure (3) Drainage map of the study area

Geology of the Research Area

The research area is mainly composed of Miocene and Pliocene sedimentary deposit covered with Quaternary sediments. The rocks of Upper Pegu Group are distributed in the southern part of the area.

Upper Pegu Group

This group comprises the Hlawla Shale, Thadugan Sandstone and Besapat Alternation. The Besapat Alternation is well exposed in this area especially in Hmawun Chaung, Kyauktan area. The rocks in the alternation of fine grained, grey to yellowish brown, fairly hard argillaceous sandstones alternated with shale lamination.

Irrawaddy Formation

This formation consists of Arzanigon sandrocks and Danyingon clay in Upper Miocene to Pliocene in age. The clay unit is poorly exposed in some localities of Thanlyin Golf Club.

Older Alluvium

Laterite and lateritic soils are predominantly composed in the unit which is widely distributed in the study area as shown in figure (4). The other residual soils are exposed in the western part of the Kyaikkauk Range.

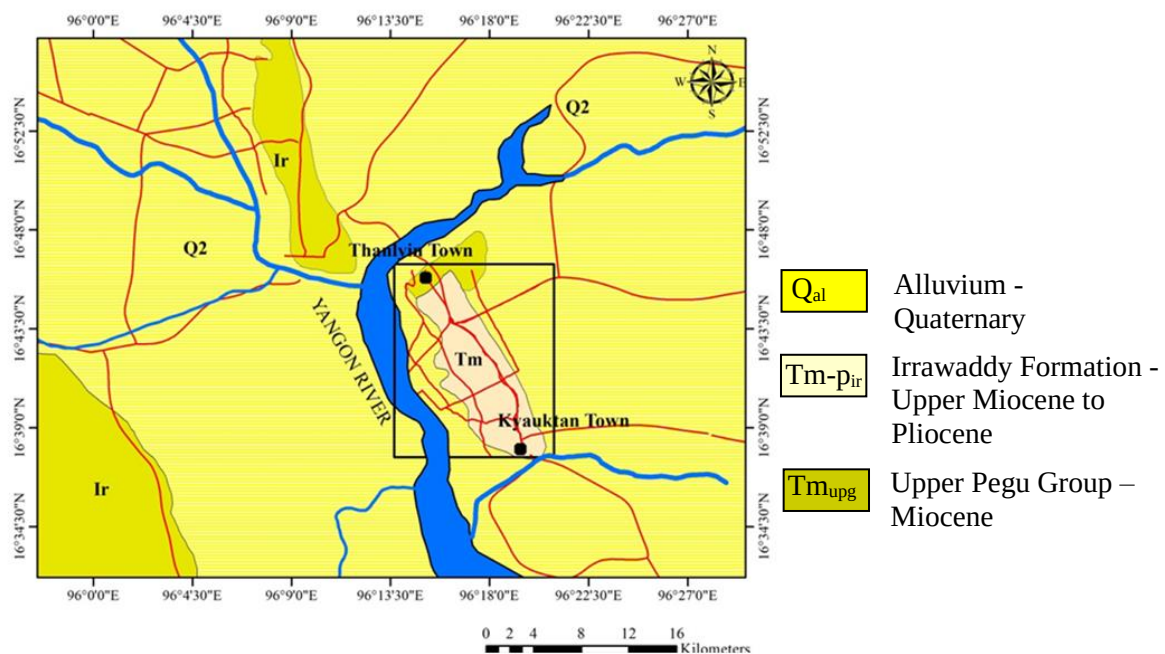


Figure (4) Geological map of the research area (After Kyi Nwe Nwe Aung, 2004)

Aim and Objectives

The main aim of this investigation is to examine laterite morphology as well as type of laterite and lateritization processes on the geochemical data in Thanlyin Area. The objectives are;

- to observe morphology of laterite and lateritic soils in each outcrop
- to explore the mineral assemblages of laterite by petrographic study
- to evaluate the geochemistry of laterite
- to explore the types of laterite on the Ternary diagram
- to interpret the degree of lateritization

Methodology

The literatures such as Buchanan, 1807, Ollier and Rajguru, 1991, McFarlane, 1976, Sivarajasingham et al., 1962 and Aye Thandar Bo, 2001 were collected for this research.

Firstly, field investigation has been done on measurement of laterite outcrop and collection of laterite samples in each outcrop for laboratory analysis.

Some laterite samples were prepared for microscopic study to analysis petrography of laterite. Besides, laterite samples were tested with EDXRF to explore the composition of oxides and elements percent in laterite for laboratory investigation.

The identification and analysis of laterite and lateritic soils were made by using SPSS 16 software based on the geochemical data to construct the histograms and correlation of the elements. Finally, ternary diagram based on SiO_2 , Fe_2O_3 and Al_2O_3 is used to identify the stages of lateritization processes.

Results and Discussions

The samples are collected in (22) locations of Thanlyin area for the laterite and lateritic soils investigation which is illustrated in figure (1).

Morphology and Texture of laterite outcrops

The laterite samples are varied in colour such as whitish grey, reddish yellow, orange red, light yellow. The uppermost layer is recent soil layer. It is consisting of top soil with biomass, thin or absent humus. Laterite outcrops were covered by recent soil (A) layer. The second is laterite (B) layer. It is subdivided into four layers. There are loose whitish coloured clay with insoluble iron and aluminum oxides and quartz (B_1) layer, loosely cemented yellowish or reddish coloured lateritic soil (B_2) layer, reddish coloured highly cemented, wormlike structure laterite (B_3) layer (laterite duricrust) and clayrich or sand-rich (plasmic horizon) (B_4) layer. Laterite layers are divided by underlying weathered bed rock.

In the research area, B_3 layer occurred in the (7) localities. Laterite outcrops are exposed in the southern part of the research area which are reddish coloured, wormlike texture. Other outcrops are loosely cemented yellowish or reddish coloured lateritic soil (B_2) layer covered with recent soil.

In the middle and northern parts of the area, lateritic soil layers are exposed which comprise loosely cemented yellowish or reddish coloured lateritic soil (B_2) layer covered with sandy clay or clayey recent soil layer. Laterite and lateritic soil outcrops are illustrated in figures (5 to 22).

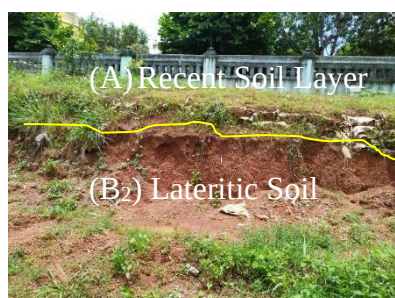


Figure (5) Two layers of laterite outcrop at Location (1)



Figure (6) B_3 layers of laterite outcrop exposed at Location (2)



Figure (7) B_3 layers of laterite outcrop exposed at Location (3)



Figure (8) B₂ layers of lateritic soil outcrop exposed at Location (4)



Figure (9) B₃ layers of laterite outcrop exposed at Location (5)



Figure (10) B₃ layers of laterite (duricrust) outcrop exposed at Location (6)

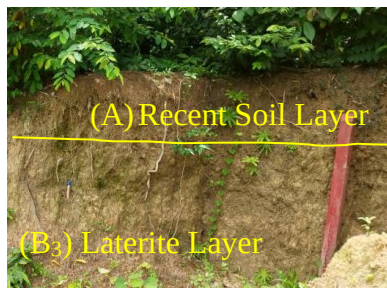


Figure (11) The two layers of laterite outcrop exposed at Location (7)

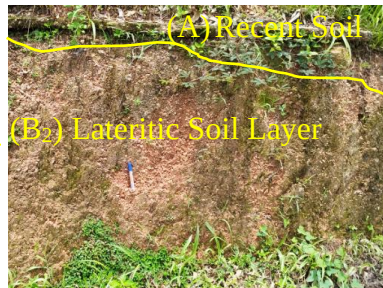


Figure (12) The two layers of laterite outcrop exposed at Location (8)



Figure (13) B₂ layers of lateritic soil outcrop exposed at Location (9)



Figure (14) B₂ layers of lateritic soil outcrop exposed at Location (10)



Figure (15) B₂ layers of Sandy clay soil outcrop exposed at Location (11)



Figure (16) The two layers of lateritic soil outcrop exposed at Location (12)



Figure (17) B₂ layers of lateritic soil outcrop exposed at Location (13)

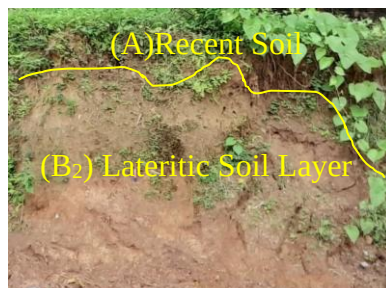


Figure (18) The two layers of outcrop exposed at Location (14)



Figure (19) B₂ layers of lateritic soil outcrop exposed at Location (16)



Figure (20) The two layers of lateritic soil outcrop exposed at Location (20) Figure (21) The two layers of lateritic soil outcrop exposed at Location (21) Figure (22) The two layers of lateritic soil outcrop exposed at Location (21)

Petrographic Studies of Laterite

Petrographic study deals with the classification and description of rocks and the minerals and textural relationship within the rocks are described in detail. The petrographic analysis is done both macroscopically and microscopically. The detailed analysis such as micro-texture and structure of minerals are studied under microscope.

As revealed by petrographic observation, all ferromagnesium minerals have been transformed to a mixture of large quantity of hematite, goethite and less percentages of limonite. The iron minerals are undergoing for lateritization. Quartz is being more resistant minerals in the rock.

In this study, laterite sample of location 1 is made up of medium grained quartz, a few feldspars with iron oxide matrix. Quartz grains occur as poorly sorted, sub-rounded to angular in shape. They are poorly sorted showing a mixture of various sizes. Quartz is essential and feldspar is minor amount. Feldspar grain shows simple contact twin between Cross Nichol. Goethite displays in irregular texture (Figure 23).

The sample in the location 2 contains fine to medium grained quartz, hematite and goethite. Quartz is mainly composed with poorly sorted, sub-rounded to angular nature. Hematite shows reddish brown to dark brown in colour and some of the iron oxide are altered to goethite with pisoliths nature which is illustrated in figure (24).

The sample in the location 3 is mainly composed of fine-grained quartz with hematite matrix. Quartz occurs as sub-rounded to angular fragment which is shown in figure (25).

The laterite sample in the location 4 is mainly composed of fine to medium grained, partly coarse-grained quartz where most of the quartz grains are angular and some occur as sub-rounded grain. Goethite is found along the fracture plane with irregular texture. Hematite occurs as iron oxide groundmass (Figure 26).

In thin sections of location 5, the minerals are mainly composed of medium to coarse grained quartz, dark red hematite and goethite. Reddish brown hematite and black hematite are set in a red hematite matrix. Quartz grains are sub-rounded to angular which are shown in figure (27).

The slide of the location 8 is mainly composed of fine to medium grained, sub rounded to subangular quartz grains. Wormlike nature is noticed, progressive lateritization is observed in the sample (Figure 28).

Petrographic observations of quartz and iron in laterite are transformed from sandstone and shale of Upper Pegu Group and Irrawaddy Formation where also reveal that all the silicate minerals have been transformed to a mixture of Fe and Al oxide and hydroxides.

Pisoliths and nodules can form in a variety of weathering and sedimentary environments. Their morphology and characteristics suggest three common environments of formation, in soil, saprolite and sub-aqueous environments. In this area, iron nodules are not

found, pisoliths formed in soil are homogeneous. Therefore, laterite and lateritic soil in the study area occurred in soil environments.

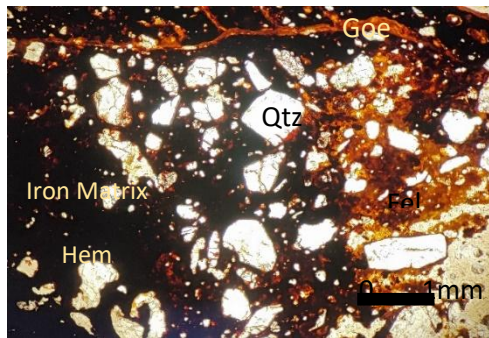


Figure (23) Showing sub-rounded to angular quartz with iron matrix at Location (1)

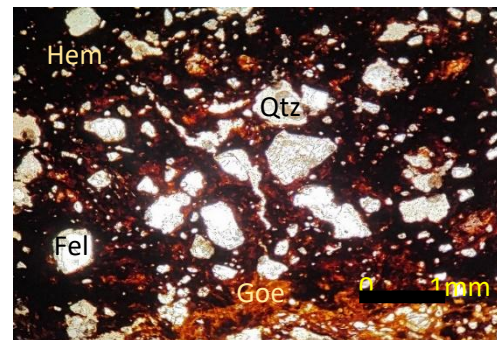


Figure (24) Fine to medium grained quartz, dark red hematite and light red goethite rich at Location (2)

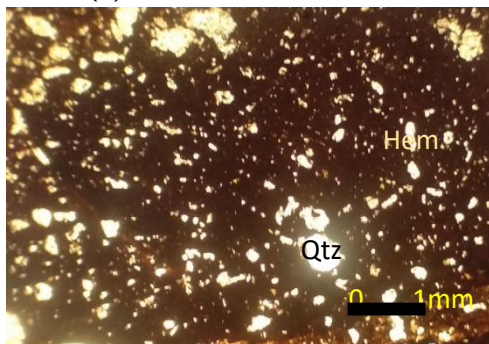


Figure (25) Fine grained, sub-rounded to angular quartz and dark red hematite at Location (3)

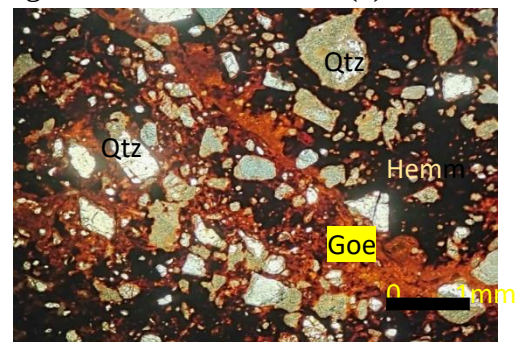


Figure (26) Fine to coarse grained quartz, dark red hematite and light red goethite at Location (4)

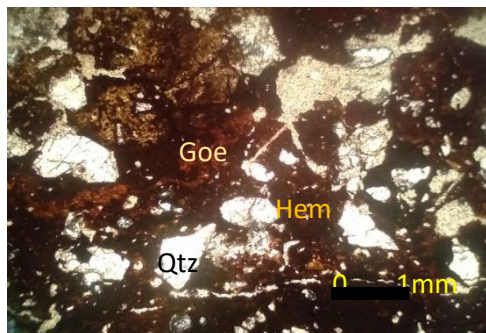


Figure (27) Medium to coarse grained quartz, dark red hematite and red hematite at Location (5)

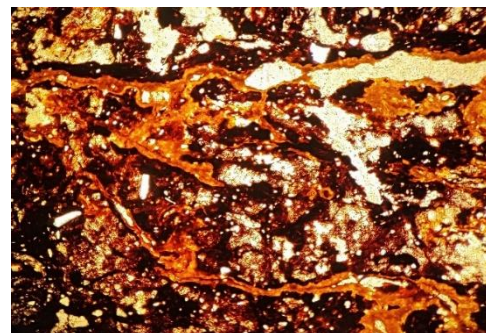


Figure (28) Fine to coarse grained, sub rounded to subangular quartz, dark red hematite and red goethite grains with Pisolithic texture at Location (8)

Geochemical Analysis of the Investigated Area

Geochemical Analysis

Based on the EDXRF results of Thanlyin area, histogram was constructed to analyze oxide distributions of laterite and lateritic soils and correlation of two oxides were also built on these data. Moreover, ternary diagram showing lateritization stages diagram was drawn based on Fe_2O_3 , SiO_2 and Al_2O_3 . Histograms and correlation between iron and others oxides were

made by using SPSS 16 software. In Thanlyin area, composed of (8) major oxides and (30) trace elements. Histogram showing oxides distribution of the studied area as shown in Figure (29).

Distribution of oxides in the study area

The composition of Fe_2O_3 percent is highest in the southern part of the study area and SiO_2 percent is lesser in these areas. Consequently, the SiO_2 percent is higher than Fe_2O_3 percent in the northern part. The highest quantity of iron is 67.7% and the smallest amount is 10%. The range of silica is 14% to 63% in the study area. Two of these oxides, iron and silica are inversely proportional in each outcrop. Al_2O_3 contains moderate percent in all laterite exposures of the study area. The range percent of aluminum oxide is 5.33% to 28.7%. The highest amount of TiO_2 is 1.21% and the least amount is 0.188 %. The highest amount of K_2O is 1.84% and the least amount is 0.1%. Other oxides are not contained in each outcrop. Fe_2O_3 is distributed in all outcrops. The mean value is 33.77 and its standard deviation is 17.372. The distribution of Fe_2O_3 is observed in two populations and shows positive skewness. The mean value of SiO_2 is 42.58 with 13.358 standard deviation. The distribution of SiO_2 shows one population and nearly symmetrical distribution. The mean value of Al_2O_3 is 20.82 and its standard deviation is 6.51. The distribution of Al_2O_3 shows two populations and frequency histogram is negative skewness. The mean value of TiO_2 is 0.82 and the distribution of TiO_2 is observed in one population. The standard deviation of this oxide is 0.33 and frequency histogram is negative skewness. The mean value of K_2O is 0.88 and its standard deviation is 0.438. The distribution of K_2O is observed in two populations. The frequency histogram shows symmetrical distribution. The mean value of MgO is 0.21 and its standard deviation is 0.098. The distribution of MgO is observed in one population. The frequency histogram also shows symmetrical distribution. The mean value of CaO is 0.23 with 0.387 standard deviation. The distribution of CaO is observed in three populations. According to the histogram, most oxides, especially SiO_2 , K_2O and MgO are distributed in every exposure because most of the histogram shows symmetrical distribution. Al_2O_3 and TiO_2 display negative skewness and Fe_2O_3 show positive skewness respectively. Relationships of Fe_2O_3 and Al_2O_3 , and TiO_2 are inversely proportioned in all outcrops.

Correlation between Fe_2O_3 and other oxides

Correlation is a statistical method which is used to determine a relationship between two variables. Measurement of strength of the relationship between two variables is called a correlation coefficient. Firstly, correlation between iron and other elements of the Thanlyin area is constructed. The absolute value of correlation coefficient value (R^2) between Fe_2O_3 and SiO_2 is 0.868. The relationship of these two variables shows moderate. The line of regression can be found as a slope downward line from left to right. The relationship between these two variables is negative. Correlation coefficient value (R^2) between Fe_2O_3 and Al_2O_3 is 0.507. Hence, the relationship of these two variables is also remarked as moderate. The line of regression displays a slight slope downward from left to right. The relationship between these two variables is also negative. The absolute value of correlation coefficient value (R^2) between Fe_2O_3 and K_2O is 0.235. The relationship of these two variables is remarked as moderate. The line of regression can be seen as a slope downward line from left to right. The relationship between these two variables is also negative. The scatter plot of correlation coefficient value (R^2) for Fe_2O_3 and TiO_2 is 0.287 which is situated slope downward from left to right. Correlation coefficient value (R^2) between Fe_2O_3 and CaO is 0.124. The relationship of these two variables is rather moderate. The line of regression is a slope gently downward line from left to right. The relationship between these two variables is a negative relationship. The scatter plot of correlation coefficient value (R^2) between Fe_2O_3 and MgO shows 0.261. The line of

regression of Fe_2O_3 and MgO shows slope downward from left to right. They are in a negative relationship. A positive relationship exists when both variables increase at the same time. In a negative relationship, one variable increase and the other variable decreases (Howarth, R.J, 1983). In the study area, Fe_2O_3 increases when SiO_2 , Al_2O_3 , K_2O , MgO , CaO and TiO_2 decrease because the relationship between Fe_2O_3 and the other oxide variables is a negative relationship. The relationships between iron and other oxides are shown in Figure (30).

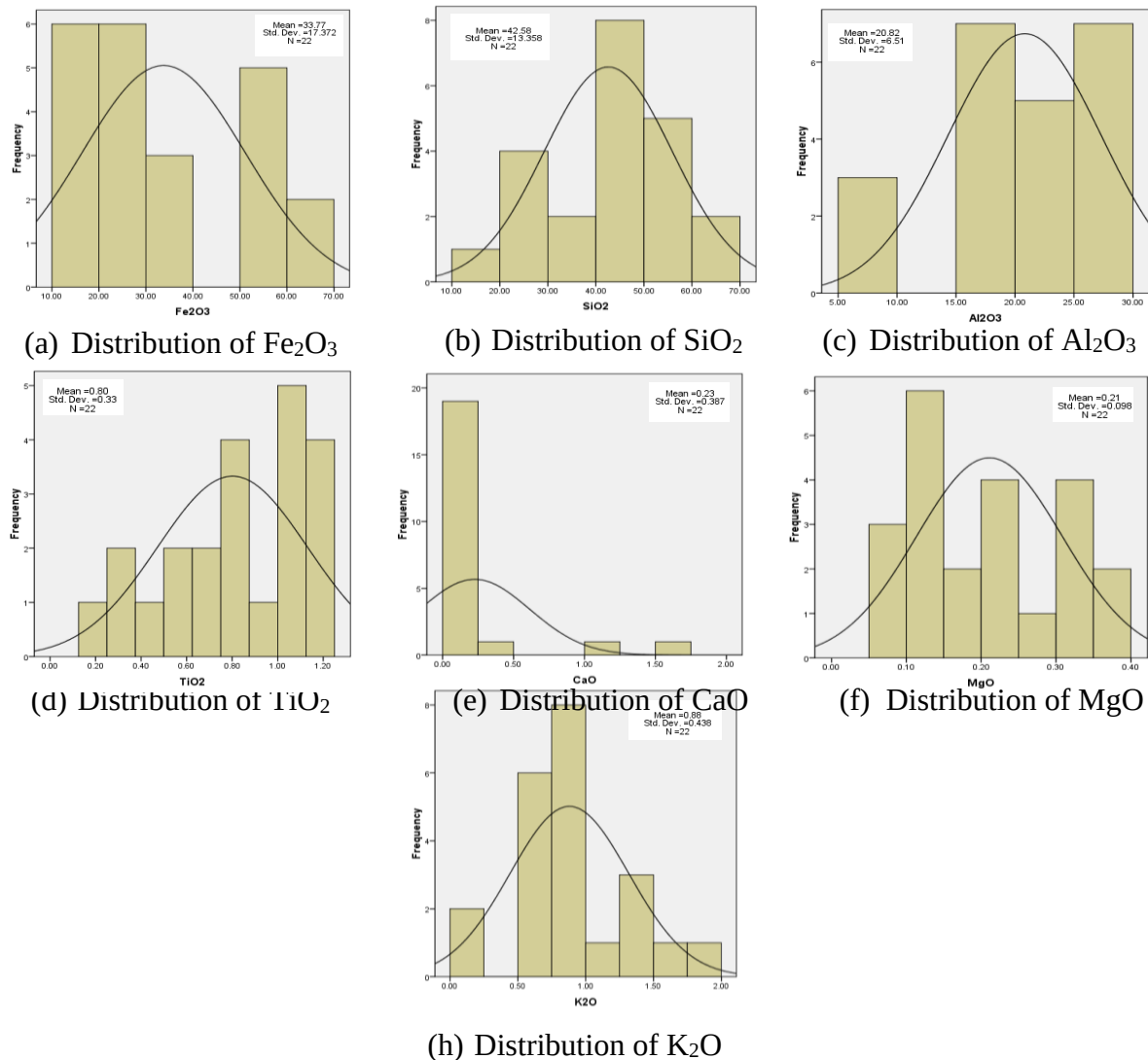


Figure (29) (a-h) Histogram showing distribution of oxides in Thanlyin Area

Identification of Laterite

In Thanlyin area, the composition of SiO_2 , Fe_2O_3 and Al_2O_3 is used to compute according to Molar ratio for classification of laterite type. Ratio less than 1.33 is true laterite, between 1.33 and 2.0 indicate lateritic soils while those greater than 2.0 indicate non-lateritic soils (Person, B.S., 1970).

In the research area, the percentage of each of the three essential constituents is constructed based on Luken's diagram in 1964. And then plot the results in a triangular diagram (Figure.31). Laterite samples at locations 1, 2, 3, 4, 5, 6 and 8 fall in laterite zone. In this zone, the contents of Al_2O_3 and Fe_2O_3 increase and SiO_2 content decreases. In lateritic soil zone, SiO_2 content is more than, and also Al_2O_3 and Fe_2O_3 are lower than the laterite zone. The samples

at locations 7, 9, 10, 12, 13, 14, 16, 17, 18, 19, 20, 21 and 22 lie lateritic soil zone. The samples at locations 15 and 11 fall in non-lateritic zone; these samples contain mainly the quartz than another zone. So, SiO_2 percent is higher than other samples.

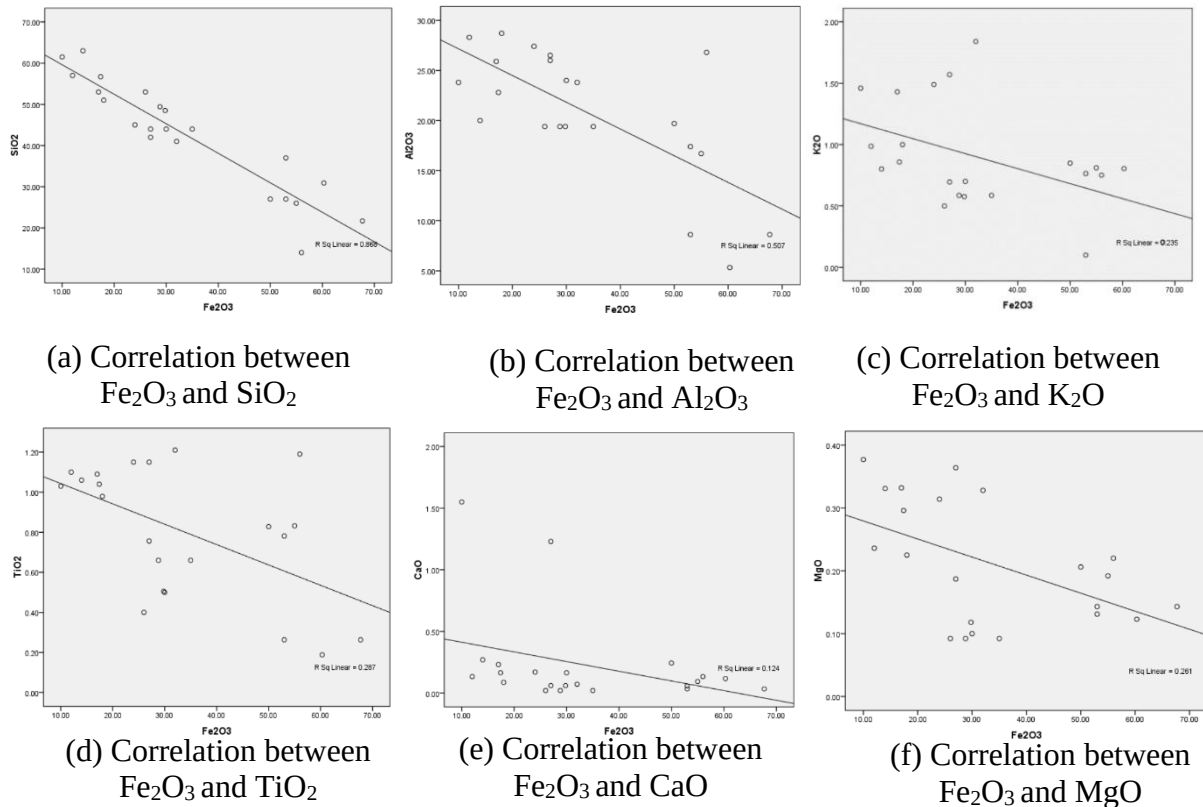


Figure (30) (a-f) Correlation between iron and other oxides in Thanlyin Area

Classification of laterite in study area

Ternary diagram is used to estimate the degree of lateritization in the study area. Schellman (1982) classified laterite by degree of lateritization on a Si-Al-Fe diagram into four stages. These four stages of alteration are classified as lateritization processes: (i) kaolinitization, (ii) weak lateritization, (iii) moderate lateritization, and (iv) strong lateritization. Accordingly, the Schellmann scheme is useful for determining the degree of alteration of laterites. In the Thanlyin area, location 15 and 11 lie in kaolinitization stage. Location 1, 2, 3, 4, 5 and 8 fall in moderate lateritization stage. Moreover, the laterite sample at location 6 falls in strong lateritization stage. The other samples lie weak lateritization stage which is used as subbase materials as shown in figure (32). Besides, the laterites at Natsintayar (location 6) is more indurate than other areas. These can be used as more suitable for sculpture and building stone.

Conclusion

The research is carried out to explore the lateritization process and its controlling factors in the Thanlyin Area. The rocks in this area are composed of Cenozoic sediments especially Neogene sediments. Most of the sediments comprise the rocks of Upper Pegu Group, Irrawaddy Formation, laterite and lateritic soil of Older Alluvium and recent sediments of Younger Alluvium.

The laterite samples are varied in colour such as whitish grey, reddish yellow, orange red, light yellow. The uppermost layer is the recent soil (A) layer. Laterite outcrops were covered by a recent soil (A) layer. The second is the laterite (B) layer. It is subdivided into four layers. There are loose whitish coloured clay with insoluble iron and aluminum oxides and quartz (B₁) layer, loosely cemented yellowish or reddish coloured lateritic soil (B₂) layer, reddish coloured highly cemented, wormlike structure laterite (B₃) layer (laterite duricrust) and clay-rich or sand-rich (plasmic horizon) (B₄) layer. Laterite layers are divided by underlying weathered bedrock.

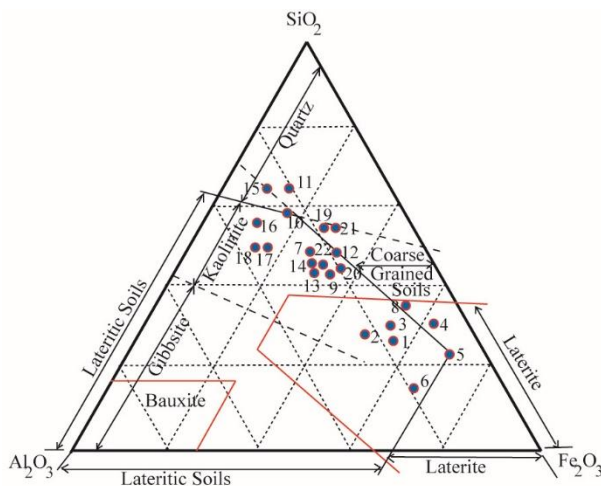


Figure (31) Identification of Laterite in study area based on Lukens's Molar Ratio

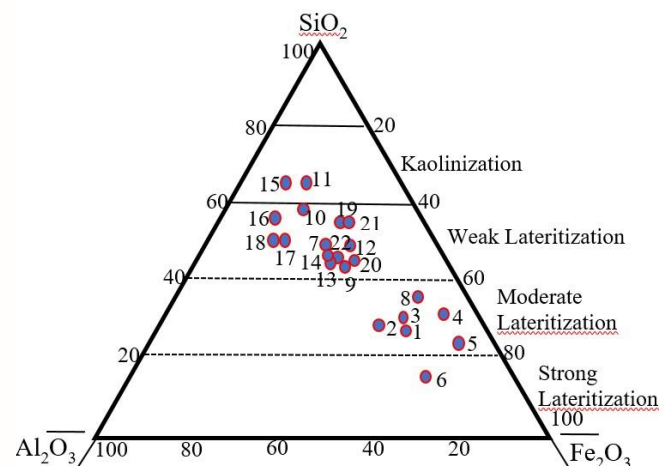


Figure (32) Ternary diagram showing lateritization stage in Thanlyin Area

In the research area, B₃ layer occurred in the (7) localities. Laterite outcrops are exposed in the southern part of the research area which are reddish colour, wormlike texture. Other outcrops are loosely cemented yellowish or reddish coloured lateritic soil (B₂) layer covered with recent soil. In the middle and northern parts of the area, lateritic soil layers are exposed which comprise loosely cemented yellowish or reddish coloured lateritic soil (B₂) layer covered with sandy clay or clayey recent soil layer.

In petrographic identification, all ferromagnesium minerals have been transformed to a mixture of large quantities of hematite, goethite and less percentages of limonite. The presence of quartz is noticed in many samples which were undergone for petrographic studies.

All of the slides contain various sizes of quartz and hematite, goethite minerals. Quartz grains are sub-rounded to angular fragments. Hematite and goethite are found as matrix. Pisoliths and nodules can form in a variety of weathering and sedimentary environments. According to petrographic analysis of laterites, the depositional environments can be suggested as in soil environment, saprolite and sub-aqueous environments. In this area, iron nodules are not found, but pisoliths formed in soil are homogeneous. Therefore, laterite and lateritic soil in the study area occurred in soil environments.

Moreover, according to the laboratory test, laterite and lateritic soils are composed of (8) major oxides and (30) trace elements by EDXRF results. The composition of Fe₂O₃ percent is highest in the southern part of the study area and SiO₂ percent is lesser in this area. Consequently, the SiO₂ percent is higher than Fe₂O₃ percent in the northern part. The highest quantity of iron is 67.7% and the smallest amount is 10%. The range of silica is 14% to 63% in the study area. Two of these oxides, iron and silica are inversely proportioned in each outcrop. Al₂O₃ contains moderate percent in all laterite exposures of the study area. According

to correlation between iron and other oxides, Fe₂O₃ increases when SiO₂, Al₂O₃, K₂O, MgO, CaO and TiO₂ decrease because the relationship between Fe₂O₃ and the other oxide variables is a negative relationship.

Besides, the composition of SiO₂, Fe₂O₃ and Al₂O₃ is used to compute the Molar ratio for classification of laterite type in this area. As the laterite's classification, the southern part of this area falls in the laterite zone. Hence, laterite from the southern part of the study area can be assumed as true laterite. The other two areas, middle part and northern part are lateritic soils except two locations. In the lateritization stage analysis by Ternary diagram, locations 15 and 11 lie in the kaolinization stage. Consequently, locations 1, 2, 3, 4, 5 and 8 fall in moderate lateritization stage. Moreover, the laterite sample at location 6 falls in strong lateritization stage. The other samples lie in a weak lateritization stage which is used as subbase materials. The laterites at Natsintayar (location 6) is more indurate than other areas. Finally, it can be concluded that the laterite and lateritic soil can be more suitable for sculpture and building stones and some can be used as subbase materials.

Acknowledgements

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LEGAL STUDY ON WORKING HOURS OF EMPLOYEES IN MYANMAR

Khaing Khaing Win¹, Thin Thin Wai², Phyu Zin Ei³, Khin Kay Khaing³, Su Su Naing³

Abstract

‘Working hours’ is the period of time that an individual spends at paid work. The concept of decent work emphasizes the importance of working hours as a fundamental aspect of employment that contributes to the well-being and dignity of workers. Myanmar labour laws set a maximum of 8 hours per day and 44 or 48 hours per week for adult employees. Children’s working hours are regulated by the Factories Act and the Shops and Establishments Law. According to these laws, at 14 years old children can be admitted to employment in the daytime. However, working hours for children between the ages of 14 and 16 years shall be no more than four hours in a day and they are not permitted to work overtime. Many children in Myanmar work hours which are almost equal to those of adults. The objectives of this paper are to identify and analyse relevant legal frameworks in Myanmar relating to working hours for employees, describe how the relevant rules are being implemented and enforced, and point to any discrepancy, and set out whether the above complies with international labour or/and human rights standards. The study reviewed relevant literature, including international and domestic legal instruments, and collected data through interviews. Myanmar’s current labor laws do not include and do not specifically limit the employment or work of children and working hours in sectors other than factories, shops and establishments. Appropriate legislative amendments are needed to have fixed working hours for children working outside factories, shops and factories.

Keywords: children, decent work, employees and working hours

Introduction

Work is a fundamental activity that many people engage in almost every day. Because of its significance, closely examining how much time people spend working can provide valuable insights into their lives and the societies in which they live.⁴ The regulation of working hours has been a central focus of labor legislation for over a century, aiming to protect workers’ rights and promote their health, safety, and well-being. The International Labour Organization (ILO) has recognized the importance of limiting working hours since its inception. The Hours of Work (Industry) Convention, 1919 (No. 1) was among the first conventions adopted by the ILO, underscoring the significance of regulating working hours to ensure decent working conditions for workers worldwide. By explicitly acknowledging the right to rest and leisure, both the Universal Declaration of Human Rights (Article 24) and the International Covenant on Economic, Social and Cultural Rights (Article 7) highlight the importance of limiting working hours to achieve a balance between work and other aspects of life. These provisions reflect a commitment to promoting human dignity, social justice, and the well-being of workers. They serve as guiding principles for policymakers, employers, and other stakeholders in labor regulation and practice.⁵

The standard working hours for adult workers in Myanmar are typically 8 hours per day and either 44 or 48 hours per week, depending on the nature of the work. Working hours

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⁴ Charlie Giattino, Esteban Ortiz-Ospina and Max Roser (2013), “Working Hours”, available from: <https://ourworldindata.org/working-hours>.

⁵ The Danish Institute for Human Rights, “Working Hours”, available from: <https://biz.sdg.humanrights.dk/salient-issue/working-hours>.

for children between the ages of 14 and 16 years in Myanmar are legally limited to no more than four hours per day (five hours, if breaks are included), and they are not permitted to work overtime. However, according to the Myanmar Child Labour Survey Report and various media reports, many children often work hours that are almost equal to those of adults.

According to the Myanmar Annual Labour Force Survey 2018, the total population of children (aged 5-17) was 12.4 million. Of these, more than 600,000 are working children, and 430,000 were found in child labour.⁶ Here, the terms 'child', 'child labour', and 'working children' are defined as follows:

The term "child" is defined as a person under 18 years of age.⁷

There is no official definition of child labor in Myanmar. However, classifications can be made based on the definitions used in the Myanmar Annual Labor Survey and the ILO. The definition of Myanmar's annual labor survey is consistent with the resolution of the 18th International Conference of Labor Statisticians. According to the ILO, "child labor" refers to work that is:

- Mentally, physically, socially, or morally dangerous and harmful to children
- Interfering with their schooling by depriving them of the opportunity to attend school, obliging them to leave school prematurely, or requiring them to combine school attendance with excessively long and heavy work.⁸

According to the Annual Labour Force Survey 2020, the following types of working children are considered as child labour:

1. Those aged 5-18 who are engaged in hazardous work for pay or profit for at least one hour per week or working at night (6 pm to 6 am) for pay or profit; or
2. Those aged 5-14 who are engaged for at least one hour per week for pay or profit; or
3. Those aged 14-16 who are engaged for more than 24 hours per week; or
4. Those aged 16-18 who are engaged in work for more than 44 hours a week for pay or profit.

In some cases, children may be involved in activities such as helping their families with household chores or engaging in light work that does not interfere with their education or well-being. These children are typically referred to as "working children" rather than being labeled as engaged in child labor.⁹ This distinction is important to acknowledge, as not all work performed by children is considered harmful or exploitative. The key factors are whether the work adversely affects their health, development, or schooling.

Many children in Myanmar are engaged in various forms of work, including those in teashops, restaurants, factories, construction, mining, tourism, farms, and plantations.¹⁰ In practice, children work an average of 51.7 hours per week, more than seven hours per day, so educational and recreational opportunities for these children are diminishing.¹¹ This study

⁶ Annual Labour Force Survey, 2018, Quarterly Report, (1st Quarter, February-April 2018), The Government of the Republic of the Union of Myanmar Ministry of Labour, Immigration and Population Department of Labour, 2019, p-8.

⁷ Article 1 of the United Nations Convention on the Rights of the Child (1989), Article 2 of the Worst Forms of Child Labour Convention (1999) and Section 3(b) of the Child Rights Law (2019).

⁸ International Programme on the Elimination of Child Labour (IPEC), "What is child labour", available from: <https://www.ilo.org/ipec/facts/lang-en/index.htm>.

⁹ Annual Labour Force Survey, 2020, First Semi-Annual Report (January to March 2020), The Government of the Republic of the Union of Myanmar Ministry of Labour, Immigration and Population Department of Labour, 2021, p-3.

¹⁰ Children's Rights and Business in Myanmar, April 2017, Myanmar Centre for Responsible Business, p-20.

¹¹ Ministry of Labour, Immigration and Population, 2016, Myanmar Child Labour Survey Report 2015, p-85.

focuses on the working hours of employees/workers. In particular, since children are a vulnerable group, the study is based on children's rights in relation to working hours under international and domestic law. The objectives of this paper are to identify and analyse relevant legal frameworks in Myanmar relating to working hours for employees/workers, describe how the relevant rules are being implemented and enforced, and point to any discrepancy, and set out whether, or to what extent, the above complies with international labour or/and human rights standards. The research questions driving the study are as follows:

1. Are the laws of Myanmar relating to the protection of adult employees/workers and working children in compliance with international labour and human rights standards?
2. What measures can be taken to ensure that working children access rights that may be threatened due to their working hours?

Research Methodology

The study examined relevant literature including international and domestic legal instruments. International legal instruments including the Convention on the Rights of the Child, the Minimum Age Convention, the Worst Forms of Child Labour Convention, the Universal Declaration of Human Rights, and the International Covenant on Economic, Social and Cultural Rights. Domestic legal instruments include the Child Rights Law 2019, the Myanmar Factories Act 1951 (amended in 2016) and the Shops and Establishments Law 2016. Data collection was done from books, articles, research papers, reports and interviews. The 2015 Myanmar Child Labour Survey Report was referred to as a source of empirical data concerning the actual working hours of children in Myanmar, while the source for the number of children engaged in child labour and the number of working children in Myanmar was the 2018 Annual Labour Force Survey Report and 2020 Annual Labour Force Survey Report. Both these survey reports are collated by the Ministry of Labour, Immigration and Population which collected data in every state and division of Myanmar, other than in insecure areas.

International Labour and Human Rights Standards on Protection of Employees at Work

Working hours regulation has long been a central issue in labor rights and employment law, drawing attention from international organizations and national legislatures. This focus is on rest, which is essential to worker health and productivity. It reflects the critical importance of balancing work with health and personal life. Working Hours (Industry) Convention, 1919 (No. 1) was one of the first ILO Conventions to establish 8-hours working day and a 48-hour working week for adults as the standard, with a few exceptions under special circumstances.¹² The Forty-hour week Convention, 1935 (No. 47) moved towards shorter working hours and advocated a gradual reduction of the work week to 40 hours without reducing workers' wages.¹³ The regulation of working hours for adult workers in commerce and offices is dealt with by the Working Hours (commerce and Offices) Convention of 1930 (No. 30), adopted by the International Labor Organization (ILO). This Convention emphasizes the importance of limiting working hours to protect the health and well-being of workers, and lays down specific guidelines to ensure just and reasonable working conditions. The inclusion of fixed working hours as a right in the UDHR¹⁴ and the ICESCR¹⁵ highlights the universal recognition of the

¹² Article 2 of the Hours of Work (Industry) Convention, 1919 (No. 1).

¹³ Article 1 of the Forty-Hour Week Convention, 1935 (No. 47).

¹⁴ Article 24 of the Universal Declaration of Human Rights.

¹⁵ Article 7 of the International Covenant on Economic, Social and Cultural Rights.

need for fair working conditions. It not only protects the health and well-being of workers, but also promotes a fairer and more humane work environment around the world. These standards guide national laws to ensure the right to rest and recreation as a fundamental aspect of human rights.

Children who are legally entitled to work have both a real right to work and a right to protection from work. The UNCRC's mandates regarding child labor are vital for protecting children's rights and ensuring their well-being. By setting a minimum age for employment, regulating working hours and conditions, and enforcing these standards through penalties and sanctions, the convention provides a strong framework for eliminating child labor. States Parties are tasked with adopting a comprehensive approach that includes legislative, administrative, social, and educational measures to fully implement these principles, ensuring that children are safeguarded from exploitation and have the opportunity to thrive.¹⁶

The Minimum Age Convention, 1973 (No. 138), plays a vital role in protecting children and adolescents from labor exploitation and ensuring their rights to education and safe working conditions. A minimum age agreement regarding the minimum age for admission to employment or work; 1973 (No. 138) set the general minimum age for entry to employment or work at 15¹⁷ (or 14 for developing countries)¹⁸ and at least 18 for hazardous work¹⁹ (16 under some strict conditions)²⁰. In addition, The Convention's light work provision allows children "between the ages of 13 and 15"²¹ (or between the ages of 12 and 14 in developing countries)²² to perform up to 14 hours of light work per week. The types of work classified as the worst forms of child labor are completely unacceptable to all children under the age of 18²³, and their abolition is a matter of immediate urgency action.²⁴ According to international labour standards, "adolescents over the age of 16 are allowed to work the same hours as adults",²⁵ but "overtime and night work are strictly prohibited in order to obtain adequate rest and leisure time".²⁶

Myanmar's Domestic Legislation on Protection of Employees/Worker at Work

Regarding the protection of employees/workers in the workplace, the following provisions are found in the Constitution of 2008.

The Union should enact laws necessary to protect workers' rights.²⁷

All citizens should have equal employment opportunities.²⁸

The Union protects individuals from exploitation while allowing for certain civic responsibilities and lawful punishments.²⁹

¹⁶ Article 32 of the United Nations Convention on the Rights of the Child, 1989.

¹⁷ Article 2(3) of the Minimum Age Convention, 1973 (No.138).

¹⁸ Article 2(4) of the Minimum Age Convention, 1973 (No.138).

¹⁹ Article 3(1) of the Minimum Age Convention, 1973 (No.138).

²⁰ Article 3(3) of the Minimum Age Convention, 1973 (No.138).

²¹ Article 7(1) of the Minimum Age Convention, 1973 (No.138).

²² Article 7(4) of the Minimum Age Convention, 1973 (No.138).

²³ Article 2 of the Worst Forms of Child Labour Convention 1999 (No. 182).

²⁴ Article 1 of the Worst Forms of Child Labour Convention 1999 (No. 182).

²⁵ Hours of Work (Industry) Convention, 1919 (No-1).

²⁶ The ILO Night Work of Young Persons (Non-Industrial Occupations) Convention, 1946(No.79) and the ILO Night Work of Young Persons (Industry) Convention (Revised), 1948 (No.90).

²⁷ Section 24 of the Constitution of the Republic of the Union of Myanmar (2008).

²⁸ Section 349 of the Constitution of the Republic of the Union of Myanmar (2008).

²⁹ Section 359 of the Constitution of the Republic of the Union of Myanmar (2008).

Working hours are regulated in various laws, the most important of which are the Shops and Establishments Law (2016) and the Factories Act (1951) as amended in 2016.

Working hours for adult employees in Myanmar are limited by the nature of the work. Employees from shops, companies, trading centers, service enterprises, places of establishment and establishments may work up to 8 hours per day, 48 hours per week plus a maximum of 12 hours overtime per week; up to 16 hours per week if there is a special case for overtime.³⁰ It is “8 hours per day”, “44 hours per week, and not more than 48 hours per week for specific purposes” for workers from factories.³¹ Overtime work can be granted through prior approval under the Factories and General Labour Laws Inspection Department. With respect to the provisions of working hours for adult oil workers in oilfields and mines, it is “44 hours per week, and not more than 48 hours per week for specific purposes”³².

Regarding the provisions on rest breaks, “the prescribed minimum rest period is 30 minutes after four hours of work in shops and establishment”³³, and “30 minutes after five hours of work in the factories”³⁴.

If any adult employee working in a shop or establishment is forced to work for four consecutive hours without a break of at least 30 minutes on any day, the offending employer shall be punished with imprisonment for a term not exceeding three months or a minimum fine of one million kyats to a maximum of three million kyats, or both punishments shall be imposed.³⁵ If it is contrary to the provisions of the Factory Act, the offending employer or factory manager shall be punished with imprisonment for a term not exceeding three months or a fine not less than two million kyats or both punishments.³⁶

In connection with the provisions for shift workers, working hours and rest breaks for shift workers must be approved by the Directorate of Labour and Factories and General Labour Laws Inspection Department. The Factories Act (1951) states that shift systems cannot be arranged such that more than one relay of employees is engaged in work of the same kind at the same time. Mandatory overtime payments must be paid for every hour/day worked beyond the prescribed limits.

Children younger than 14 are not considered employable and are thus prohibited from engaging in any form of employment.³⁷ Myanmar Labour laws prohibit children from engaging in hazardous or dangerous work that is likely to jeopardize their health, safety, or morals.³⁸ Employers should not employ children between the ages of 14 and 16 for more than 4 hours (a maximum of 5 hours if breaks are included).³⁹ They should not be forced to work at night times and overtime.⁴⁰

Current Situations concerning Working Hours of Employees/Workers in Myanmar

According to the interviews for this study, adult employees/workers work more than the legal maximum number of hours per day in certain circumstances, however, the adult

³⁰ Section 11 (a)(b) of the Shops and Establishments Law, 2016.

³¹ Section 62 and 59 of the Factories Act 1951, amended in 2016.

³² Section 30 of the Oilfield (Workers and Welfare) Act, 1951.

³³ Section 12 (a) of the Shops and Establishments Law, 2016.

³⁴ Section 63 of the Factories Act 1951, amended in 2016.

³⁵ Section 26 of the Shops and Establishments Law, 2016.

³⁶ Section 85 of the Factories Act 1951, amended in 2016.

³⁷ Section 48 (b) of the Child Rights Law (2019), Section 13 (a) of the Shops and Establishments Law (2016) & Section 76 of the Factories Act 1951, amended in 2016.

³⁸ Section 14 (d) of the Shops and Establishments Law, 2016 and Section 29 of the Factories Act 1951.

³⁹ Section 14 (a) of the Shops and Establishments law 2016 and Section 79 (1) (a) of the Factories Act 1951.

⁴⁰ Section 14(b) of the Shops and Establishments Law 2016 and Section 79(1)(b) of the Factories Act 1951.

workers receive overtime pay for working overtime hours and are satisfied without any difficulties. If any dispute arises, it is settled by the decision of the dispute settlement conciliation body, arbitration body and arbitration council.

However, most children in Myanmar work almost the same hours as adults. According to the 2015 Myanmar Child Labor Survey, child laborers work an average of 51.7 hours per week, with boys working 51 hours or more and girls working more than 52 hours. Children's educational and recreational opportunities are significantly reduced if they work more than seven hours a day.⁴¹ Children aged 12-14 and 15-17 work an average of 52 hours per week.⁴² These findings underscore the challenges faced by children in Myanmar who are engaged in labor at the expense of their education, well-being, and development. Addressing child labor issues requires concerted efforts from government agencies, civil society organizations, and communities to enforce existing labor laws, provide support services for vulnerable families, and promote access to quality education for all children.

The following incidents, reported in the local media, are examples of non-compliance with legal provisions. Myanmar Now journal reported that Ma Htet Htet Zaw, a 12-year-old girl and a third-grade student, was sent by her mother to work at Swe Nyi Naung Store on Monywa Road, Aung Mingalar Highway Bus Terminal, Yangon for 35,000 kyats per month because it was difficult for her to stay in school. At the store, Htet Htet Zaw had to work from 7 am to 11:30 pm every day. Human rights activists report that children are living in the workplace and working more than 16 hours a day, with some children getting as little as three hours of sleep a night.⁴³ In another case, Maung Chit Min Htwe, a 12-year-old and a fourth grade student, dropped out of school to work for his struggling parents. He had to work from 6:30 am to 7:30 pm at the sack factory in the Hlaing Tharya Industrial Zone, Yangon.⁴⁴

According to the interview for this paper, these events relating to work hours show that measures must be taken by the authorities concerned to ensure that such children are given their right to proper working hours, a break, time to sleep, days off, and the right to study part-time. In addition, officials should conduct regular inspections to see how employers treat working children. In addition to routine inspections, spot inspections should also be done.

Implementation to Protect Children and Young People at Work

Labour and workplace inspections are typically carried out by government agencies such as the Labor Inspection Department under the Ministry of Labour. These inspections are important to ensure that employers comply with labor laws and workplace safety regulations, and they protect the rights and well-being of workers. However, there are not enough labor inspectors and the ability to conduct thorough inspections is weak. Child labor often occurs in sectors or industries where inspections are less frequent or where informal employment is prevalent. If there are not enough inspectors to conduct thorough and regular inspections in various sectors, child labor can really slip through the cracks and go undetected. Nevertheless, if child labor is found in the workplace, it is reported to the Department of Social Welfare. The Department of Social Services is responsible for the child and has a responsibility to work with the child's family and employer to ensure there is a follow-up and remedial plan in place. However, like the Labour Inspectorate, it is also hindered by capacity constraints as it does not

⁴¹ Ministry of Labour, Immigration and Population, 2016, Myanmar Child Labour Survey Report 2015, p-60.

⁴² Ibid, p-85.

⁴³ Ei Cherry Aung, Weak laws: Child labour is being abused because of poverty, Myanmar Now, published on 4 April 2017, available at: <http://myanmar-now.org/mm/news/739>.

⁴⁴ Win Nada, "The dream of a clever son who was crushed in a machine", Myanmar Now, published on 11 Jan 2019, available at: <http://myanmar-now.org/mm/news/553>.

have the required number of trained social workers who can manage cases. In addition, the Labor Inspectorate does not have the authority to inspect informal sectors and farms where child labor is prevalent. Related to this is that an initiative of the Myanmar Program for the Elimination of Child Labor (My-PEC) project to provide training for labor inspectors and other officials, including the police, is an important step in building capacity to deal effectively with child labour. In addition, the ILO's recommendations emphasize the importance of a coordinated approach involving all stakeholders to effectively address child labor. By working together through mechanisms like the tripartite structure, governments, employers, trade unions, and civil society organizations can leverage their respective strengths and resources to create an environment where child labor is not tolerated, and children are protected, educated, and given opportunities for a better future.⁴⁵ The Myanmar Mobile Education Project (myME) appears to be working to address the educational needs of marginalized and vulnerable children in Myanmar. By targeting places like tea shops restaurants, monasteries and poor communities, myME connects children who would otherwise be excluded from the formal education system due to various socio-economic conditions. Such initiatives promote inclusive and equitable education. Fulfilling children's right to education is essential for achieving sustainable development in the country.⁴⁶

Table: International, Domestic Legal Frameworks and Current Situation on Work Hours

Age	International Legal Framework	Domestic Legal Framework	Current Situation
Adults (Over 18 Years)	-8 hours in the day -48 hours in the week ⁴⁷	-8 hours per day -44 or 48 hours per week ⁴⁸	-8 hours a day -48 hours a week -56 hours a week including overtime hours ⁴⁹
Children (Under 18 years)	Over 16 years -allow same working hours as adults -prohibit overtime hours and night work 15 years (14 years for developing countries) -regulate the number of working hours by the governments ⁵⁰	Between 16-18 years-old -allow same working hours as adults -prohibit overtime hours and night work Between 14-16 years-old -allow 4 hours a day -allow 5 hours including interval for rest -prohibit overtime hours and between 6 p.m. and 6 a.m. ⁵¹	Between 16-18 years-old work -60 hours or more per week ⁵² Between 13-15 years-old work 45-60 hours per week ⁵³

⁴⁵ Children's Rights and Business in Myanmar, Myanmar Centre for Responsible Business, April 2017, p-30.

⁴⁶ Children's Rights and Business in Myanmar, Myanmar Centre for Responsible Business, April 2017, p-28.

⁴⁷ Hours of Work (Industry) Convention, 1919 & Hours of Work (Commerce and Offices) Convention, 1930.

⁴⁸ Factories Act 1951 (amended in 2016), Oilfield (Workers and Welfare) Act & Shops and Establishments Law 2016.

⁴⁹ Questioning 20 employees/workers who work in the companies, factories, and shops.

⁵⁰ Minimum Age Convention, Minimum Age Recommendation, ILO Night Work of Young Persons (Non-Industrial Occupations) Convention, & ILO Night Work of Young Persons (Industry) Convention.

⁵¹ Factories Act 1951 (amended in 2016) & Shops and Establishments Law 2016.

⁵² Questioning 5 boys who work in a restaurant and a purified water factory.

⁵³ Questioning 5 boys and girl who work in restaurants.

Finding

Article 32 of the UNCRC requires that every child be protected from work that may endanger or interfere with their education or jeopardize their health or development. The use of the words "every child" makes it obvious that this Article applies to all working children whether the work they are employed in is legal or not. In respect of working hours of children in Myanmar, it has been found that although Myanmar's Factories Act, 1951 and the Shops and Establishments Law, 2016 provide that children between the ages of 14 and 16 are only allowed to work for four hours a day, must not be made to work between 6 pm and 6 am; or to work overtime hours; nor be allowed to work in more than one workplace on the same day, in practice these laws are often broken. This discrepancy between law and practice is borne out by the Myanmar Child Labour Survey Report 2015. This shortcoming needs to be addressed since children often work for long hours, beyond the legal maximum, which has been recognised as a sub-category of hazardous labour under the ILO Recommendation No. 190 and adversely affects their mental and physical development. It is essential that all employers ensure that children realise their right to be protected from hazardous work, as stated in Article 32 of the CRC. One method of addressing the issue would be to introduce an effective monitoring system that could ensure implementation of the legal provisions on working hours for children.

It has also been found that existing labour laws cover only the formal employment sector such as factories, shops and establishments. This means that although there are a great many children working in the informal sector, in teashops, doing domestic work, on farms etc. these children receive no legal protection. The Labour Department needs to take steps to extend protection measures to cover the informal sector. Additionally, a provision in the amended Factories Act prohibits children from working in "the worst forms of labor, such as in hazardous conditions, conditions injurious to health, or conditions that impede education". However, implementation of the Law is insufficient to prevent child labour. This inadequacy is due to the prevalence of work in the informal economy and insufficient staff to address all cases, a general lack of legal awareness by employers and workers, the lack of monitoring mechanisms and corruption.

Recommendations

According to international labour standards, States must protect working children and guarantee their rights concerning working hours. Children who are allowed to work under the law should be protected by ensuring that they get their rights at work, with regard to the type of work they do and especially with regard to their working hours. Employers should adhere to the hours stipulated by law. In Myanmar, under the Shops and Establishments Act 2016 and the Factories Act 1951, amended in 2016, factory employers cannot employ children under the age of 16 in regular full-time work. They may not employ children between the ages of 14 and 15 for more than four hours per day (a maximum of five hours including breaks). They are not allowed to make them work at night, nor require them to work overtime hours. It has been seen however that children, including underage children, often work for extremely long hours, beyond this legal maximum, as seen in the data of the Myanmar Child Labour Survey Report 2015. This difference between law and practice needs to be corrected.

The following are possible approaches to address this implementation gap:

- All employers require a fitness certificate from a recognized authority confirming the child's age.
- The establishing of alternative methods to confirm age, including: medical examination prior to employment, inspection of documents and affidavits (such as National Registration Card, township registration or birth certificate), end of compulsory

schooling certificate for those above minimum age, school enrolment certificate for those in light work.

- Regular monitoring and inspections as well as spot checks should be undertaken by the Labour Department to ensure that the working hours and types of work conform to legal requirements.
- Increase parent's wages so as to reduce the hours children need to work.
- Take steps to ensure that child workers receive proper on-the-job training. (TVET could be introduced in the workplace)
- Make it mandatory for employers to be able to prove that a child worker has not worked in some other factory or workplace during the same day.
- Reduce working hours that exceed the legal limit, but do not reduce wages along with hours. (This will give child workers time to attend school without reducing family income).

Conclusion

International and domestic laws permit children and adolescents to participate in work that does not negatively affect their health and personal development or interfere with their schooling, and generally regard such work as being positive. It contributes to children's development and to the welfare of their families; it provides them with skills and experience and helps to prepare them to be useful and productive members of society during their adult life. Thus, not all work is harmful to children and should not be equated with child labour. Work can help children gain skills, self-confidence, and a sense of responsibility, but the nature of the tasks or chores must be carefully chosen to fit the age and strength of the child. Work must not be hazardous, and most importantly must be limited to hours stipulated by law.

In addition, although some children do not drop out of school prior to beginning work, children's work hours, even when within the legal limit, combined with family responsibilities, can conflict with school attendance, causing them to drop out of school. To ensure that such children are able to access their right to education, vocational and other training could be provided at their workplaces. Vocational education is essential to the wellbeing of working children. Such education must meet the needs of the market economy and must support all kinds of technology and work. When children reach adulthood, they should be able to apply the skills they have learned. Every child should be provided with a quality education from an early age. Such vocational training can be combined with a productive activity for children who may not wish to return to education due to the risk of losing income while learning.

Furthermore, both large and small businesses can make a contribution by raising awareness about the importance of education in their workplaces, communities, industries or sectors. In addition, support for children's education could be provided in agreement with the public education authorities, by paying to improve (or set up) schools near a plantation or factory, or by helping families pay for their children's school fees. Alternatively, an allowance could be paid to parents for schooling expenses. This could be a small sum of money given to all adult workers who have school-age children. Wages could also be paid to working children for the hours spent away from work while they attend school. This emphasises that the quickest way to reduce the number of full-time child workers is to continue to pay them while they attend school and by developing and offering apprenticeship programmes to businesses.

Finally, it has been observed that some sectors are not covered by existing labour laws. There is no general minimum age of work specified outside factories, shops and establishments, meaning that working children are not covered by any legal protection in certain areas, a discrepancy in the law that needs to be addressed by appropriate amendments. Such positive amendments have been made to the Factories Act and the Shops and Establishments Act by raising the minimum working age from 13 to 14 years of age for young workers in the

manufacturing sector and in shops and establishments. Another positive development is that a provision in the amended Factories Act prohibits children from working in “the worst forms of labour such as a hazardous situation, a situation harmful to his health, a situation deterring his education and, in a workplace, wherein he would be exploited”. These two laws however cover only a part of the working child population. They do not cover those working in agriculture, as domestic workers, selling small items in public places, and others working in the informal sector. Steps need to be taken to ensure that all working children are protected by the law. This is not only due to the lack of relevant legal provisions, but also to the general lack of legal awareness of both employers and workers, a lack of monitoring mechanisms and corrupt practices. Since domestic legislation is a key element in the government arsenal for protecting the rights of children and young people at work, priority should be given to introducing appropriate amendments to labour laws.

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STEERING INTO THE FUTURE OF ROBOTICS WITH ARDUINO AND SMARTPHONE HARMONY

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Abstract

This research paper explores the comprehensive design, implementation, and implications of an innovative Arduino-based robot car harmonized seamlessly with smartphone control. This system involves the fundamental components such as Arduino microcontroller, L298N motor driver module and HC-05 Bluetooth module which are carefully assembled to create a reliable and energetic robotic platform. The Bluetooth module facilitates the exchange of data between a smartphone and Arduino microcontroller. A smartphone device operates by utilizing dedicated application software. The Arduino interprets data received from the smartphone to command the car, enabling movements in backward, forward, left, and right directions. The fusion of Arduino and smartphone technologies not only transforms the robot into a dynamic entity but also lays the foundation for future developments in intelligent robotic systems. The objective of this research is to enhance the flexibility and control range of the robot by employing Bluetooth technology to establish a seamless wireless communication link between the smartphone and microcontroller. This project demonstrates the practical application of Arduino technology in robotics, showcasing its potential in real-world structure such as automation, surveillance, or remote-controlled devices.

Keywords: Arduino, HC-05 Bluetooth module, L298N motor driver, smartphone

Introduction

In the dynamic landscape of robotics and technological innovation, the fusion of Arduino and smartphone technologies indicates a new era of intelligent and accessible robotic systems. The project, appropriately named “Steering into the Future of Robotics with Arduino and Smartphone Harmony”, captures the essence of this transformative journey. This system has been used to construct a Bluetooth-controlled car, utilizing a circuit that incorporates the L298 motor driver, HC-05 Bluetooth module, and Arduino. Utilizing the smartphone and a dedicated application, the car is adeptly controlled through a Bluetooth communication system. To ensure optimal motor performance, the L298 motor driver circuit has been carefully implemented, providing the necessary current for efficient motor operation (Craig, J. J., 2005). This system can be described with the help of following block diagram in Figure 1. This system not only empowers the robot car with versatile movements but also reflects a broader vision of harmonizing diverse technologies for a more connected and responsive future (Jinbo, D., 2012). The working diagram of the whole system is shown in Figure 2.

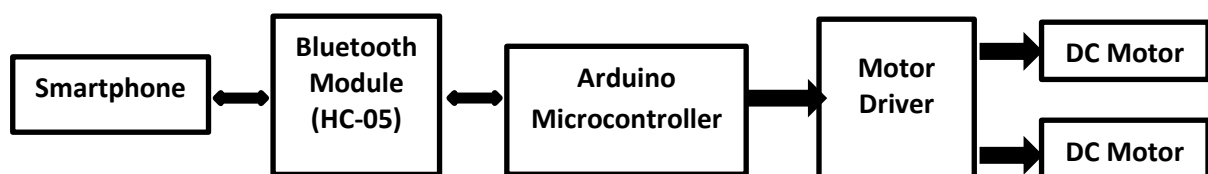


Figure 1. The block diagram of the whole system

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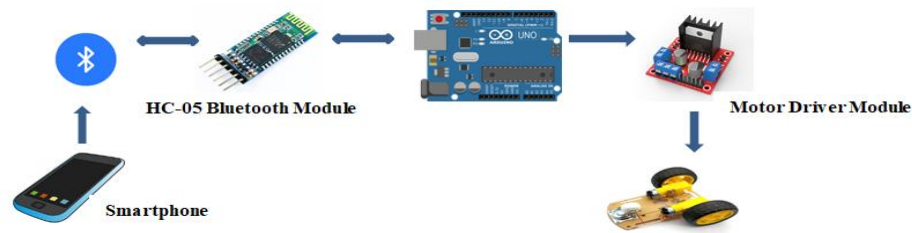


Figure 2. The working diagram of the system

Methodology of the System

To construct the proposed Bluetooth-controlled robot car, the whole system consists of essential components, which include an Arduino Uno board, L298 motor driver module, HC-05 Bluetooth module, DC motors, wheels, robot car chassis, and a power source.

Hardware and Software Requirements of Circuit Construction

Arduino Uno

Arduino Uno is a microcontroller board based on the Atmega 328P. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. “Arduino” name came from a bar in Ivera which is located in Italy. “Uno” means “one” in Italian language. Arduino board is easy to use and freely available in market. It also has a function that every user can develop without any problem. Arduino IDE software is used to handle this designed board easily with flexible manner. Figure 3 suggests the photo of Arduino board.

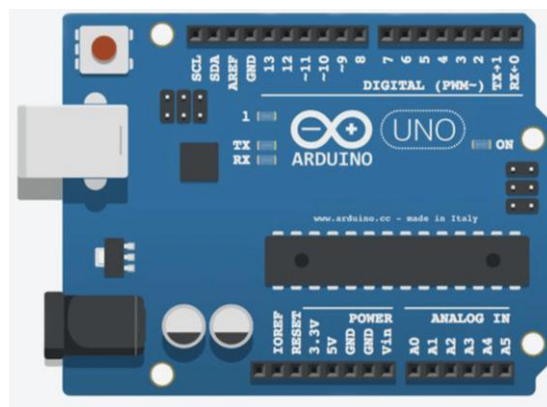


Figure 3. The photo of Arduino board

HC-05 Bluetooth Module

The HC-05 Bluetooth module is a fundamental component known for its robust wireless communication capabilities. Integrated seamlessly with the Arduino microcontroller, the HC-05 facilitates bidirectional data exchange through its RX (receive) and TX (transmit) pins. This enables effective communication with external devices, allowing for versatile applications in electronics projects. Its user-friendly interface, combined with reliable RX and TX functionality, positions the HC-05 as a preferred choice for implementing efficient and seamless wireless connections, making it an integral part of various electronic systems (Franco, T. T., 2010). The front side and back side photos of HC-05 Bluetooth module is shown in Figure 4.

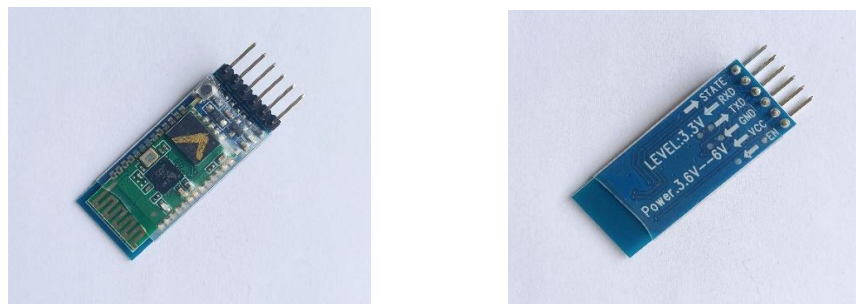


Figure 4. The front side and back side photos of HC-05 Bluetooth module

DC Motor

A DC (direct current) motor is a crucial electromechanical device converting electrical energy into mechanical motion. Its simple design consists of a rotor and a stator, with the former powered by direct current. DC motors are widespread applications in various industries, from robotics to automotive systems, due to their efficiency, controllability, and ease of implementation. They play a pivotal role in countless electronic projects, providing reliable rotational motion for a wide range of applications. The photograph of DC motor is shown in Figure 5.



Figure 5. The photograph of DC motor

L298N Motor Driver

The L298N Motor Driver Module stands out as a high-power driver, specially designed to control both DC and stepper motors efficiently. It consists of a L298 motor driver IC, 78M05

voltage regulator, resistors, capacitors, power LED, 5V jumper in an integrated circuit. It can control both the speed and rotation, direction of two DC motors or one stepper motor at the same time (Loukianov, A. A., 2004). The photograph of L298N motor driver module is illustrated in Figure 6.

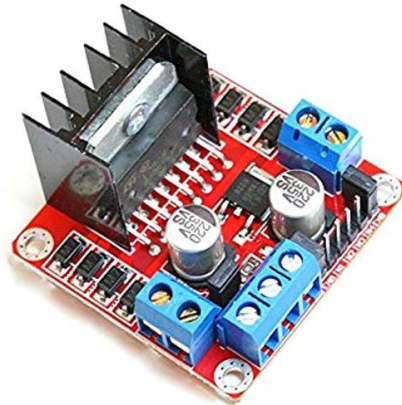


Figure 6. The photograph of L298N motor driver module

Arduino Integrated Development Environment (IDE) Software

The core software utilized in this project is the Arduino Integrated Development Environment (IDE), a comprehensive platform that facilitates the programming and uploading of code to the Arduino microcontroller. The Arduino IDE software is essential for creating, editing, and managing the code that governs the behavior of the Arduino board. The photograph of uploading a program to Arduino IDE software is shown in Figure 7.

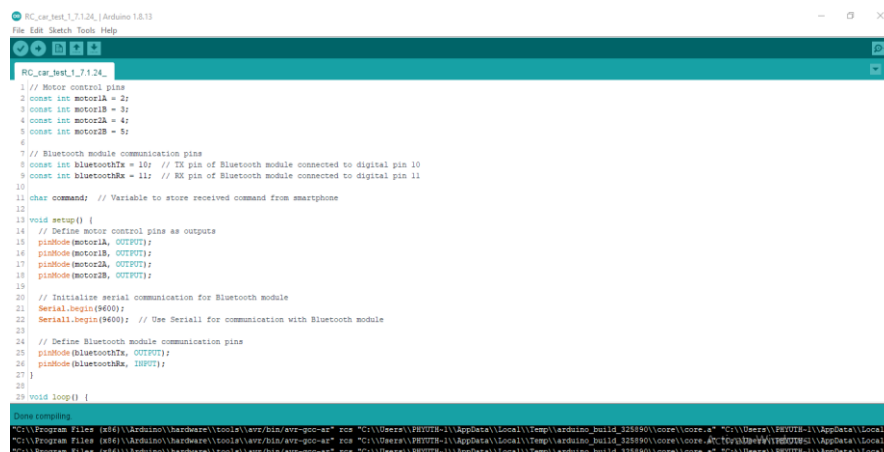


Figure 7. The photograph of uploading a program to Arduino IDE software

Smartphone Bluetooth Application Software

To establish a wireless communication link between the smartphone and the Arduino robot car, the Bluetooth application software was employed. The application, installed on an Android smartphone, facilitated the transmission of control commands to the robot car with the HC-05 Bluetooth module. Any Bluetooth controlled application can be used. The Bluetooth controlled application software can easily be downloaded in Google play store. The photograph

of downloading software in Google play store and the photograph of the commands setting of the software are as shown in Figure 8.

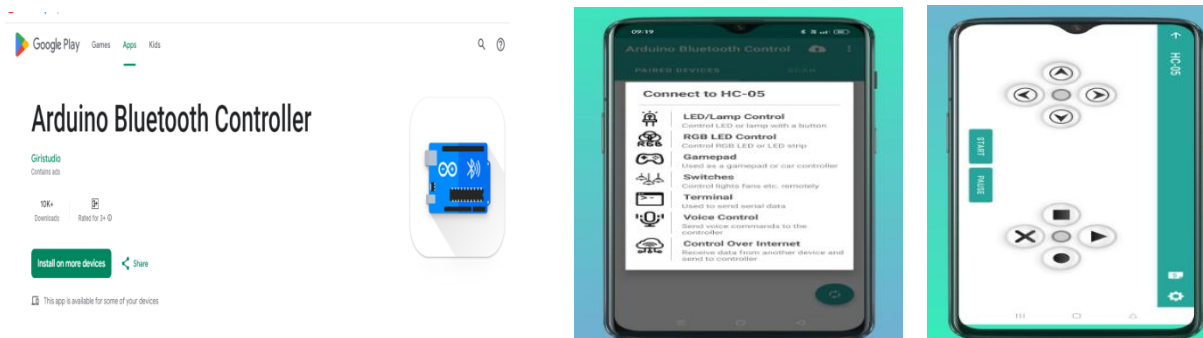


Figure 8. The photographs of downloading software in Google play store and the commands setting of the software

Design and Construction of the System

Assembling of Robot Car

Firstly, collect the necessary components. The components which are contained in the robot car chassis are as given below Figure 9. Then peel off all of the paper backings covering the plexiglass. And make a position for the motors on the chassis frame. Use the brackets or mounts to attach the motors securely. Align the motors parallel to each other. Mount wheels onto the shafts of the motors. Wheels usually come with screws for attachment. Ensure the wheels are securely fixed and can rotate freely. For the connection of two motors to motor driver module, connect the terminals of the motors to the output terminals of the motor driver. And make the connection of power supply. Battery pack connect to the power input of the motor driver or directly to the motors. For placing the Arduino board on the chassis, use double-sided tape or screws to secure it. Need to care in making a position of Arduino where it won't interfere with the movement of the wheels. Establish a connection between the motor driver and the Arduino by employing jumper wires. Connect the control pins on the motor driver to the appropriate digital pins on the Arduino. For using a Bluetooth module like HC-05, connect it to the Arduino. Connect the TX pin of the Bluetooth module to the RX pin on the Arduino and vice versa. The step by step construction of the robot car is explained with the photos as shown in Figure 10.

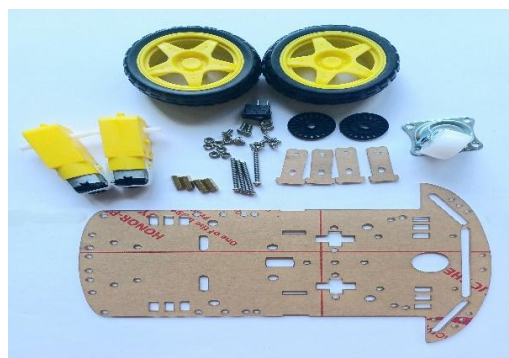


Figure 9. The photograph of the components which are contained in the robot car chassis

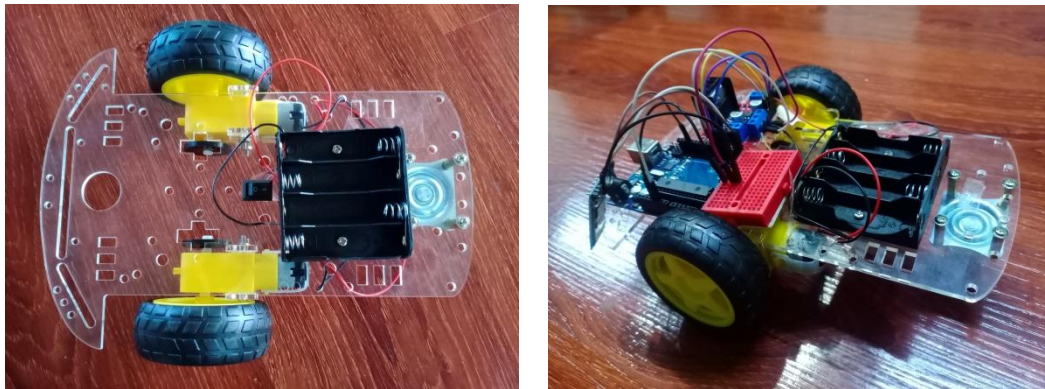


Figure 10. The photographs of step by step construction of the robot car

Construction of Arduino with Bluetooth

To establish a communication link between an Arduino Uno and an HC-05 Bluetooth module, follow these wiring instructions. Connect the VCC pin of the HC-05 to the 5V pin on the Arduino, ensuring that the Bluetooth module receives the required power. Next, establish a common ground by connecting the GND pin of the HC-05 to the GND pin on the Arduino. For bidirectional communication, connect the TX pin of the HC-05 to the RX pin (Digital Pin 0) on the Arduino, enabling data transmission from the Bluetooth module to the Arduino. Conversely, ensure connectivity by linking the RX pin of the HC-05 to the TX pin (Digital Pin 1) on the Arduino, facilitating the reception of data from the Arduino by the Bluetooth module. The circuit diagram for connection of Arduino and Bluetooth Module is shown in Figure 11.

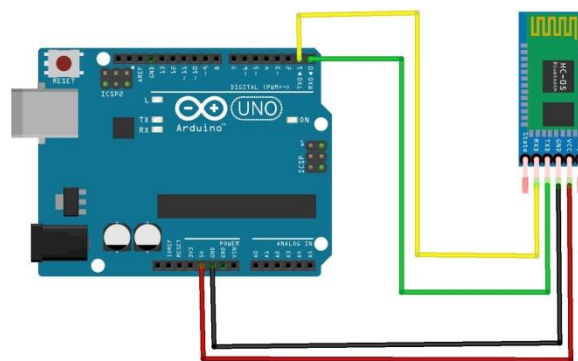


Figure 11. The circuit diagram for connection of Arduino and Bluetooth Module

Construction of Arduino with Motor Driver

To build the hardware connections between an Arduino Uno and an L298N Motor driver, follow these step-by-step instructions. Begin by attaching the DC motors to the L298N motor driver, connecting one motor to the "OUT1" and "OUT2" terminals and the other motor to the "OUT3" and "OUT4" terminals. For power supply, connect the positive terminal of the battery pack to the VCC input on the L298N and the negative terminal to the GND (ground) on the motor driver. To enable motor control through the Arduino, link the "IN1," "IN2," "IN3," and "IN4" inputs on the L298N to digital pins on the Arduino, such as Digital Pins 7, 6, 5, and

4. Optionally, for speed control, connect the "ENA" and "ENB" pins on the L298N to PWM-enabled digital pins on the Arduino, like Digital Pins 9 and 10. These connections establish a functional interface, allowing the Arduino to control the direction and speed of the DC motors through the L298N Motor Driver. The circuit diagram for connection of Arduino and Motor Driver Module is shown in Figure 12.

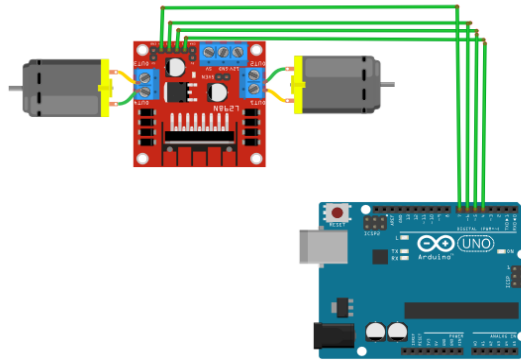


Figure 12. The circuit diagram for connection of Arduino and Motor Driver Module

Construction of the whole circuit

The robot car is assembled correctly and the Arduino, motor driver, and Bluetooth module are connected according to the hardware construction steps provided earlier. Then double-check all wiring to ensure that there are no loose connections or short circuits. Insulate exposed wires to prevent unintended contacts. Then upload the Arduino code to the Arduino board using the Arduino IDE and a USB cable. The whole circuit diagram is shown in Figure 13. After finishing all these steps, make a communication with smartphone and robot car. To make a connection between a smartphone and a robot car, firstly, careful attention must be given to the assembly of the robot car, ensuring that the constituent elements such as the Arduino, motor driver, and Bluetooth module are interconnected in accordance with the hardware construction steps provided earlier. Subsequently, the robot car is powered on by connecting the battery pack or power source. Moving on to the smartphone integration, Bluetooth is enabled and a committed scan for available devices is conducted within the Bluetooth settings. Once the HC-05 Bluetooth module on the robot car is identified, the smartphone pairs with it, typically using the default PIN '1234' or '0000'. To ensure the establishment of a connection, it is crucial to verify that the smartphone is successfully connected to the Bluetooth module on the robot car, often indicated by the illuminated status LED on the Bluetooth module, indicating a successfully paired and connected state. By using a smartphone with a Arduino Bluetooth control application to send commands and observe the movement of the robot car. The photograph of the whole circuit connection system is as shown in Figure 14. The photographs of left-side view and right-side view of the whole system is illustrated in Figure 15.

Results and Discussion

The Bluetooth connection between the HC-05 module on the robot car and the smartphone was successfully established, as confirmed by the smartphone's Bluetooth settings and the status LED on the HC-05 module. The reliable Bluetooth connection forms the foundation for wireless communication between the smartphone and the robot car, enabling remote control. The Arduino code, written to interpret Bluetooth commands and control the motors accordingly, executed as expected. The seamless execution of the Arduino code underscores the effective integration of hardware components, showcasing the responsiveness of the robot car to commands sent from the smartphone. The robot car responded to directional commands ('F' for forward, 'B' for backward, 'L' for left, 'R' for right) sent from the smartphone. The successful movement of the robot car in response to smartphone commands demonstrates the accuracy and precision of the control system, highlighting the practicality of the project for various applications. Real-time control of the robot car using the smartphone provided a responsive and engaging user experience. The real-time control capability enhances the user experience, making the robot car a versatile tool for exploration and interactive demonstrations. This feature could be particularly valuable in educational settings. Overall, the successful implementation of the Arduino robot car controlled by a smartphone demonstrates the feasibility and practicality of integrating these technologies for remote robotic control. The project's results open avenues for further exploration and improvements to enhance the capabilities of the robot car in various process. Figure 16 shows the photograph of smartphone controlled robot car using Bluetooth communication system.

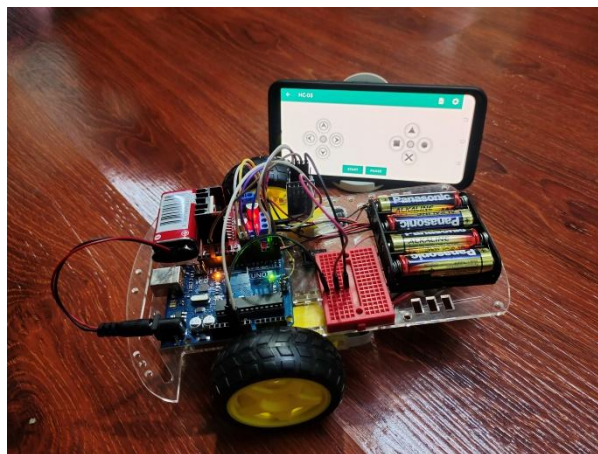


Figure 16. The photograph of smartphone-controlled robot car using Bluetooth communication system

Conclusion

This research utilizes a Bluetooth communication system to control a car, enabling it to move in different directions. The successful completion of this project underscores the potential of merging these technologies to create a versatile and engaging robotic platform. The establishment of a robust Bluetooth connection between the HC-05 module and the smartphone laid the groundwork for seamless communication. The execution of Arduino code translated

smartphone commands into precise movements, allowing real-time control and interaction. Further research can be done to communicate with microcontroller by using such as integrating additional sensors or employing advanced control algorithms for improved stability. Other wireless communication methods, such as Wi-Fi serial transceiver modules, GPS communication system can also be employed to communicate with the controller. Overall, this project not only contributes to the practical exploration of robotics but also serves as a stepping stone for further innovations, showcasing the exciting possibilities that arise from the fusion of Arduino and smartphone technologies.

Acknowledgements

We would like to express our gratitude to Rector Dr Nay Win Oo, East Yangon University, for his permission to work this research. We would like to thank Pro-Rectors Dr Aye Aye Ko, Dr Wah Wah Lwin, Dr Thida Aung, East Yangon University, for their permissions to work on the present research. We are greatly indebted to Professor Dr Hmwe Hmwe Kyu, Head of Department of Physics, East Yangon University, who provides with generous help and kind permission in this research paper. We would like to thank to Professor Dr Khin Lay Nwe, Department of Physics, East Yangon University, for her help and encouragement to complete our project. We are also deeply grateful to Professor Dr Su Su Aung, Department of Physics, East Yangon University, for her help and guidance in this research work. We would like to express our sincere gratitude and appreciation to all those who have contributed to the completion of this project.

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INVESTIGATION ON BOTANICAL CHARACTERS AND ANTIMICROBIAL ACTIVITY OF THE RHIZOMES OF *KAEMPFERIA GALANGA* L.

Phyo Moh Moh Zin¹, Khin Cho Cho Oo²

Abstract

An indigenous plant *Kaempferia galanga* L. is locally known as Kun-sar-gamone belonging to the family Zingiberaceae which had been collected from Ka - wa Township, Bago Region. The collected plants were classified and identified by using literatures for morphological characters. In morphological study, the plants are herbaceous with aromatic rhizomes, leaves simple, opposite and distichous. Inflorescences are terminal spike with showy flower. A fertile stamen, two lateral staminodes and a labellum with violet spot are present. The style passes through the channel of the anther lobes. In histological study, the tetracytic of upper surface of stomata are more abundant than the lower one. Air cavities are found in the midrib, petiole and leaf - sheath. Starch grains, calcium oxalate crystals and yellowish oil globules are abundant in rhizomes. In the diagnostic characters of the odour of rhizomes is more aromatic than leaves. Antimicrobial activities of different solvents extracts of rhizomes from *Kaempferia galanga* L. were also investigated by using agar- well diffusion method with nine pathogenic microorganisms. In antimicrobial activities, ethyl- acetate extract showed that the most significant activity against *Escherichia coli* and *Proteus mirabilis*.

Keywords: *Kaempferia galanga* L., tetracytic stomata, Zingiberaceae, antimicrobial activity

Introduction

The medicinal plant, *Kaempferia galanga* L. belongs to family Zingiberaceae. *Kaempferia galanga* L., is known as “Kun-sar-gamone” in Myanmar. The Zingiberaceae family distributed throughout the tropics and subtropics has about 47 genera and 1400 species (Lawrence, 1964). In Myanmar, it has 25 genera and 161 species (Kress *et. al.*, 2003). In Peninsular Malaysia and Indonesia the leaves and rhizomes are chewed as an expectorant for coughs, sore throat and used in poultices or lotions, they are often used as an ingredient of children’s medicines and tonics (De Padua *et.al.*, 1999).

Antimicrobial activities of different solvents extracts of *Kaempferia galanga* L. were tested with *Bacillus subtilis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Bacillus pumalis*, *Candida albicans*, *Escherichia coli*, *Vibrio cholerae*, *Klebsiella pneumoniae*, *Proteus mirabilis*. The antimicrobial properties of medicinal plants are being increasingly reported from different parts of the world. It is expected that plant extracts showing target sites other than those used by antibiotics will be active against drug resistant microbial pathogen. Traditionally used medicinal plants produce a variety of compounds of known therapeutic properties (Harbone and Boxtter, 1995).

The aim of the research work is to explore the Myanmar medicinal plants and to promote the Myanmar traditional medicine scientifically. To achieve the aim, the objectives are to verify both vegetative and reproductive part of the plant, to find out the antimicrobial activities of various solvent extracts of rhizomes from *Kaempferia galanga* L.

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Materials and methods

Morphological study of *Kaempferia galanga* L.

Collection and identification

The plant specimens of *Kaempferia galanga* L. were collected from Ka-wa Township, Bago Region during the flowering and fruiting periods from June to October. For morphological study, the specimens were measured, described in detail and identified with the help of available literatures (Hooker, 1894; Backer, 1968; Dassanayake, 1983; Wu Delin and Kai Larsen; 2000). The specimens such as habit, leaves, inflorescences and flowers were recorded with the photographs. Herbarium specimens were prepared and kept in the Herbarium, Department of Botany, University of Yangon.

Histological study of *Kaempferia galanga* L.

In histological study, *Kaempferia galanga* L. was prepared by free hand sections and examined according to the methods of Esau (1965), Tomlinson (1969), Trease and Evans (1978), Pandey (1998) at the Department of Botany, University of Yangon.

The following reagents were used to examine the section cutting and powdered samples according to the method of Kokate (2000).

- Chloral hydrate solution B.P as clearing reagents.
- Acetic acid and concentrated sulphuric acid for testing calcium oxalate crystals.
- The oil globules were confirmed by using Sudan III and IV.
- N/50 iodine solution B.P for starch grains.

Antimicrobial activities of various solvent extracts of rhizomes from *Kaempferia galanga* L.

Apparatus

Autoclave, beaker, bottle, conical flask, clean bench, cotton wool, hot air sterilizer, loops, measuring cylinders, micropipettes, steam-drying oven, petridishes, pipette and water bath.

Microorganisms

The solvent extracts of rhizomes were tested against nine pathogenic microorganisms by using agar-well diffusion method. In the test microorganisms *Bacillus subtilis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Bacillus pumalis*, *Candida albicans*, *Escherichia coli*, *Vibrio cholerae*, *Klebsiella pneumoniae* and *Proteus mirabilis* were included. The test was conducted at the Pharmaceutical Research Department (PRD).

Procedure for antimicrobial activity

The study of antimicrobial activities was performed by agar-well diffusion method and nutrient agar was prepared according to the method of Cruickshank (1975). Nutrient agar was boiled and 20-25 ml of the medium was poured into each test tube and plugged with cotton wool and sterilized at 121 °C for 15 minutes in an autoclave. Then, the tubes were cooled down to 30-35°C and the content was poured into sterilized petridishes and 0.1-0.2 ml of test organism was also added into the dishes. The agar was allowed to set for 2-3 hours. Then, 10 mm plate agar-well was made with the help of sterilized agar-well borer. After that, about 0.2 ml of sample was introduced into the agar-well and incubated at 37 °C for 24 hours. The inhibition zone appeared around the agar-well, indicating the presence of antimicrobial activity.

The diameter of the inhibition zones was measured with the help of transparent ruler, at the diameter zone of inhibition including the agar well.

Results

Morphological characters of *Kaempferia galanga* L.

Scientific name	-	<i>Kaempferia galanga</i> L.
Myanmar name	-	Kun-sar-gamone
English name	-	Sand ginger, Aromatic ginger
Family	-	Zingiberaceae

Herbs with aromatic rhizome, rhizomes yellowish white inside, fragrant. Leaves opposite and distichous, simple, the lamina broadly elliptic to slightly orbicular, 12.0-15.5cm long and 10.0-13.1cm wide, the bases cuneate, the margins entire, the tips acuminate, both surfaces glabrous; shortly petioles; leaf-sheath open, 10.0-23.0 cm long and 0.35-0.5 cm wide. Inflorescence terminal, compact spike; bracts lanceolate, 5.8-6.0 cm long and about 1.0 cm wide. Flower white with violet center, 5.6-5.8 cm long and 2.6-2.8 cm wide, complete, bisexual, irregular, zygomorphic, trimerous, epigynous; sepals (3), synsepalous, tubular, 2.0-2.3 cm long and about 0.3 cm wide, spathaceous splitting, white; petals (3), synpetalous, tubular, the tubes 3.6-3.8 cm long and about 0.3 cm wide, the lobes 1.6-1.8 cm long and 0.25-0.35 cm wide, white; stamens 1+ (2)st+2st, epipetalous, 1 fertile stamen 4.5mm long and 5.0mm wide, 2-outer staminodes fused to form a labellum, 17.0mm long and 18.0mm wide, white with violet center and 2-inner lateral petaloid free staminodes, 12.0 mm long and 8.0 mm wide, filaments grooved, exserted, anthers dithecous, introrse, dorsifixed, longitudinal dehiscence; ovary inferior, ovoid, 2.5 mm long and 2.0 mm wide, tricarpellary, syncarpous, trilocular, axile placentation, the style long and slender, 37.0mm long and 0.5 mm wide the stigma capitate as shown in Figures (1 to 12). Fruits and seeds not seen. Flowering and fruiting time is June to October.

Histological characters of leaves, roots and rhizomes of *Kaempferia galanga* L.

Macroscopical characters

Herbs with yellowish white, aromatic rhizome. Leaves are opposite and distichous. Lamina broadly elliptic to slightly orbicular in outline, the bases cuneate, the margins entire and the tips acuminate. Shortly petiole and leaf-sheath are present. Inflorescence are terminal and compact spike. The odour of the leaves is aromatic pungent, the colour is green and the taste is bitter.

Microscopical characters

Lamina

In surface view, the epidermal cells of both surfaces are rectangular to slightly polygonal shaped, anticlinal walls are straight. Trichomes are absent on both surfaces. The cuticle is thin-walled. Tetracytic type of stomata are present. Stomata of lower surface are more abundant than upper one. In surface view of lamina as shown in Figures (13 and 14). In transverse section, cuticle layer is smooth and thin on both surfaces. The epidermal cells are one layered, parenchymatous and barrel shaped. Lower epidermal cells are smaller than the upper one. Mesophyll cells are not well differentiated, consist of very small cells, palisade like parenchyma cells, irregular in shape. Mesophyll cells of both sides, two layers each but the upper cells larger than those of lower one as shown in Figures (15). Vascular bundles are closed

collateral type. Xylem always lying towards the adaxial and the phloem lying towards the abaxial side.

Midrib

In surface view of midrib, the upper epidermal cells are parenchymatous, thin-walled, hexagonal-shape and anticlinal walls are straight. The lower epidermal cells are rectangular to polygonal shaped. Tetracytic type of stomata are found on both surfaces. In surface view of midrib as shown in Figure (16). The transverse section of midrib is V-shaped in outline. Cuticle present on both surfaces. The epidermis one layered, mesophyll is not differentiated into palisade and spongy cells, mesophyll composed of three to four layers of parenchymatous cells below the vascular bundles. Large bundle and small bundles are connected with air cavities (or) aerenchyma cells. Oil cells are present as shown in Figure (17). Vascular bundles are closed collateral type which are surrounded by a sheath of sclerenchymatous cell.

Petiole

In surface view of petiole, both surfaces of epidermal cells are thin-walled parenchymatous cells rectangular to slightly hexagonal in shape and anticlinal walls are straight. Stomata are absent on both surfaces. In surface view of petiole as shown in Figure (18). In transverse section of petiole, more or less V-shaped in outline. The epidermal cells are parenchymatous barrel-shaped and compactly arranged. Three different types of vascular bundle are found. Main vascular bundles are alternating with air cavities (or) aerenchyma cells as shown in Figures (19). Vascular bundles are closed collateral type.

Leaf-sheath

In surface view of leaf-sheath, the upper surface of epidermal cells are thin-walled parenchymatous cells, slightly hexagonal in shape and anticlinal walls are straight. The lower surfaces are elongated and compact, anticlinal walls are straight. In surface view of leaf-sheath as shown in Figure (20). In transverse section of leaf-sheath, opposite margins are overlapping. Both surfaces of the epidermis cells are one layered and cortical region composed of only parenchymatous cells, thin walled. Parenchymatous cells at the adaxial sides 4 to 12 layers, at the abaxial sides 2 to 4 layers as shown in Figures (21). Vascular bundles are three different types. Main vascular bundles are alternating with air cavities (or) aerenchyma cells and closed collateral type. Seven to fourteen vascular bundles are present, xylem endarch type.

Root

In surface view of root, epiblema cells are rectangular in shape. The cells are elongated along the length of the root. In surface view of root as shown in Figure (22). In transverse section, circular in outline. Epiblema cells are single layered, barrel in shape, thin-walled parenchymatous. Uniseriate unicellular trichomes are present. Below epiblema, cortical cells are initially transform to periderm layers and the cells are 5-7 layered, polygonal to rectangular shaped, thin-walled parenchymatous cells. The endodermis cells are single layered, barrel in shape. Pericycle consists of 2-3 layered, polygonal in shape and surround the vascular bundles as shown in Figures (23). Vascular bundles are polyarch and radial type. Xylem and phloem strands alternating radially. Starch grains, calcium oxalate crystals and yellowish oil globules are present as shown in Figure (38).

Rhizomes

In surface view of rhizome, epidermal cells are polygonal in shape, anticlinal walls are straight. In surface view of rhizomes as shown in Figure (24). In transverse section of rhizomes, circular in outline. Periderm consists of 4-5 layers, thin - walled parenchymatous cells. A broad

cortical region consists of 24-27 parenchymatous cells, oval to rounded shaped and thin-walled. Endodermal cells are single layered, distinct and well developed. Pericycle is found under the endodermis as shown in Figures (40 and 42). Vascular bundles are closed collateral type. Starch grains, yellowish oil globules and calcium oxalate crystals are present as shown in Figure (25).

Diagnostic characters of powdered leaves, leaf-sheath and rhizomes of *Kaempferia galanga* L.

The powdered leaves of *Kaempferia galanga* L. was green colour and aromatic in odour. It was also bitter in taste and granular in texture. It consists of fragment of pieces of epidermal cells with stomata, spiral vessel and pitted vessel as shown in Figures (26 to 28). The powdered leaf-sheath was light green and aromatic in odour. It was also slightly bitter in taste and granular in texture. It consists of fragment of parenchyma cells, scalariform vessel and spiral vessel as shown in Figures (29 to 31). The powdered rhizomes was cream colour and strongly aromatic in odour. It was also warm and bitter in taste and fibrous in texture. It consists of reticulate vessel, prism-shaped calcium oxalate crystals and single starch grains as shown in Figures (32 to 34). The sensory characters of powdered leaves, leaf-sheath and rhizomes as shown in Table (1).

Table .1. Sensory characters of powdered leaves, leaf-sheath and rhizomes

Sample			
	 Leaves	 Leaf-sheath	 Rhizomes
Colour	Green	Light green	Cream colour
Odour	Aromatic	Aromatic	Strongly aromatic
Taste	Bitter	Slightly bitter	Warm and bitter
Texture	Granular	Granular	Fibrous

Morphological characters of *Kaempferia galanga* L.



Fig.1. Plants in natural habit

Fig.2. Rhizome

Fig.3. Leaves



Fig.4. Bract with flower



Fig.5. Bract



Fig.6. L.S of flower



Fig.7. Calyx



Fig.8. Corolla



Fig.9. Corolla with petaloid staminodes and fertile stamen



Fig.10. Pistil



Fig.11. L.S of ovary

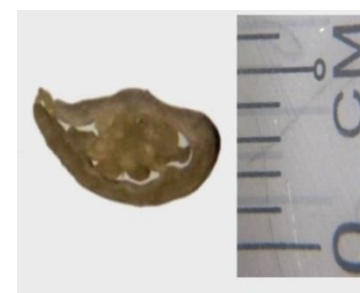


Fig.12. T. S of ovary

Histological characters of leaves, midrib, petiole, leaf-sheath, roots and rhizomes from *Kaempferia galanga* L.

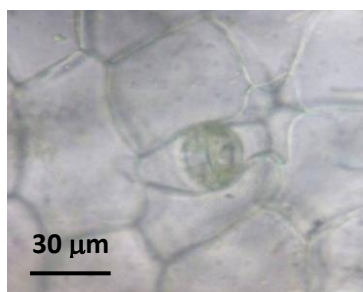


Fig.13. Upper surface view of lamina with stomata

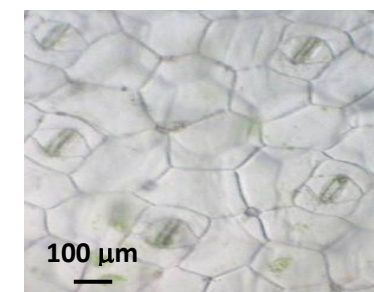


Fig.14. Lower surface view of lamina with stomata

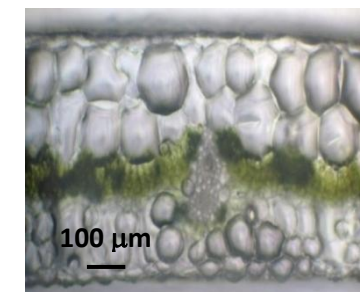


Fig.15. T.S of lamina epidermis and parenchymatous cells

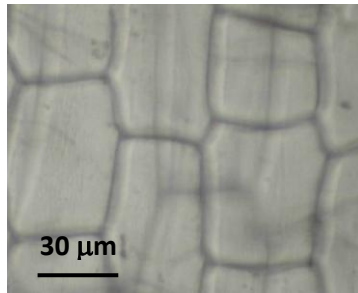


Fig.16. Surface view of midrib showing epidermal cells

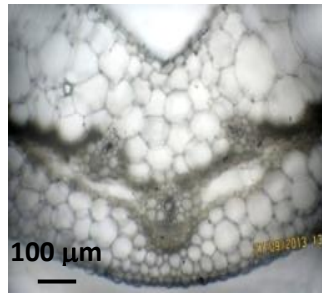


Fig.17. T.S of midrib showing mesophyll cells and vascular bundles

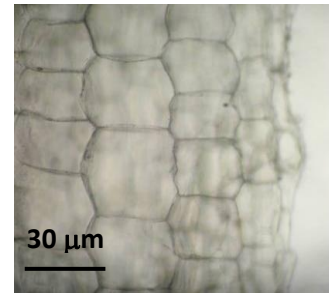


Fig.18. Surface view of petiole showing epidermal cells

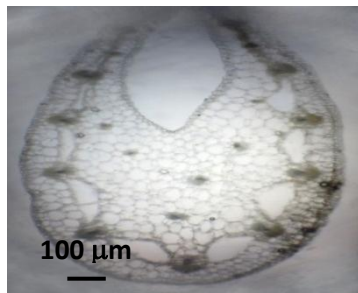


Fig.19. T.S of petiole showing cortex, vascular bundles and air cavities

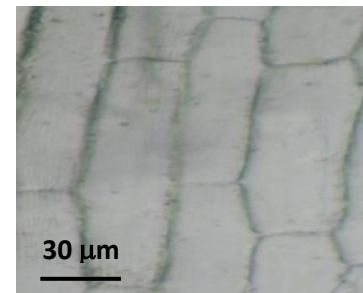


Fig.20. Surface view of leaf-sheath showing epidermal cells

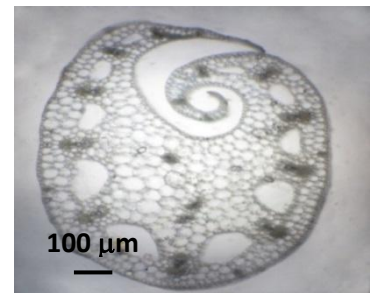


Fig.21. T.S of leaf-sheath showing cortical cell, air cavities and vascular bundles

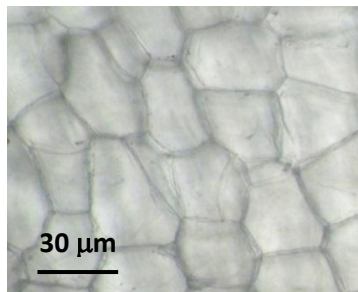


Fig.22. Surface view of root showing epiblema cells

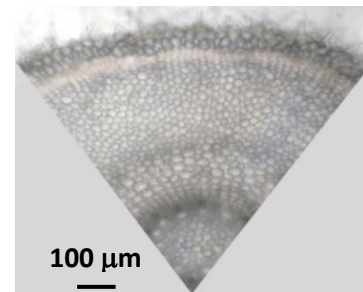


Fig. 23. T.S of root showing epiblema layer and vascular bundles

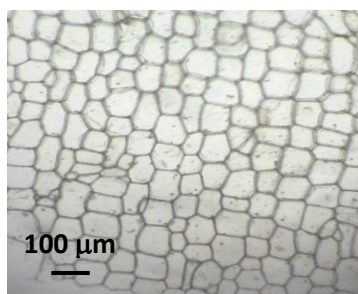


Fig.24. Surface view of rhizome showing cylindrical cells

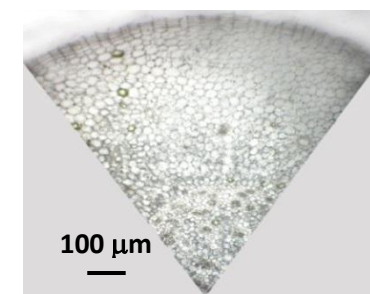


Fig.25. T.S of rhizome showing epidermis and cortical region

Diagnostic characters of powdered leaves of *Kaempferia galanga* L.

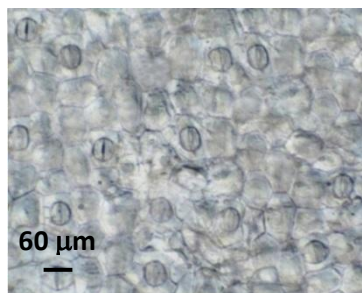


Fig.26. Pieces of epidermal cells with stomata

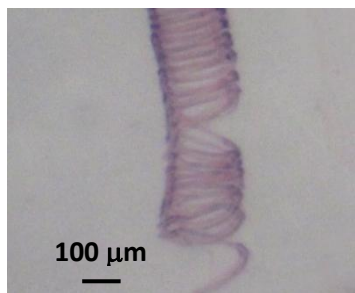


Fig.27. Spiral vessel

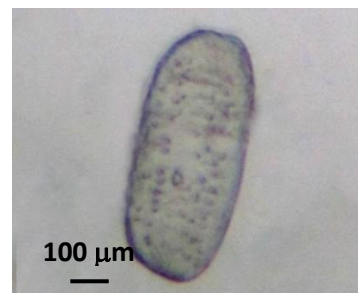


Fig.28. Pitted vessel

Diagnostic characters of powdered leaf-sheath of *Kaempferia galanga* L.

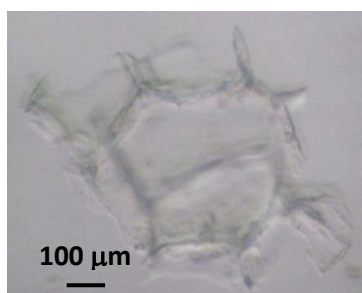


Fig.29. Fragment of parenchyma cells

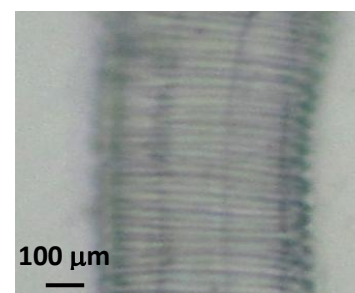


Fig.30. Scalariform vessel

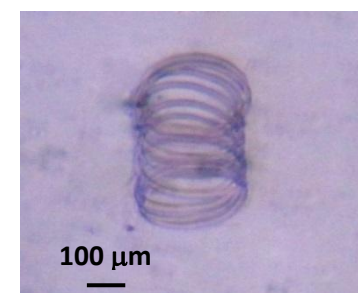


Fig.31. Spiral vessel

Diagnostic characters of powdered rhizomes of *Kaempferia galanga* L.

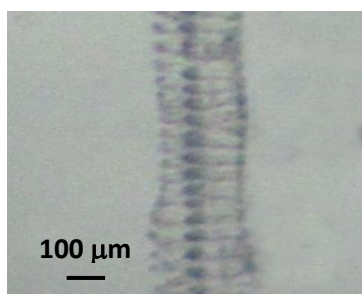


Fig.32. Reticulate vessel

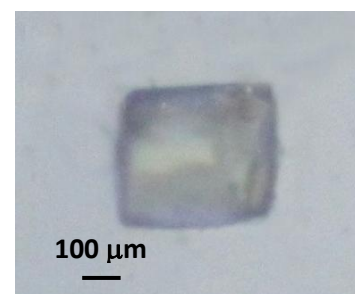


Fig.33. Prism-shaped calcium oxalate crystal

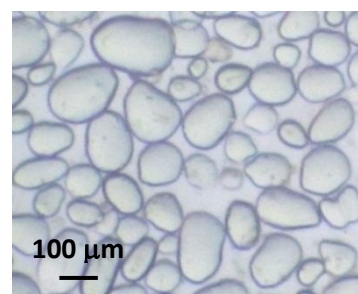


Fig.34. Single starch grains

Antimicrobial activities of various solvent extracts of rhizomes from *Kaempferia galanga* L.

Antimicrobial activity was studied with 70% pet-ether, chloroform, methanol, acetone, ethyl acetate, ethanol, aqueous extract. Agar-well diffusion method was used to determine the zone of inhibition of microbial growth at particular concentration of various extracts are as shown in Tables (2) and Figures (35).

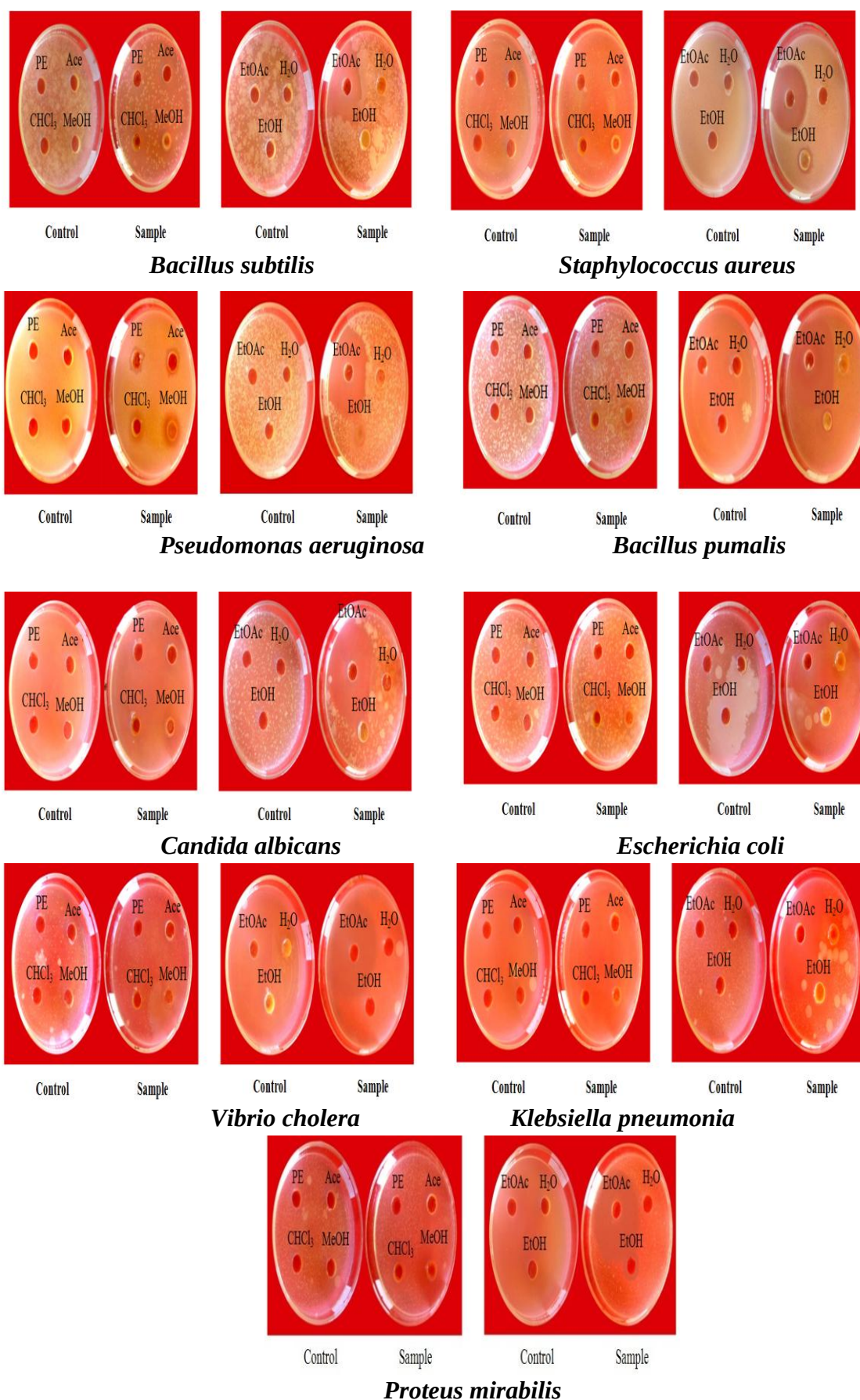


Fig.35. Antimicrobial activity of various solvent extracts of rhizomes from *Kaempferia galanga* L.

Table.2. Antimicrobial activity against nine test microorganisms by using various solvent extracts of rhizomes from *Kaempferia galanga* L.

Extracts	Test Organisms								
	<i>Bacillus subtilis</i>	<i>Staphylococcus aureus</i>	<i>Pseudomonas aeruginosa</i>	<i>Bacillus pumalis</i>	<i>Candida albicans</i>	<i>Escherichia coli</i>	<i>Vibrio cholerae</i>	<i>Klebsiella pneumoniae</i>	<i>Proteus mirabilis</i>
Pet-ether	18mm	18mm	15mm	11mm	-	-	-	-	12mm
CHCl ₃	16mm	20mm	13mm	12mm	11mm	-	-	-	19mm
MeOH	17mm	20mm	15mm	14mm	12mm	-	-	-	30mm
Acetone	20mm	-	13mm	13mm	12mm	-	16mm	-	20mm
EtOAc	35mm	34mm	36mm	45mm	36mm	50mm	45mm	-	50mm
EtOH	-	22mm	15mm	12mm	12mm	14mm	-	-	22mm
H ₂ O	-	-	-	-	-	-	-	-	-

Agar well-10mm

Discussion and Conclusion

In the present research, the morphological characters on the vegetative and reproductive parts of the plant and histological study of leaves, roots and rhizomes have been undertaken. In the morphological study, *Kaempferia galanga* L. are herbs with yellowish white, aromatic rhizome. Leaves are opposite and distichous, simple and broadly elliptic to slightly orbicular lamina. The colour of upper surface is brighter than the lower ones. The petioles are short and leaf-sheath are present. These characters were similar to those mentioned by Ridley and Hutchinson (1967) and Backer (1968). Inflorescences are terminal spike with lanceolate bracts. Flowers are large and showy, white with violet center, bisexual, zygomorphic, trimerous and epigynous. Sepals are (3), synsepalous, tubular and spathaceous splitting. Petals are (3), synpetalous, tubular and reflexed lobes which were in agreement with the findings of Hooker (1894) and Dassanayake (1983). Androecium are composed of one fertile stamen, two outer staminode fused to form labellum, white with violet center and two lateral petaloid staminodes, filament grooved and exserted. These characters were in agreement with those given by Ridley and Hutchinson (1967) and Jiang Ke (2000). Ovary is tricarpeal, syncarpous and axile placentation, the style long and slender. The stigma is capitate which were in agreement with those reported by Lawrence (1964) and Dassanayake (1983).

In histological study, anticlinal walls of both surfaces of lamina of *Kaempferia galanga* L. are straight. Both surfaces are tetracytic type of stomata. Numerous stomata of lower surface are more abundant than the upper one. The mesophyll cells are not well differentiated which are large, thin-walled and colourless, made up of palisade like parenchyma cells. These characters are similar to those mentioned by Esau (1965), Tomlinson (1969) and Thein Kyi (1992). The transverse section of midrib of *Kaempferia galanga* L. are V-shaped in outline large bundle and small bundle connected with air cavities (or) aerenchyma cells. Closed collateral type of vascular bundles are found. These characters were in agreement with those described by Pandey and Chadha (1998).

In transverse section of petiole of *Kaempferia galanga* L. are V-shaped in outline and leaf-sheath are open and opposite margins are overlapping. Vascular bundles of petiole and leaf-sheath are variable in size according to different arcs. Main vascular bundles are forming as a single ring, conspicuous and alternating with air cavities (or) aerenchyma cells and closed collateral type. Medium and small vascular bundles are scattered in parenchymatous ground tissue. These characters were in agreement with the findings of Wallis (1967) and Evert (2006). Thein Kyi (1992) revealed that in transverse section of leaf-sheath, chlorenchymatous cells at the adaxial sides 1 to 3 layered, cells at the abaxial sides 1 to 2 layered. In the research paper,

parenchymatous cells of leaf -sheath are 4 to 12 layers at the adaxial sides and 2 to 4 layers at the abaxial sides. In the transverse section of root, the stele is bounded by an endodermis and pericycle, exarch xylem and alternate with phloem. Rhizome is differentiated into a wide cortex and a central cylinder. The innermost layer of the cortex is a single endodermoid layer. Pericycle is found under the endodermis. Secretory cells, prism shaped calcium oxalate crystals and single starch grains are abundant in rhizome. These characters were in agreement with these described by Pandey and Chadha (1998) and Trease and Evans (2009).

In sensory characters, Tunsaringkarn *et.al.*, (2007) revealed that starch grain, parenchyma cells, reticulate vessel and spiral vessel were found in the powdered of rhizomes from *Kaempferia galanga* L. In present study, fragment of parenchyma cells, pieces of epidermal cells with stomata, spiral vessel, starch grains, prism-shaped calcium oxalate crystals, scalariform vessels and reticulate vessels are observed in powdered sample of leaves, leaf-sheath and rhizomes of *Kaempferia galanga* L. The starch grains are simple, oval, rectangular shaped and hilum is eccentric. According to the above data, it is proved that the both morphological and histological characters of the specimen studied are useful for identification and standardization of drugs.

In antimicrobial activities of different solvents extracts were tested on nine pathogenic microorganisms by using agar-well diffusion method. Especially, ethyl-acetate extract was more effective than other solvents extracts but aqueous extract did not show antimicrobial activity. Antimicrobial activities of various solvents extracts did not effect on *Klebsiella pneumonia*. Kochuthressia *et.al.*, (2012) revealed that various extracts such as ethanol, methanol, pet-ether, chloroform, aqueous extract showed antimicrobial activity against *Staphylococcus aureus*, *Bacillus subtilis*, *Klebsiella pneumonia*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Vibrio cholera*, *Candida albicans* respectively. Cruickshank (1975) stated that the antimicrobial tests indicate *Kaempferia galanga* L. is powerful in diarrhoea, pneumonia, inflammation, dysentery, food poisoning and urinary tract infection.

It can be concluded that the morphological characters, histological characters and antimicrobial activities on the rhizomes of *Kaempferia galanga* L. can serve as an important source of information to ascertain the determination of identify the plant material. It is hoped that evaluation of drugs from this plant will be healthful and developing news therapeutic medicine. For further study, the extracts of rhizomes from *Kaempferia galanga* L. should be investigated for isolation of other bioactive compounds to get new drugs for the prevention and treatment of infectious diseases.

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MORPHOLOGICAL CHARACTERS, HISTOLOGICAL CHARACTERS, PHYTOCHEMICAL ANALYSIS AND ANTIMICROBIAL ACTIVITIES OF *MILLINGTONIA HORTENSIS* L. F.

Lin Lin Htet¹, Win Win Nu²

Abstract

Millingtonia hortensis L. f. belongs to the family Bignoniaceae and is commonly known as Ega-yit in Myanmar and Indian Cork tree in English. In this research, morphological and histological characters, phytochemical analysis and antimicrobial activities of this plant were studied. Morphological study showed that it is a tall deciduous evergreen tree with tripinnately compound leaves. Flowers are white with didynamous stamens, open at night and shed in the early morning. Histological study showed that both surfaces of lamina consist of striated cuticle. Anomocytic stomata were present on both surfaces. Calcium oxalate crystals and oil globules were abundantly occurred in leaves. Wings are found in petiolule, and petiole. Vascular bundles are collateral and open type. Peltate trichomes present on upper and lower surfaces of leaves. In phytochemical study, alkaloids, carbohydrates, glycosides, phenolic compounds, proteins, reducing sugars, steroids, terpenoids, tannins and α -amino acids were analyzed in the powdered leaves. In antimicrobial screening, methanolic extract was found the highest activity (22.46 mm) against *Agrobacterium tumefaciens*. Pet-ether extract did not show any activities on all test organisms.

Keywords: Morphology, Histology, Phytochemical analysis, Antimicrobial activities

Introduction

Bignoniaceae includes 120 genera with 800 species mainly distributed within tropical and neo-tropical regions of America, Asia and Africa; however, some species are also used worldwide as ornamentals (Rossini and Castillo, 2010).

Millingtonia hortensis L. f. is commonly known as Indian Cork tree. It is found in the Central India, Myanmar (Burma) and Thailand. It is the sole species in genus *Millingtonia* and native to South-East Asia. The name *Millingtonia* comes from Thomas Millington, an English botanist, while *hortensis* means grown in gardens. The tree is favorite garden and avenue tree (Nagaraja and Padma, 2011).

In the Thai folklore medicine, it is used as antipyretic, sinusitis, cholagogue and tonic. This plant is widely distributed in Myanmar and is collected from Thanlyin-Township. Medicinal plants are of great importance to the health of individual and communities. Many of these indigenous medicinal plants are also used for medicinal purposes. In recent years, use of antimicrobial drugs in the treatment of infectious disease has developed multiple drug resistance and with increase in production of new antibiotics, by pharmaceutical industry, resistance to these drugs has also increased (Sharma and Kumari, 2013). The aim of this research is to identify *Millingtonia hortensis* L. f. and to evaluate its pharmacognostic properties. The objectives are to study the morphological and histological characters and to examine the phytochemical constituents and antimicrobial activities of this plant.

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Materials and Methods

Collection and identification of plant materials

The plant samples were collected from Thanlyin Township, Yangon Region. The morphological study was undertaken with the help of available literatures, such as Backer (1965), Bailey (1993) and Hundley and Chit Ko Ko (1987).

Preparation of powdered sample

The collected plants were washed with water and then air dried at room temperature. When constant weight was obtained, the dried samples were pulverized by grinding machine and stored in air tight bottles for further use.

Histological examination

The fresh specimens were examined by cutting free hand sections and studied under microscope. The microscopic study was performed according to the methods of Metcalf and Chalk (1950), Esau (1953), Pandey (1999) and Trease and Evans (2002) at the Department of Botany, East Yangon University.

Preliminary Phytochemical investigation of *Millingtonia hortensis* L. f.

Phytochemical screening was performed of Department of Botany East Yangon University East Yangon by using standard procedures such as Harborne (1973) and Sofowora (1993)

Test for alkaloids (Mayer's reagent)

Ethanol extract (2 ml) mixed with 0.2 mL dilute HCL and then 1mL of Mayer's reagent was added to the mixture. The white precipitation indicates alkaloids.

Test for alkaloids (Dragendorff's reagent)

Ethanol extract (2 ml) mixed with 0.2 mL dilute HCL and then 1mL of Dragendorff's reagent was added to the mixture. The orange precipitation indicates alkaloids.

Test for alkaloids (Wagner's reagent)

Ethanol extract (2 ml) mixed with 0.2 mL dilute HCL and then 1mL of Wagner's reagent was added to the mixture. The brown precipitation indicates alkaloids.

Test for Steroids and Terpenoids

Aqueous extract (3ml) was dissolved with 2ml of chloroform. Then mixture was treated with concentrated H₂SO₄. The result showed the colour from red to greenish yellow due to the presence of steroids and terpenoids.

Test for Carbohydrates

Aqueous extract (2 ml) was mixed with 1 mL of 10% α -naphthol solution and the mixture was shaken. Conc; H₂SO₄ (2 mL) was then poured carefully down the side of the test tube. A purple ring at the interphase will indicate the carbohydrate.

Test for Cyanogenic glycosides

Powdered 0.5 g moistened with water was added into the test tube. The strip of filter paper was soaked in the sodium picric acid solution and dried at room temperature. The dried sodium picric paper strip was suspended in the neck of the test tube. The tube is stopped and then warm for about 40°C. If the filter paper turns to brick- red color, it indicates the presence of cyanogenic glycosides.

Test for Flavonoids

Aqueous extract (2 ml) was treated with sodium hydroxide solution. If it shows increase in the intensity of deep yellow color which would become colorless on addition of few drops of dilute hydrochloric acid, flavonoids present.

Test for Glycosides

Aqueous extract (2 ml) was mixed with a few drops of 10% lead acetate solution. If the white precipitate indicates, glycosides present.

Test for Proteins

Aqueous extract (2 ml) was mixed with a few drops of Millon's reagent. If the white precipitates turns red when heated, the protein present.

Test for Phenolic compound

Ethanol extract (2 ml) was mixed with 2 ml of distilled water and 1 to 2 drops of 10% FeCl_3 was added. A blackish precipitation will be the positive test.

Test for Reducing sugars

Aqueous extract (2 ml) was mixed with a few drops of Benedict's reagent and heated gently. If the brick-red precipitate appears, the reducing sugars present.

Test for Starch

Aqueous extract (2 ml) was mixed with a few drops of iodine solution. If the formation of blue-black precipitation indicates, starch will be present.

Test for Saponins

Aqueous extract (2 ml) was mixed with 2 ml of distilled water and the mixture was shaken vigorously. The formation of stable foam will indicate the saponins.

Test for Tannins

Aqueous extract (2 ml) was mixed with a few drops of 5% FeCl_3 solution. If the formation of greenish or blackish precipitates indicates, tannins present.

Test for α - amino acids

One drops of aqueous extract was spotted on a filter paper allowed to dry and spray with ninhydrin reagent. The paper was dried at room temperature and kept at 110°C for a few minutes. A violet color spot appeared on the filter paper shows α -amino acids are present.

Antimicrobial activities

Antimicrobial activities of different solvent extracts were tested on five pathogenic microorganisms by using agar-well diffusion method (Cruickshank, 1975). This study was carried out at the Microbiology Laboratory, Department of Botany, East Yangon University in January, 2024. Nutrient agar was boiled and 20 - 25mL of the medium was poured into a test tube and plugged with cotton wool and autoclaved at 121°C for 15 minutes. Then the tubes were cooled down to $30 - 35^\circ\text{C}$ and poured into sterilized petridishes and 0.1 - 0.2 mL of test microorganisms were also added into dishes. Then, about 0.2 mL of sample was introduced into the agar-well and incubated at 37°C for 24 hours. The inhibition zone appeared around the agar-well, indicate the presence of antimicrobial activity. The extent of antimicrobial activities was measured from the diameter zone of inhibition.

Results**Morphological Characters of *Millingtonia hortensis* L. f.**

Scientific Name - *Millingtonia hortensis* L.f.

Family - Bignoniaceae

Myanmar Name - Ega- yit

English Name - Indian cork tree, Tree Jasmine

Tall deciduous evergreen tree, straight trunk with corky bark and few branches, branches drooping, bark grey color, rough and corky, elongated pyramidal stem, yellowish-white wood, brittle, versatile tree, grow on various soil; **Leaves:** imparipinnate, opposite and decussate, tripinnately compound, leafbranch, petiolule, exstipulate, petiolate, upper tertiary leaflet sessile, exstipulate and leaflets ovate-lanceolate, bases a rounded or cuneate margins serrate, with tips acuminate, young pubescent; **Inflorescences:** paniculate cymes, terminal or axillary the cymules 3- flowered, bracts inconspicuous, minute; **Flowers:** corymbose, long tubular, bracteates, ebracteolate, pedicellate, complete, irregular, zygomorphic, pentamerous, white, waxy, pleasant fragrance, hypogynous. **Calyx:** sepal(5), synsepalous, 5- toothed,

campanulate; **Corolla:** petal (5), synpetalous, white, corymbose, long tubular, somewhat two lipped with five subequal lobes, infundibuliform, corolla 5- lobes, imbricate in bud, valvate, ovate- lanceolate, densely pubescent adaxially margin, waxy, corolla tube long, slender, cylindrical, white; **Androecium:** stamens(4), didynamous, with parallel anthers, basifixed, ditheous, anther divergent, the filament shortly exerted, **Gynoecium:** bicarpellary, syncarpous, ovary sessile, ovoid, style long, stigma lingulate compressed, 2-lobed, slightly exerted from corolla tube, bilocular with axile placentation, ovules numerous, ovary superior. **Fruits:** smooth ,flat capsule and partitioned into two, dehiscent septic dally long linear, compressed; **Seeds:** discoid, compressed, winged, except the base, the wing narrow at the apex, non-endospermic. The results were shown in Figure 1.

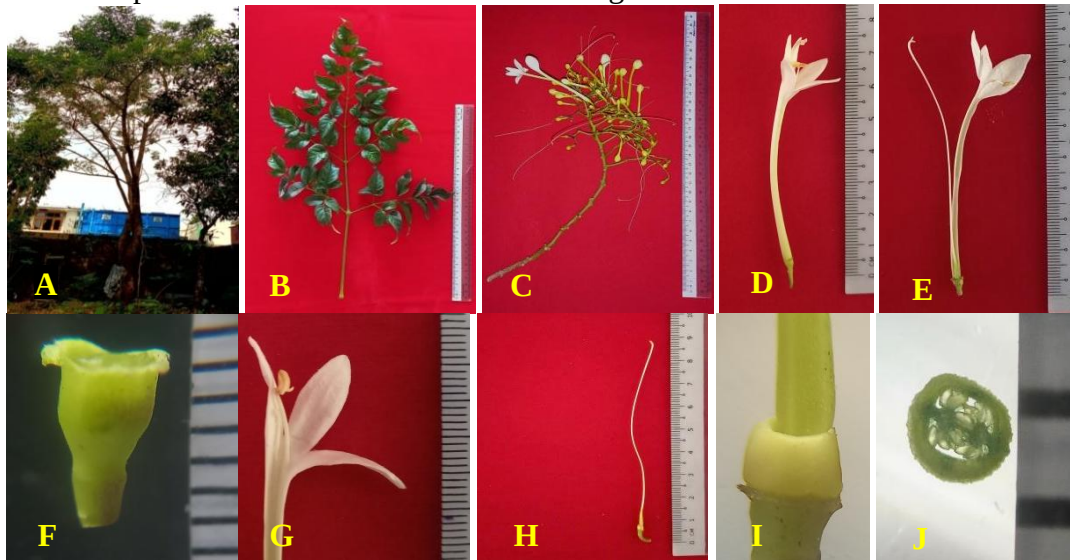


Figure 1 Morphological characters of *Millingtonia hortensis* L.f., (A) Habit, (B) Leaf, (C) Inflorescence, (D) Flower, (E) L.S of flower, (F) Calyx, (G) Stamens, (H) Gynoecium, (I) Disc under the ovary, (J) T.S of ovary

Histological characters of leaves of *Millingtonia hortensis* L. f.

Lamina

In surface view, the cuticle is striated and thin walled parenchymatous cells. The upper epidermal of anticlinal wall are thin and wavy but lower epidermal layer is wavier than the upper one. Anomocytic types of stomata, peltate glandular trichomes, and uniseriate trichomes were present on both surfaces of lamina.

In transverse section, the upper and lower epidermal cells were only one layer thick and barrel shaped. Under the upper epidermis, two layers of compactly arranged palisade mesophyll cells and 4 – 5 layers of loosely arranged spongy mesophyll cells were present. Oil globules were present in the mesophyll cells. Peltate glandular trichomes and uniseriate trichomes were present on both epidermis of lamina.

Midrib

In transverse section, the outline is more or less rectangular in shape. In the abaxial portion, the cortex was composed of 2-3 layers of collenchymatous cells and 4-7 layers of parenchymatous cells. The vascular cylinder was heart-shaped, collateral and open type. The calcium oxalate crystals were abundantly present in the phloem region. Peltate glandular trichomes and uniseriate trichomes were present on both epidermis of midrib.

Petiolue

In transverse section, the adaxial part was shallowly concave and the outline was heart-shaped. The peltate glandular trichomes and uniseriate trichomes were present on the surface

of petiolue. Vascular bundles were heart- shaped and opened collateral type. Oil globules or droplets were present in the cortex region.

Petiole

In transverse section, the outline was irregular to heart-shaped. The peltate glandular trichomes and uniseriate trichomes were present on all the surface of petiole. Vascular bundles were heart- shaped and opened collateral type. Groups of fibres were found near the phloem region. Oil globules or droplets were present in the cortex region. The results were shown in Figure 2 – 4.

Histological characters of leaves of *Millingtonia hortensis* L. f.

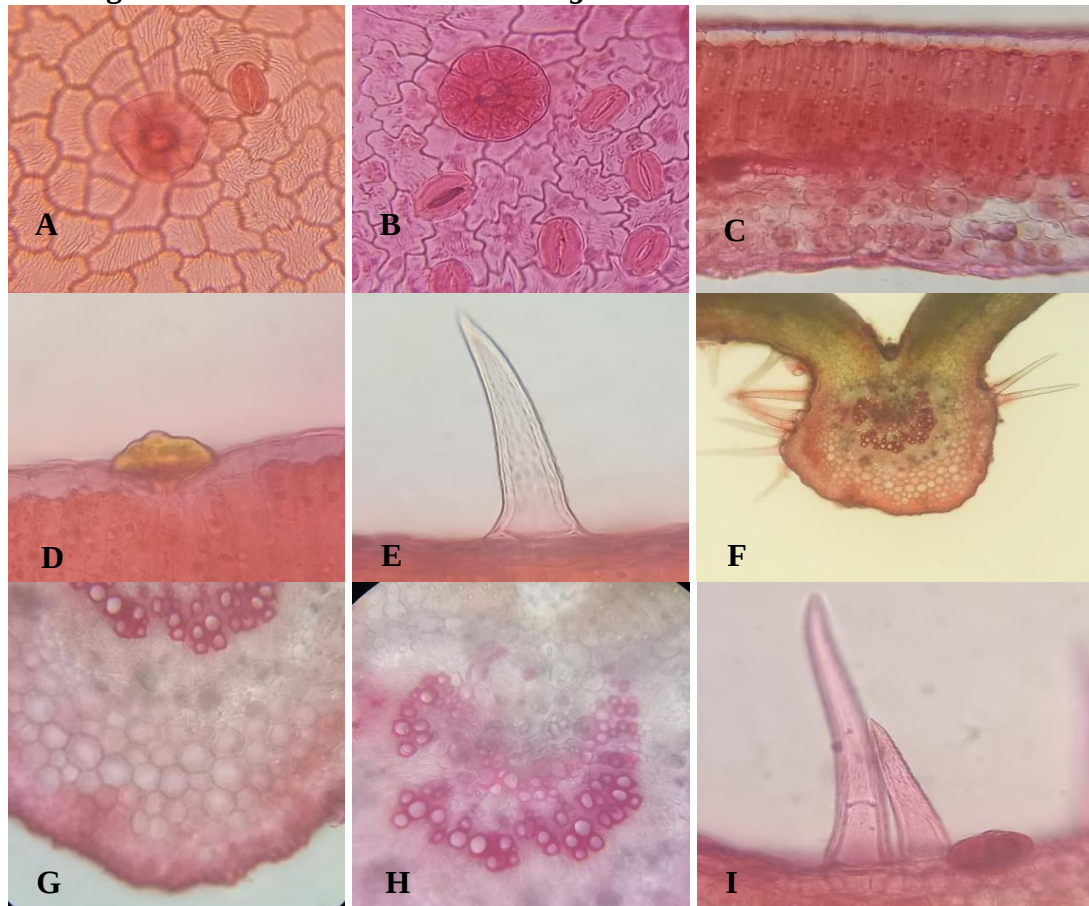


Figure 2 Histological characters of leaves of *Millingtonia hortensis* L. f.(400x)
 (A) Upper surface view of lamina, (B) Lower surface view of lamina, (C) T.S of lamina, (D) Peltate glandular trichome found on both surfaces of lamina, (E) Unicellular and uniseriate trichome found on both surfaces of lamina, (F) T.S of midrib, (G) Cortex of midrib, (H) Vascular bundle of midrib, (I) Unicellular, multicellular and uniseriate trichome found on both epidermis of midrib.

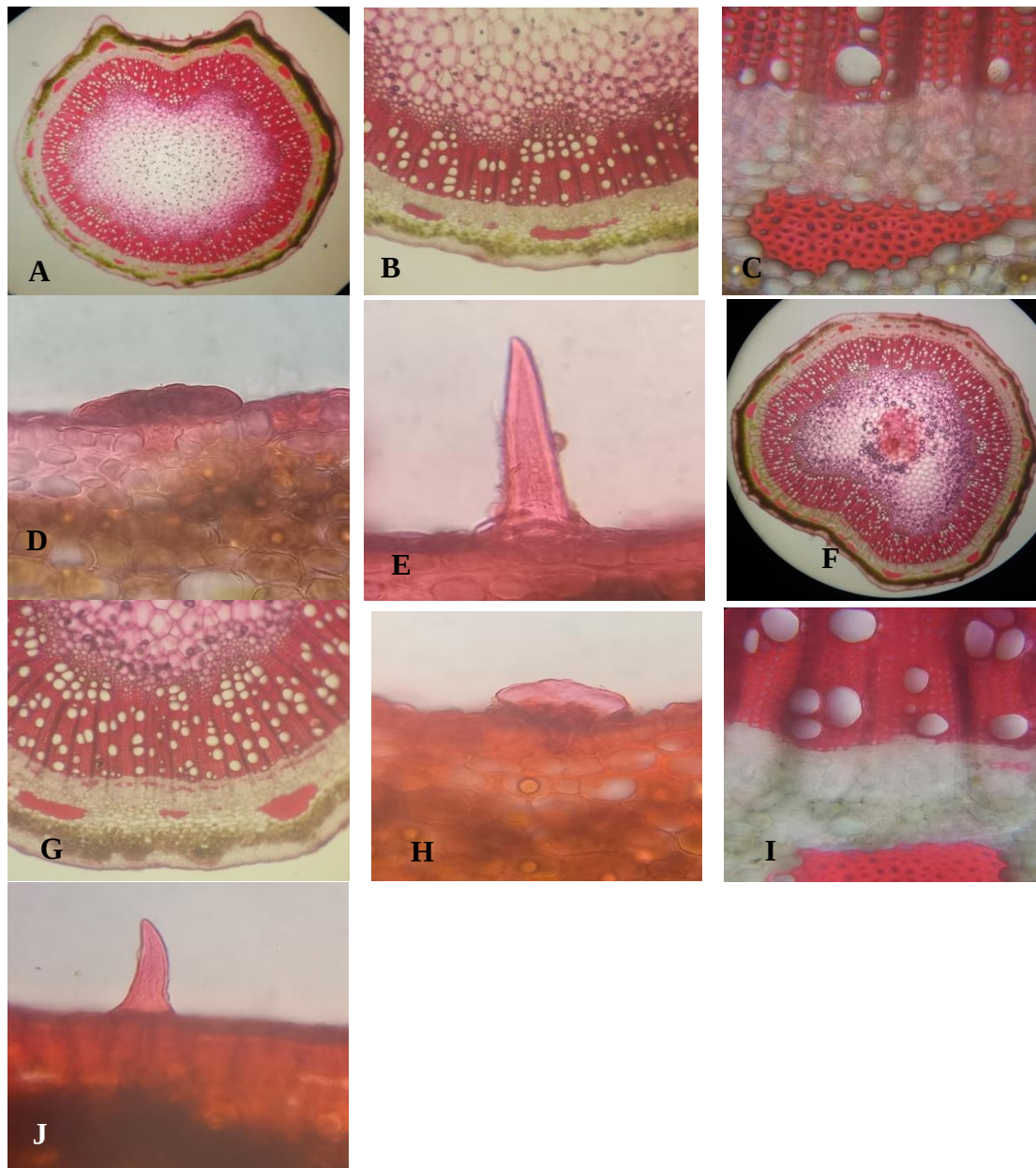


Figure 3 Histological characters of leaves of *Millingtonia hortensis* L. f.(400x)
 (A) T.S of petiolue, (B)Cortex of petiolue, (C) Vascular bundle of petiolue, (D) Peltate glandular trichome found on petiolute (E)Unicellular and uniseriate trichome of petiolue, (F) T.S of petiole in outline, (G) T.S of petiole in cortex layer (H) Vascular bundle of petiole, (I) Peltate glandular trichome of petiole, (J) Unicellular and uniseriate trichome of petiole

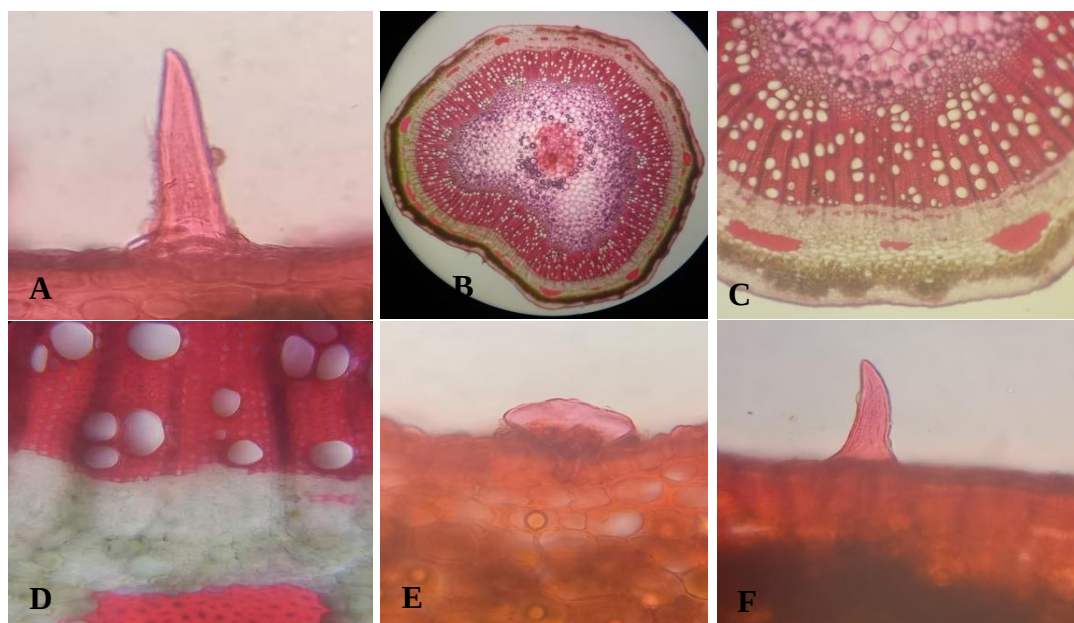


Figure 4 Histological characters of leaves of *Millingtonia hortensis* L.f., (400x)
 (A) Unicellular and uniseriate trichome of petiole, (B) T.S of petiole, (C) Cortex of petiole (D) Vascular bundle of petiole, (E) Peltate glandular trichome of petiole, (F) Unicellular and uniseriate trichome of petiole

Phytochemical analysis of leaves of *Millingtonia hortensis* L. f.



Figure 5

Phytochemical analysis of leaves of *Millingtonia hortensis* L. f.

Table 1 Phytochemical analysis of leaves of *Millingtonia hortensis* L. f.

No.	Test	Observation	Result
1	Alkaloids (Mayer's reagent)	White ppt.	+
	Alkaloids (Dragendorff's reagent)	Orange ppt.	+
	Alkaloids (Wagner's reagent)	Brown ppt.	+
2	Carbohydrates	Purple ring	+
3	Cyanogenic glycosides	No colour change	-
4	Flavonoids	No colourless	-
5	Glycosides	White ppt.	+
6	Phenolic compounds	Blackish ppt.	+
7	Proteins	Red ppt.	+
8	Reducing sugars	Brick-red ppt.	+
9	Saponins	Stable frothing	+
10	Starch	Brown	-
11	Steroids/terpenoids	Red at interface/yellow at lower	+
12	Tannins	Blackish ppt.	+
13	α -amino acids	Purple spot	+

+ = present, - = absent, ppt. = precipitate

Antimicrobial activities of leaves of *Millingtonia hortensis* L. f.

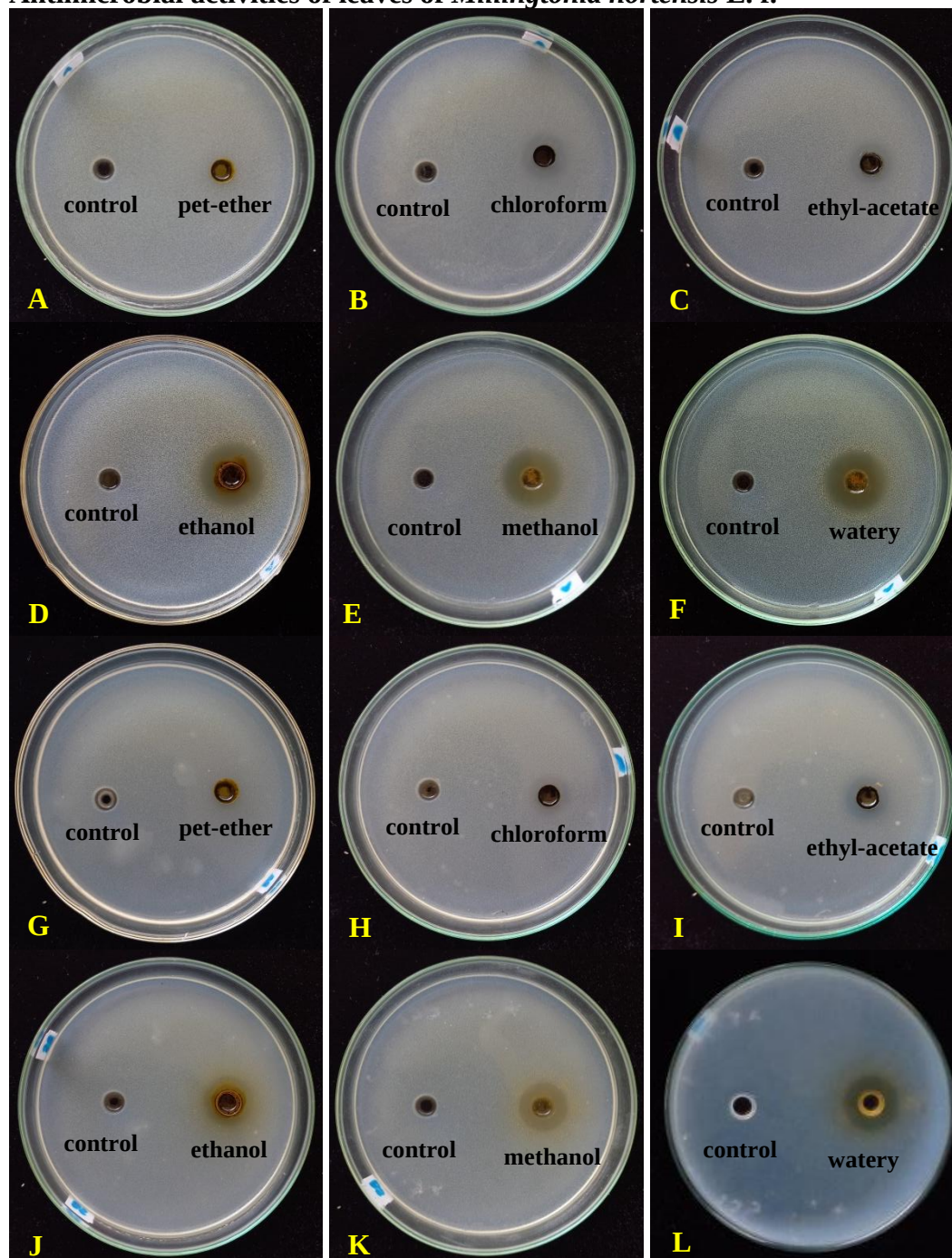


Figure 6 Antimicrobial activities of different solvent extracts of *Millingtonia hortensis* L. f. leaves against on test organisms, (A – F) *Agrobacterium tumefaciens*, (G – L) *Bacillus subtilis*

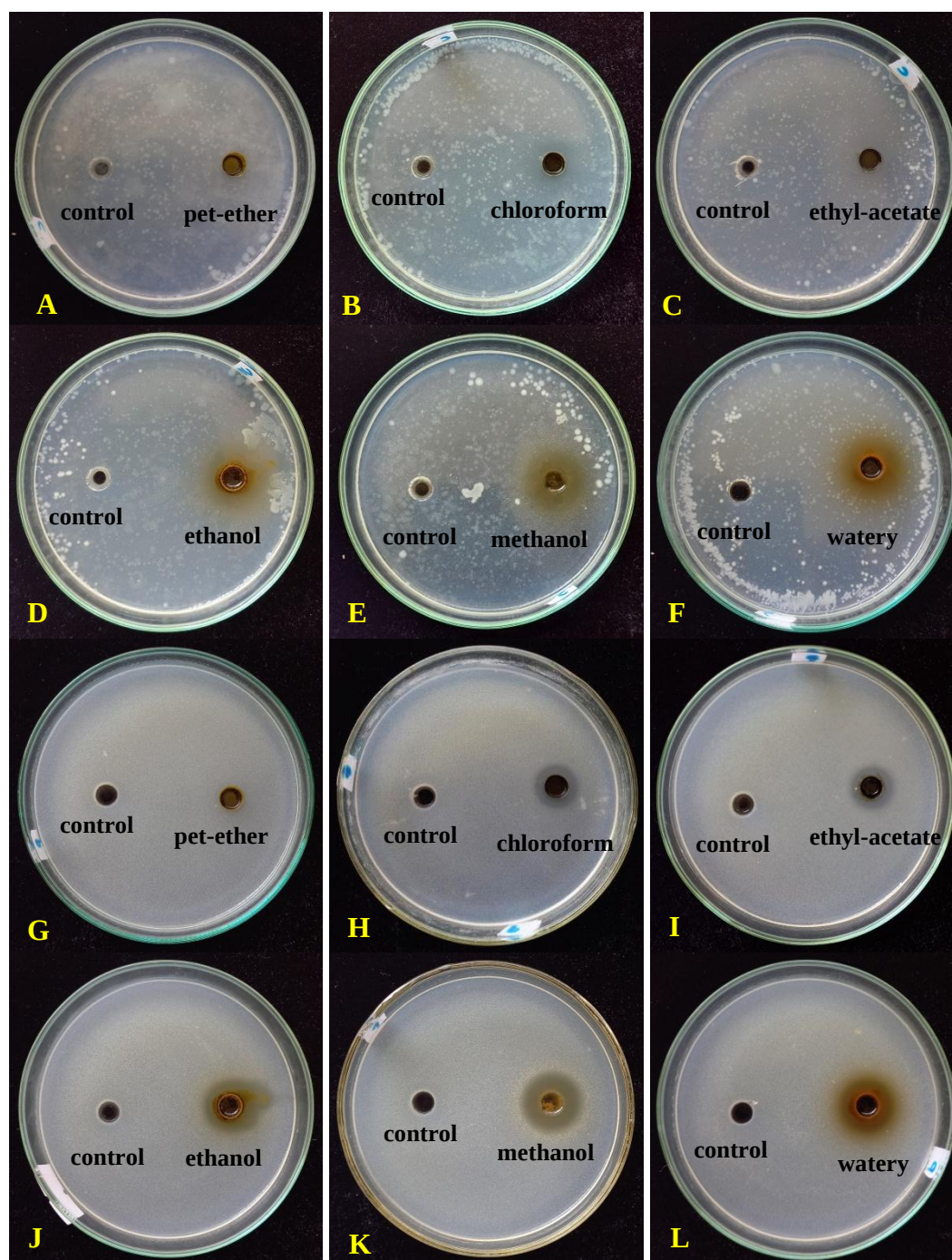


Figure 7 Antimicrobial activities of different solvent extracts of *Millingtonia hortensis* L. f. leaves against on test organisms, (A – F) *Candida albicans*, (G – L) *Pseudomonas aeruginosa*

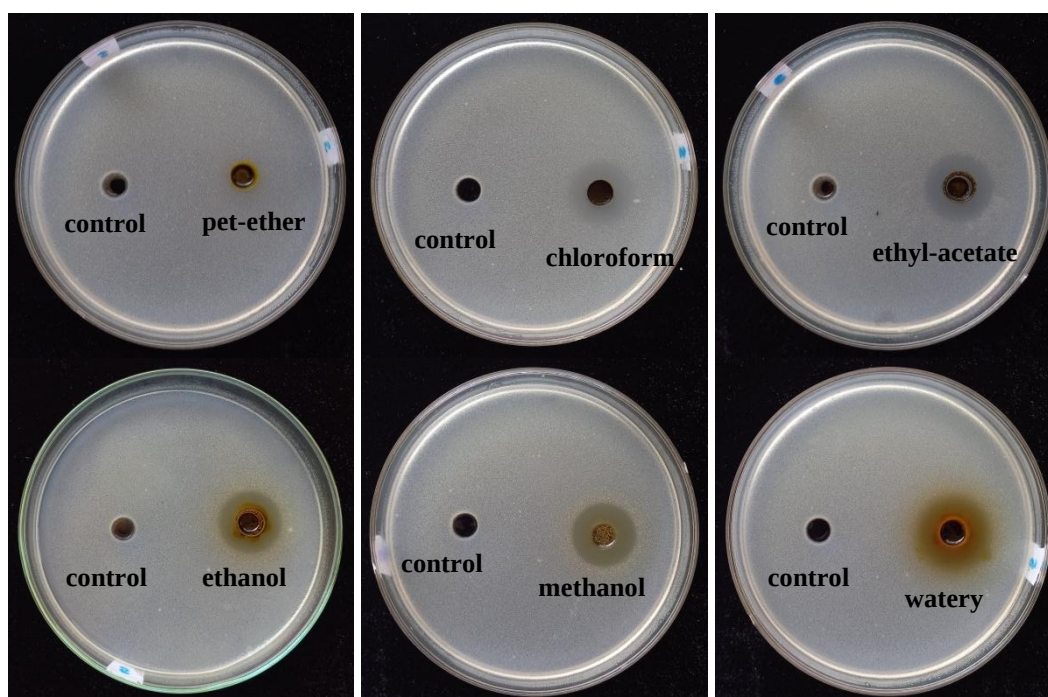


Figure 8 Antimicrobial activities of different solvent extracts of *Millingtonia hortensis* L. f. leaves against on *Staphylococcus aureus*

Table 2 Antimicrobial activities of leaves of *Millingtonia hortensis* L. f.

Extract	Inhibition zone (mm)				
	A	B	C	D	E
	<i>Agrobacterium tumefaciens</i>	<i>Bacillus subtilis</i>	<i>Candida albicans</i>	<i>Pseudomonas aeruginosa</i>	<i>Staphylococcus aureus</i>
Pet-ether	-	-	-	-	-
Chloroform	14.02	14.95	17.81	14.57	17.30
Ethyl acetate	13.90	14.40	14.12	15.39	21.53
Ethanol	22.15	17.43	20.28	20.96	21.15
Methanol	22.46	17.69	19.18	22.38	20.44
Watery	22.11	17.02	21.69	18.85	20.22

Discussion

In this study, the morphological, histological characters, phytochemical analysis and antimicrobial screening of *Millingtonia hortensis* L. f. were investigated. In the morphological study, the distinct characters were revealed that the plants are trees, flower bisexual, zygomorphic, stamens connivent, bicarpellary and syncarpous, tripinnately compound leaves, inflorescence cymose, stamens didynamous, capsule dehiscing septicidally and seeds winged. These characters are in agreement with those mentioned by Zhiyun and Santisuk (1998).

In histological study, the stomata were anomocytic type with striated and wavy epidermal cells. Uniseriate non-glandular trichomes and peltate glandular trichomes were also present in lamina. Vascular bundles are collateral and open type in the midrib, petiole and stem. These distinct histological characters are the same with the reports of Metcalfe and Chalk (1950) and Moe Zin Zin Thet *et. al.* (2020).

In phytochemical study, cyanogenic glycosides, flavonoids and starch were not detected in the leaves of *Millingtonia hortensis* L. f.. The alkaloids, carbohydrates, glycosides, phenolic compounds, proteins, reducing sugars, steroids, terpenoids, tannins and α -amino acids were analyzed in this leaves. These finding were the same with the reports of Kumar, *et al.* (2014), Janaki, *et al.* (2017) and Moe Zin Zin Thet, *et al.*, (2020).

Sivarj, *et al.* (2019) stated that the methanol extract of *Millingtonia hortensis* L. f. has antibacterial activity against *Bacillus subtilis* and *Staphylococcus aureus*. Moe Zin Zin Thet, *et al.* (2020) mentioned methanol extract showed highest activity on the test organisms and it is better than other extracts. In this study, the methanolic extract was found the highest activity (22.46 mm) against *Agrobacterium tumefaciens*, 17.69 mm against *Bacillus subtilis* and 22.38 mm against *Pseudomonas aeruginosa*. Watery extract showed the highest inhibition zones (21.69) mm on *Candida albican*. Ethyl acetate extract had the most significant activity (21.53 mm) on *Staphylococcus aureus*. Pet-ether extract did not show any activities on all test organisms.

Conclusion

In this study, various solvent extracts such as pet-ether, chloroform, ethyl-acetate, ethanol, methanol, and watery were tested on five pathogenic microorganisms by using agar-well (8mm) diffusion method. According to this results, except the petroleum ether extract, all other solvent extracts showed antimicrobial activity. Among them, methanolic extracts were showed highest activity against on *Agrobacterium tumefaciens*, *Bacillus subtilis* and *Pseudomonas aeruginosa*. Aqueous extracts showed highest against on *Candida albican*. Ethyl acetate extracts show highest against on *Staphylococcus aureus*.

Therefore, the extracts of the Mill are affective microorganisms in protecting against crown gall disease caused by *Agrobacterium tumefaciens*, endocarditis, meningitis, respiratory tract, urinary tract, gastrointestinal tract, pneumonia caused by *Bacillus subtilis*. Alimentary tract infection, cardiac infection, sore and inflammation by *Candida albicans*. Pneumonia, blood stream infection, bone and joint infection caused by *Staphylococcus aureus*. Fever, endocarditis, pneumonia, caused by *Pseudomonas aeruginosa*. Therefore, the leave is affected on protection of diseases which caused by microorganisms.

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COMPARATIVE MORPHOLOGICAL CHARACTERS OF TWO SPECIES OF GENUS *SENNA* AND THEIR SENSORY AND MICROSCOPICAL CHARACTERS AND PHYTOCHEMICAL ANALYSIS OF POWDERED LEAVES

Swe Thu Thu Aung*

Abstract

Two selected species of *Senna alata* (L.) Roxb. and *Senna tora* (L.) Roxb. were studied in this research. They belong to the family Fabaceae, Subfamily Caesalpinioideae and under the order Fabales. *Senna alata* (L.) Roxb. and *Senna tora* (L.) Roxb. were compared and identified with their morphological characters of vegetative and reproductive organs. In morphological study, the two species can be distinguished by some distinct characters. *Senna tora* (L.) Roxb. *Senna alata* (L.) Roxb. is a shrubs and *Senna tora* (L.) Roxb. is a herb. The character of leaflet shape, base and tip are also different. Foliar gland is only present in *Senna tora* (L.) Roxb. *Senna alata* (L.) Roxb. can be differentiated from *Senna tora* (L.) Roxb. by the presence of golden yellow anther, four angle pods with broadly crinkly wings and flattened triangular seeds whereas *Senna tora* (L.) Roxb. possess pale green anther, rod-like rounded pod and round, compressed seeds. In sensory evaluation, colour, texture, odour and taste of both species are different. In microscopical evaluations of powdered leaves, vessel elements, tracheids and fibres were found abundantly in both species. In phytochemical analysis, tannin, starch and cyanogenic glycosides were not detected in the leaves of both species. Saponins were not found in *Senna tora* (L.) Roxb. This research may support the information to distinguish the two related species.

Keywords: Morphological, Microscopical and Phytochemical

Introduction

The genus *Senna* belongs to the Family Fabaceae (Leguminosae) and subfamily Caesalpinioideae. Leguminosae is the presence of root nodules containing bacteria (*Rhizobium* spp.) which is capable of taking up atmospheric nitrogen and converting it into other nitrogenous compounds. Thus the leguminous plant can benefit from an augmented nitrogen supply and can grow well on relatively poor soils (Cronquist, 1981).

The Leguminosae is the second largest family of the flowering plants and contains about 700 genera and about 17,000 species. It includes more important drugs than any other family. It is divided into three subfamilies- Papilionoideae, the Mimosoideae and the Caesalpinioideae (Stevens, 2001).

In genus *Senna* are trees, small trees, shrubs or herbs, the leaves are unipinnately compound, paripinnate, inflorescences are racemes or panicle, their flowers are zygomorphic and pentamerous, mostly yellow; the sepals and petals are 5 in number and free; the stamens 10, some plants all fertile and some seven fertile and three sterile (Heywood, 1978). *Senna alata* (L.) Roxb. are used as medicine for the following disease such as ringworm, skin disease, laxative and itching (Kirtikar and Basu, 1933).

Senna tora (L.) Roxb. are used as eaten Moe-kya-hlaphet. Medicinal uses are vermifuge, ringworm, scabies, diuretic and antipyretic, asthma, cough, heal boils and pustule, cellulitis, eye diseases, hypertension and ophthalmic (Kapoor, 2001).

The selected study area is Thanlyin Township in Yangon Region. It is located at Southern bank of Bago River mouth in the Southern province of Yangon Region. It is situated East by Thon-khwa Township, South by Kyauk-tan Township and West and North by Bago

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River. The study area is situated between north latitude 16° 40' to 17° 10'. The climate of this area is hot and the minimum and maximum temperature is ranged from 18°C to 30°C. The annual average rainfall is about 76 inches. The aim of this study is to distinguish the two related species, *Senna alata* (L.) Roxb. and *Senna tora* (L.) Roxb. and to analyses the phytochemical constituents of leaves of both species. The objectives are to study the morphological, sensory and microscopical characters of the two species and to carry out the phytochemical examination of these two species.

Materials and Methods

Collection of plant samples

The two species of genus *Senna* were collected from Thanlyin Township, Yangon Region. *Senna alata* (L.) Roxb. was usually flowering from November to February and *Senna tora* (L.) Roxb. was from July to October. Fruiting period of *Senna alata* (L.) Roxb. was from December to March. *Senna tora* (L.) Roxb. was from August to December.

The specimens used in this work were mostly from wild plants. They were collected during their flowering and fruiting periods. It was ensured that the plants were healthy and uninfected.

Identification of selected species

Senna alata (L.) Roxb. and *Senna tora* (L.) Roxb. were identified and authenticated in the Department of Botany, East Yangon University with the help of available literature (Hooker, 1879; Kirtikar and Basu, 1918; Backer, 1963).

Sensory characters and Microscopical characters

The sensory characters of samples like colour, texture, odour and taste were examined by preparing of powder. The fine powders of samples were usually cleared by Chloral Hydrate solution before microscopical examinations. The microscopical studies of two species of *Senna* had been carried out according to Esau (1965).

Preliminary Phytochemical Analysis

The specimens were washed with water and dried in the room temperature for two weeks. After they were completely dried, the samples were pulverized by grinding with the grinder. The powder samples were stored in air-tight container. This study was performed at the preliminary phytochemical screening on the dried powdered leaves were performed using the respective solvent. These extracts were tested for the presence and absence of active phytochemicals viz. glycoside, reducing sugar, phenolic compound, tannin, starch, flavonoid, carbohydrate, cyanogenic glycoside, saponin, α -amino acid and alkaloid according to the reported methods (Geissman, 1962; Tin Wa, 1972; Trease and Evans, 1978; Marini-Bettolo G.B.*et al.*, 1981; Central Council for Research in Unani Medicine, 1987).

Results

Morphological Characters of *Senna alata* (L.) Roxb.

Scientific Name	-	<i>Senna alata</i> (L.) Roxb.
Myanmar Name	-	Thin-baw-mezali, Pwe-gaing, Mezali-gyi
Common Name	-	Candle brush
Flowering periods	-	November to February
Fruiting periods	-	December to March
Parts Used	-	Leaves, stems, flowers and roots

Perennial shrubs, erect, stems woody, multiple branches. Leaves alternate, unipinnately compound, paripinnate, leaflets 8-20 pairs, opposite, lowermost pair placed above the base of the petiole, oblong-elliptic, oblong oblique at the base, mostly rounded, emarginated at the apex, the margin entire, midrib veins pilose, the petioles mostly rounded, pulvinous, glabrous, rachis and petiole without foliar gland, the petiole pale brownish, the stipules triangular,

glabrous; rachis cylindrical, glabrous. Inflorescences terminal erect spike, numerous flowered racemes, peduncles greenish, sparsely pubescent. Flowers not completely open, bright yellow, the bracts conspicuous, orange, enclosing flower buds, fall off when the flowers open, caducous, oblong to broadly ovate obovate, concave, slightly curved, both surfaces glabrous, the pedicels very short, ebracteolate, bisexual, zygomorphic, pentamerous, hypogynous; sepals 5, free, polysepalous, yellowish-orange, oblong, both sides glabrous; petals 5, free, polypetalous, bright yellow, ovate-orbicular with short claw, glabrous; stamens 7+3, 7 fertile and 3 staminodes, free, polyandrous, the filaments unequal, pale yellow, anthers dithecous, oblong and curved, golden yellow, basifixed, porous dehiscence, introrse; carpel 1, monocarpellary, unilocular, the marginal placentation, ovary elongate, pubescent, the styles terminal and slender, long and curve, pale green, glabrous, persistent, the stigmas simple, gynophore short, ovary superior. Fruits oblong, four angel pod, with broad crinkly wings, dark green, black when mature and dry, glabrous, dehiscence. Seeds numerous, flatten, triangular, laterally compressed, 50-55 seeds per pod, black, copious endosperm, and glabrous (Figure 1-10).



Figure 1 Habit

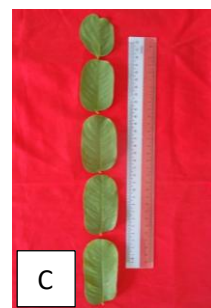
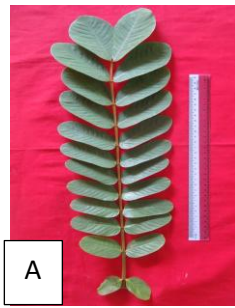


Figure 2 Compound leaves (A) Ventral view of leaf, (B) Dorsal view of leaf (C) Leaflets



Figure 3 Inflorescence



Figure 4 Flower



Figure 5 Sepals



Figure 6 Petals



Figure 8 Gynoecium



Figure 9 Fruits



Figure 10 Seeds

Morphological Characters of *Senna tora* (L.) Roxb.

Scientific Name	-	<i>Senna tora</i> (L.) Roxb.
Myanmar Name	-	Dan-gywe
Common Name	-	Java bean
Flowering periods	-	July to October
Fruiting periods	-	August to December
Part Used	-	Young shoots, leaves, roots and seeds

Annual herbs, stem greenish at the top and grayish to brown at the base, glabrous bark thin, slender, herbaceous. Leaves alternate, unipinnately compound, paripinnate, leaflets 3 pairs, opposite, ovate-lanceolate, cuneate oblique at the base, margin entire with pilose, the petiole mostly rounded, with a large sessile globose purple foliar gland, Inflorescence axillary, few flowered racemes, peduncle green, pubescent. Flowers yellow, bracts small, green, linear-lanceolate, caducous, glabrous, pedicel pubescent, green, ebracteolate, bisexual, zygomorphic, pentamerous, hypogynous; sepals 5, free, polysepalous, yellowish green, pubescent; petals 5, free, polypetalous, brilliant yellow, obovate with short claw, glabrous; stamens 7+3, 7 fertile and 3 staminodes, free, polyandrous, the filament unequal, anthers dithecal, oblong and curved, pale green, basifixed, dehiscence apical porous, introrse; carpel 1, monocarpellary, unilocular with numerous ovules, the marginal placentation, the style greenish, terete, long and curves, the stigma simple, hairy, gynophores short, ovary superior. Fruits rod-like rounded pod, green, turn into brown with light edges when mature, linear, dehiscent. Seeds are numerous, ovate, almost round, compressed, about 18-25 seeds per pod, brown, copious endosperm (Figure 11 - 20).



Figure 11 Habit



Figure 12 Compound leaves (A) Ventral view of leaf, (B) Dorsal view of leaf (C) Leaflets



Figure 13
Inflorescences



Figure 14 flowers



Figure 15 Sepals



Figure 16 Petals



Figure 17 Stamens Figure 18 Gynoecium Figure 19 Fruits Figure 20 Seeds

Table 1 Comparison of twenty two qualitative morphological characters of *Senna*

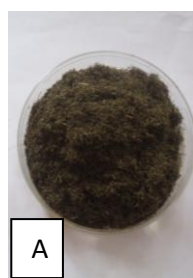
No.	Morphological characters	<i>Senna alata</i> (L.) Roxb.	<i>Senna tora</i> (L.) Roxb.
1	Habit	shrubs	herbs
2	Leaf arrangement & types	alternate, unipinnately compound	alternate, unipinnately compound
3	Leaflets shape	oblong to elliptic	ovate-lanceolate
4	Leaflets base	oblong oblique	cuneate oblique
5	Leaflets tip	emarginate	rounded cuspidate
6	Leaflets margin	entire	entire with pilose
7	Foliar gland	absent	present
8	Stipules	present	present
9	Inflorescence	erect spike	few flower raceme
10	Peduncle surface & colour	pubescent, green	pubescent, green
11	Pedicel surface & colour	very short	pubescent, green
12	Bract surface & colour	glabrous, orange	glabrous, green
13	Sepal surface & colour	glabrous, yellowish orange	pubescent, yellowish green
14	Petal surface & colour	glabrous bright yellow	glabrous, brilliant yellow
15	Petal shape	ovate-orbicular	obovate
16	Staminode	present	present
17	Anther colour	golden yellow	pale green
18	Style	long and curved	long and curve
19	Stigma	simple	simple
20	Fruits	oblong, four angle pods with broadly crinkly wings	rod like rounded pod
21	Fruit dehiscence	dehiscence	dehiscence
22	Seed	flatten triangular, black	round, compressed brown

Sensory characters of powdered leaves of two species of *Senna*

In the present study, the colour, taste, odour and texture of powdered leaves of two species of *Senna* were investigated and the results were shown in Table 2 and Figure (21-22).

Table 2 Sensory characters of powdered leaves of two species of *Senna*

Characters	<i>Senna alata</i> (L.) Roxb.	<i>Senna tora</i> (L.) Roxb.
Colour	Greenish black	Pale green
Texture	Fibrous	Smooth
Odour	unpleasant	Odourless
Taste	Bitter	Slightly bitter

Figure 21 Dried leaves of (A) *Senna alata* (L.) Roxb., (B) *Senna tora* (L.) Roxb.Figure 22 Powdered leaves of (A) *Senna alata* (L.) Roxb., (B) *Senna tora* (L.) Roxb.**Microscopical Characters of the powdered leaves of two species of *Senna***

Microscopical characters of powdered leaves sample has shown parenchyma, fibres, tracheids, spiral tracheid, vessels and crystal. The results were shown in figure 23.

Senna alata (L.) Roxb.

Senna tora (L.) Roxb.

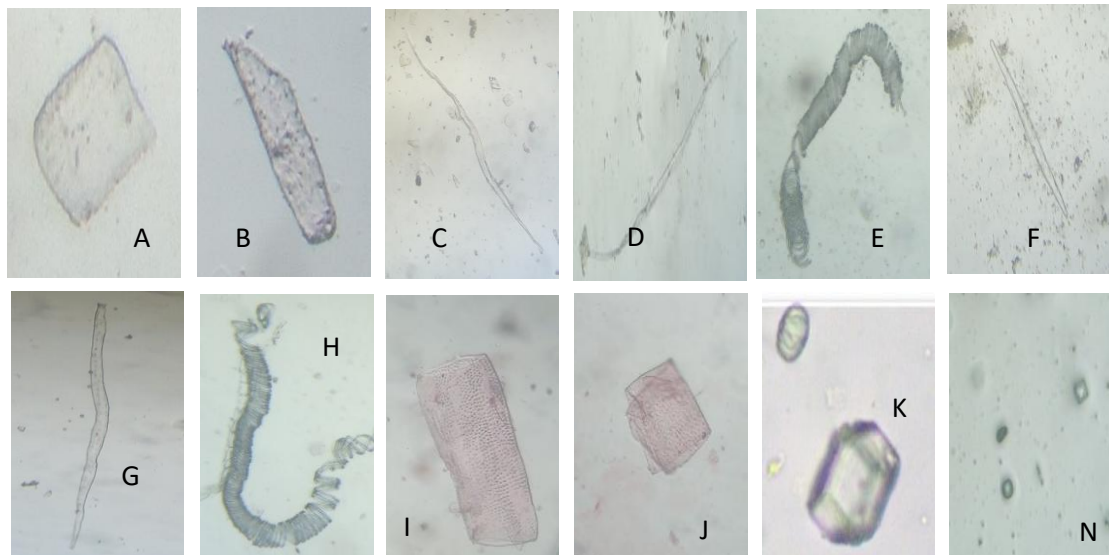


Figure 23 Microscopical character of powdered leaves (A-B Parenchyma), (C-D) Fibre, (E-F) Tracheid, (G-H) Spiral tracheid, (I-J) Vessel, (K-N) Crystal

Preliminary phytochemical tests on the leaves of two species of *Senna*

In the preliminary phytochemical examination, *Senna alata* (L.) Roxb. *Senna tora* (L.) Roxb. showed the presence of phytochemical constituents namely glycoside, reducing sugar, phenolic compound, starch, carbohydrates, flavonoid, α -amino acid, alkaloid and terpenoid and the absence of tannins and cyanogenic glycosides.

Senna. alata (L.) Roxb. revealed the presence of saponins and *Senna tora* (L.) Roxb. were absent in saponin. The chemical color reaction tests for chemical constituents of leaves extracts of the investigated plants are shown in Table 3.

Table 3 Preliminary phytochemical tests on the leaves of two species of *Senna*

No.	Test	Extract	Reagents Used	Observation		Results	
				<i>S.alata</i> (L.) Roxb	<i>S.tora</i> (L.) Roxb	<i>S.alata</i> (L.) Roxb	<i>S.tora</i> (L.) Roxb
1.	Alkaloids	10% Acetic acid+ EtOH	Mayer's reagent	White Colour ppt.	White Colour ppt.	+	+
			Wagner's reagent	Brown colour	Brown colour	+	+
			Dragendorff's reagent	Reddish Brown colour	Brown colour	+	+
			Hager's reagent	Yellow colour	Yellow colour	+	+
2.	α -amino acid	H ₂ O	Ninhydrin reagent	Pale purple colour	purple colour	+	+
3.	Carbohydrates	H ₂ O	10% alcoholic α naphthol+Conc;H ₂ S O ₄	Red ring	Red ring	+	+
4.	Cyanogenic Glycosides	H ₂ O	H ₂ SO ₄ + Sodium picate paper	No colour change	No colour change	-	-
5.	Flavonoid	70% EtOH	Mg ribbon + Conc: HCl acid	Brown colour ppt	Brown colour ppt	+	+
6.	Gycosides	H ₂ O	10% lead acetate solution	White ppt	White ppt	+	+
7.	Phenolic Compound	H ₂ O	1% FeCl ₃ solution	Greenish brown ppt	Greenish black ppt	+	+
8.	Reducing Sugar	H ₂ O	Fehling's solution(A+B)	Orange ppt.	Orange ppt.	+	+
9.	Saponin	H ₂ O	Distilled Water	Persistent foam	No Persistent foam	+	-
10	Starch	H ₂ O	Iodine solution	Brownish pink ppt	Brown ppt	-	-
11.	Steroid	Pet-ether	Acetic anhydride+ H ₂ SO ₄	Bluish green colour	Bluish green colour	+	+
12.	Terpenoid	Pet-ether	Acetic anhydride+ H ₂ SO ₄	Pink colour	Pink colour	+	+
13.	Tannins	H ₂ O	1% Gelatin+10%NaCl solution	No ppt	No ppt	-	-

present (+)

absent (-)

Discussion

In this research, the morphological characters of the whole plant of two selected species, *Senna alata* (L.) Roxb and *Senna tora* (L.) Roxb were studied. Moreover the sensory evaluation, microscopical evaluation and phytochemical analysis of powdered leaves both plants were also performed.

In the morphological studies, the result of the present work showed that the *Senna alata* (L.) Roxb are shrubs, leaves alternate, unipinnately compound, leaflets 8-26 pairs, which are flowers ebracteolate, sepals yellowish-orange, petal bright yellows, stamens 10, seven fertile and 3 staminodes. These characters are in accordance with the descriptions given by (Hooker, 1879; Backer, 1963; Dassanayake, 1980).

Senna tora (L.) Roxb was annual herbs, leaves alternate, unipinnately compound, paripinnate, leaflets 3 pairs, opposite, foliar glands, flower yellow, bracts small, petals brilliant yellow, stamens 7 fertile and 3 staminodes, which are agreed with those given by (Hooker, 1879; Kirtikar and Basu, 1933; Backer 1963; Dassanayake, 1980; Kapoor, 2001).

In phytochemical investigation of *Senna alata* (L.) Roxb revealed that the presence of flavonoid, glycosides, sterol, phenolic compounds and saponin. These characters were in agreement with those given by (Trease and Evens, 1978; Rastogi, 1979; Duke, 1980).

Senna tora (L.) Roxb revealed that the presence of glycoside, alkaloids, amino acids, carbohydrate, and flavonoids. These characters were in agreement with those given by Dwarakanath; 1987.

Conclusion

The two species of *Senna* studied in this research, grew wild or cultivated throughout Myanmar. A study has been undertaken on the morphology of the vegetative and reproductive parts of two species of *Senna*. Preliminary phytochemical properties of the plants were also investigated.

It is hoped that the result of the present investigations have contributed towards a better understanding of *Senna* grown in Myanmar or its proper utilization in the near future.

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ASSESSMENT OF WATER QUALITY IN TERMS OF WATER QUALITY INDEX (WQI)

Yoon Noe Noe Kay¹

Abstract

Water body of Aung Mingalar Lake, Thaketa township, Yangon Region was assessed for public consumption, recreation and other purposes. Water samples were collected seasonally during January to July 2019 to determine the water quality. The analysis of water was conducted at the Water and Soil Examination Laboratory, Freshwater Aquaculture Research, Department of Fisheries, Thaketa, Yangon. The quality of water was evaluated by Water Quality Index (WQI) that calculated on the basis of physicochemical parameters such as Temperature, pH, Total hardness, Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Nitrate Nitrogen (NO_3^-), Orthophosphate (PO_4P^-), Sulphate (SO_4) and Chloride (Cl). The result of physicochemical parameters was described with the standard value of International Organization. Although turbidity, DO and PO_4P^- were more than the guideline values of drinking water quality of WHO (2017), other parameters were less than the limit and especially in the pH values, it was within the guideline value and nearly the neutral. However, the most of the physicochemical parameters were within the range of guidelines values, the water condition of the Lake is unsuitable for purified drinking. According to the results, the water body of the Lake need to be proper treatment for using the water in various purposes and especially for drinking.

Keywords: physicochemical parameters, Water Quality Index, guideline value.

Introduction

Water is one of the most precious materials on earth. An average man (of 53 kg-63kg body weight), requires about 3 liters of water in liquid and food daily to keep healthy. The physicochemical properties of water have practical significant for water supply, water quality and water treatment engineers (WHO,2011).

Water sources may be mainly in the form of rivers, lakes, glaciers, rain water, ground water etc. Besides the need of water for drinking, water resources play a vital role in various sectors of economy such as agriculture, livestock production, forestry, industrial activities, hydropower generation, fisheries and other creative activities. The availability and quality of water either surface or ground have been deteriorated due to some important factors like increasing population, industrialization, urbanization etc.

According to WHO (2004) organization, about 80% of all diseases in human being are caused by water. Water Quality Index (WQI) has been regarded as one of the most effective way to assess the quality of water.

The water from the Aung Mingalar Lake was previously used for the drinking and domestic supplies and also the enhance of the income of local people by hitching cistern cart to surrounding area. The conservation of freshwater resources is required for the Lake and it is important to safe the quality of water for the region. One Way to evaluate water quality is to analyzed the physicochemical parameters of water. The analysis of water in terms of WQI include the range of pH, Chloride, sulphate, nitrate, total hardness, dissolved oxygen, biological oxygen demand, total dissolved solids as recommended by World Health Organization. The study will intend to calculate the water quality index of the study site based on physicochemical parameters and to verify its water quality according to Water Quality Index (WQI).

Material and Methods

Water samples for investigating the physicochemical parameters was collected from the surface layer (20 cm) depth of station number One, Two and Three of the Aung Mingalar

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Lake in January for cold season, in April for hot season and in July for rainy season, 2019. The physicochemical parameters of these samples were measured by the following methods (Adoni, 1987) at the Water and Soil Examination Laboratory, Freshwater Aquaculture Research, Department of Fisheries, Thaketa Township, Yangon.

Study area

In the present study, Aung Mingalar Lake stores rain water at No. (7) Ward, Thaketa Township. It is situated at the centre of Thaketa Township between the north latitudes 16° 48" and east longitudes 96° 12". It is surrounded by No.7 Basic Education High School, residential area and Kan-zun field. Total area is 19300 m and 2.4m in depth. The three sampling stations of the Lake were chosen and were shown on the map of No. (7) Ward, Thaketa Township (Fig.1).



Figure 1 Map of the Selected Stations of Aung Mingalar Lake

Station 1. Latitudes of 16° 48' 05.201" N and Longitude of 96° 12' 43.915" E

Station 2. Latitudes of 16° 48' 07.666" N and Longitude of 96° 12' 36.277" E

Station 3. Latitudes of 16° 48' 10.672" N and Longitude of 96° 12' 45.991" E

Calculation of Water Quality Index

The following physicochemical parameters were used in the calculation of the WQI: Turbidity, pH, Total hardness, Total Dissolved Solids, Dissolved Oxygen, Biological Oxygen Demand, Chemical Oxygen Demand, Nitrate Nitrogen, Orthophosphate, Sulphate and Chloride, Water Quality Index (WQI) was calculated by Horton (1965) method.

WQI Calculation (Horton, 1965)

$$WQI = \sum q_n W_n / \sum W_n$$

Quality rating (q_n)

$$q_n = [(V_n - V_{id}) / (S_n - V_{id})] \times 100$$

Where,

q_n = Quality rating for the n^{th} water quality parameter

V_n = Estimated value of the n^{th} parameter at a given water sampling station

S_n = Standard permissible value of the n^{th} parameter

V_{id} = Ideal value of n^{th} parameter in pure water (i.e. 0 for all other parameters except the parameters pH= 7.0 and Dissolve Oxygen 14.6 mg/L)

Unit weight

$$W_n = k / S_n$$

Where,

W_n = unit weight for n^{th} parameter

Table 1. Classification of Water Quality index (WHO, 2017)

Sr. No	Grading	WQI	Status	Possible usages
1.	A	0-25	Excellent	Drinking, Irrigation and Industrial
2.	B	25-50	Good	Domestic, Irrigation and Industrial
3.	C	51-75	Fair	Irrigation and Industrial
4.	D	76-100	Poor	Irrigation
5.	E	101-150	Very Poor	Restricted use for Irrigation
6.	F	Above 150	Unit for drinking	Proper treatment required before use

Results

The analysis of physicochemical parameters of water from three sampling stations of Aung Mingalar Lake in January, April and July 2018 were analysed as shown in Table-2.

Table 2. Comparison of physicochemical parameters of Surface layer of Three Selected Station

Parameters	Units	Station-1			Station-2			Station-3		
		January	April	July	January	April	July	January	April	July
Temperature	°C	29	31	30	29	32	30	29	32	29
Turbidity	FTU	10	15	10	10	20	12	12	20	12
pH	-	6.7	7.1	6.9	6.8	7.1	6.9	6.9	7.2	7.1
Total hardness	mg/L	32	66	55	20	68	58	20	66	56
Total Dissolved Solids	mg/L	25	28	15	26	30	20	24	30	22
DO	mg/L	4.5	4.5	5	3.25	4	5	4	4	5.5
BOD	mg/L	1.5	1.57	1	1.55	1.52	1.25	1.57	1.75	1.5
COD	mg/L	0.32	0.62	0.23	0.36	0.66	0.16	0.65	0.69	0.16
NO ₃ ⁻	mg/L	0.152	0.212	0.1	0.15	0.22	0.1	0.15	0.215	0.12
PO ₄ P ⁻	mg/L	0.105	0.25	0.15	0.122	0.28	0.12	0.152	0.28	0.18
Sulphate	mg/L	0.055	0.152	0.051	0.058	0.156	0.055	0.07	0.172	0.056
Chloride	mg/L	24.995	49.99	49.99	19.996	49.99	49.99	19.996	49.98	49.98

Table. 3 Comparison of Physicochemical Parameters of Three Selected Stations with Guideline values of WHO (2017)

Parameter	Unit	The physicochemical parameters of study sites	Guideline value of WHO (2017)
Temperature	°C	29 - 32	-
Turbidity	FTU	10 - 20	5
pH	-	6.7 - 7.2	6.5-8.5
Total hardness	mg/L	20 - 68	150
TDS	mg/L	15 - 30	500
DO	mg/L	3.3 - 5.5	5
BOD	mg/L	1.0 - 1.75	5
COD	mg/L	0.16 - 0.69	10
NO ₃ ⁻	mg/L	0.10 - 0.220	50
PO ₄ P ⁻	mg/L	0.105 - 0.28	0.01
Sulphate	mg/L	0.051 - 0.172	250
Chloride	mg/L	19.996-49.99	250

Data analysis**Table.4 Calculation of Water Quality Index of Aung Mingalar Lake during Cold Season**

Jan	Sn	K	Wn	S 1	qn	Wnqn	S 2	qn	Wnqn	S 3	qn	Wnqn
Turbidity	5	0.0099	0.00198	10	200	0.396	10	200	0.396	12	240	0.475
pH	6.5	0.0099	0.00152	6.7	60	0.912	6.8	40	0.060	6.9	20	0.0304
Total hardness	150	0.0099	0.000066	32	21.33	0.0014	20	13.33	0.00087	20	13.33	0.00087
TDS	500	0.0099	0.0000198	25	5	9.91	26	5.2	0.00010	24	4.8	9.51
DO	5	0.0099	0.00198	4.5	105.2	0.208	3.25	118.2	0.234	4.0	110.4	0.218
BOD	5	0.0099	0.00198	1.5	30	0.0594	1.55	31	0.0614	1.57	31.4	0.0622
COD	10	0.0099	0.00099	0.32	3.2	0.00317	0.36	3.6	0.0032	0.65	6.5	0.00644
NO₃-	50	0.0099	0.000198	0.152	0.304	6.025	0.150	0.3	5.94	0.150	0.3	5.94
PO₄P-	0.01	0.0099	0.99	0.105	1050	1040.5	0.122	1220	1209	0.152	1520	1506.3
SO₄	250	0.0099	0.0000396	0.055	0.022	8.712	0.058	0.023	9.187	0.070	0.028	1.108
Cl	250	0.0099	0.0000396	24.995	9.998	0.00039	19.996	7.998	0.000316	19.996	7.99	0.00031
Σ			= 0.998			=1065.9			= 1225			= 1524

Station One

$$WQI = \sum q_n W_n / \sum W_n$$

$$= 1065.9 / 0.99 = 1076$$

Station Two

$$WQI = \sum q_n W_n / \sum W_n$$

$$= 1224.9 / 0.99 = 1237$$

Station Three

$$WQI = \sum q_n W_n / \sum W_n$$

$$= 1523.6 / 0.99 = 1538$$

Table. 5 Calculation of Water Quality Index of Aung Mingalar Lake during Hot Season

April	S _n	K	W _n	S 1	q _n	W _n q _n	S 2	q _n	W _n q _n	S 3	q _n	W _n q _n
Turbidity	5	0.0099	0.00198	15	300	0.594	20	500	0.99	20	400	0.792
pH	6.5	0.0099	0.00152	7.1	20	0.0304	7.1	20	0.0304	7.2	40	0.0608
Total hardness	150	0.0099	0.000066	66	44	0.0029	68	45.3	0.0029	66	44	0.0029
TDS	500	0.0099	0.0000198	28	5.6	0.00011	30	6	0.00011	30	6	0.00011
DO	5	0.0099	0.00198	4.5	105.2	0.2082	4.0	110.4	0.2185	4.0	110.4	0.2185
BOD	5	0.0099	0.00198	1.57	31.4	0.0621	1.52	30.4	0.0601	1.75	35	0.0693
COD	10	0.0099	0.00099	0.62	6.2	0.00613	0.66	6.6	0.00653	0.69	6.9	0.00681
NO ₃ ⁻	50	0.0099	0.000198	0.212	0.424	0.000083	0.220	0.44	0.000087	0.215	0.43	0.00008
PO ₄ P ⁻	0.01	0.0099	0.99	0.25	2500	2475	0.28	2800	2772	0.28	2800	2772
SO ₄	250	0.0099	0.0000396	0.152	0.0608	0.0000024	0.156	0.0624	0.0000024	0.172	0.0688	0.00002
Cl	250	0.0099	0.0000396	49.99	19.996	0.000791	49.99	19.996	0.000791	49.98	19.992	0.00079
Σ			= 0.9988			≈2476			≈2773			= 2773

Station One

$$WQI = \sum q_n W_n / \sum W_n$$

$$= 2476 / 0.9988 = 2478$$

Station Two

$$\begin{aligned} WQI &= \sum q_n W_n / \sum W_n \\ &= 2773 / 0.9988 = 2776 \end{aligned}$$

Station Three

$$\begin{aligned} WQI &= \sum q_n W_n / \sum W \\ &= 2773 / 0.9988 = 2776 \end{aligned}$$

Table. 6 Calculation of Water Quality Index of Aung Mingalar Lake during Rainy Season

July	Sn	K	Wn	S 1	qn	Wnqn	S 2	qn	Wnqn	S 3	qn	Wnqn
Turbidity	5	0.099	0.00198	10	100	0.198	12	100	0.198	12	94.79	0.1876
pH	6.5	0.0099	0.00152	6.9	20	0.0304	6.9	20	0.0304	7.1	20	0.0304
Total hardness	150	0.0099	0.000066	55	36.66	0.00241	58	38.66	0.0055	56	37.33	0.00246
TDS	500	0.0099	0.0000198	15	3	0.0000594	20	3	0.0000792	22	4.4	0.0000872
DO	5	0.0099	0.00198	5	200	0.396	5	200	0.475	5.5	240	0.4752
BOD	5	0.0099	0.00198	1.0	20	0.0396	1.25	20	0.0495	1.5	30	0.0594
COD	10	0.0099	0.00099	0.23	2.3	0.00227	0.16	2.3	0.00158	0.16	1.6	0.00158
NO3-	50	0.0099	0.000198	0.10	0.2	0.0000396	0.10	0.2	0.0000396	0.12	0.24	0.0000475
PO4P ⁻	0.01	0.0099	0.99	0.15	1500	1485	0.12	1500	1188	0.18	1800	1782
SO4	250	0.0099	0.0000396	0.051	0.0204	0.000000807	0.055	0.0204	0.00000087	0.056	0.0224	0.000000887
Cl	250	0.0099	0.0000396	49.99	19.99	0.000791	49.99	19.99	0.000791	49.98	19.992	0.000791
Σ			= 0.9988			= 1485.6			= 1188.7			= 1782.7

Station One

$$\begin{aligned} WQI &= \sum q_n W_n / \sum W_n \\ &= 1485.6 / 0.9988 = 1487 \end{aligned}$$

Station Two

$$WQI = \sum q_n W_n / \sum W_n$$

$$= 1188.7 / 0.9988 = 1188$$

Station Three

$$WQI = \sum q_n W_n / \sum W_n$$

$$= 1782.7 / 0.9988 = 1784$$

Table. 7 Comparison of Water Quality Index (WQI) of three selected stations

January			April			July		
Station 1	Station 2	Station 3	Station 1	Station 2	Station 3	Station 1	Station 2	Station 3
1076	1237	1538	2478	2776	2776	1487	1188	1784

Discussion

In this study, three sampling stations were chosen from Aung Mingalar Lake to collect the water samples. The collection of water samples was carried out in January, April and July for three seasons 2019. The water quality of Aung Mingalar Lake, was measured with twelve kinds of physicochemical parameters and calculated the Water Quality Index (WQI).

The temperature of the study sites was ranging from 29°C to 32°C. It was agreed with Pulz (2004) who stated that the Lake temperature of drinking water was within the range of 16-35°C which was not adversely affected on microphytes growth.

The turbidity of the study sites were appeared 10 – 12 FTU in January, 15-20 FTU in April and 10 - 12 FTU in July. Thus turbidity values of the Lake were within 10 - 20 FTU that higher than the guideline value of 5NTU (WHO). Goel (2006) Higgins and Lodrigues (2007) stated that the amount of turbidity was higher in drinking water that hard to consume for local people.

According to the result the pH values of the study sites were 6.7-6.9 in January, 7.1-7.2 in April and 6.9-7.1 in July, this Lake of values were (6.7 to 7.2). These ranges were between the allowable limit revealed that of the water body of the pH may not be corrosive nor decreases efficiency of chlorination (Shanthi,2002).

The total hardness of the study sites were 20 - 32 mg/L in January, 66 - 68 mg/L in April and 55-58 mg/L in July. It was coincided with Kannan (1991) the Lake water was demonstrated that soft and moderately hard condition alternately should not be drink.

The total dissolved solids (TDS) of the study sites were 24 – 26 mg/L in January, 28 – 30 mg/L in April and 15– 22 mg/L in July and thus it was ranging from 15 to 30 mg/L. This values was lesser than the guideline value of (WHO, 2017). It was stated that the water of the Lake is not have good quality for drinking based on its taste.

The Dissolved Oxygen (DO) levels of the study sites were 3.25 - 4.5 mg/L in January, 4.0 - 4.5 mg/L in April and 5 - 5.5 mg/L in July and it lied between 3.3 to 5.5 mg/L. The guideline value of dissolved oxygen range was (5 mg/L). According to the result, although the dissolved oxygen levels was raised in July, the water body of the Lake water was not pollution.

This observation agreed with Shanthi *et al* (2002) who stated that dissolved oxygen concentrations are normally sufficient to maintain healthy biotic assemblages in unpolluted but low or extremely high dissolved oxygen levels can be ruinous or kill fishes.

The Biological Oxygen Demand (BOD) levels of the study sites were 1.50 - 1.57 mg/L in January, 1.57 - 1.75 mg/L in April and 1.0 - 1.5 mg/L in July. Small amount of BOD (1.0 - 1.75 mg/L) contain in the Lake water is lower than the standard value 5 mg/L (WHO, 2017), it levels indicated that the amount of organic matter present in water. Therefore, a low BOD levels is an indicator of good quality of water, while a high BOD values indicates polluted water (Shanthi, 2002) and consequently it was dissimilar.

The Chemical Oxygen Demand (COD) levels of the study sites were 0.32 - 0.65 mg/L in January, 0.62 - 0.69 mg/L in April and 0.16 - 0.23 mg/L in July. The COD levels (0.16 - 0.69 mg/L) was lower than the standard value (10 mg/L) which was regarded as the water body was unpolluted water.

Nitrate Nitrogen (NO_3^-) levels were 0.150 - 0.152 mg/L in January, 0.220 - 0.215 mg/L in April and 0.10 - 0.12 mg/L in July. NO_3^- concentrations were within 0.10 - 0.220 mg/L which were lower than the standard value (50 mg/L). According to WHO (1972), the ranges of NO_3^- (0.10 - 0.220 mg/L) were lower than the standard value (50 mg/L) which demonstrated as natural water and unpolluted condition.

The amount of Orthophosphate (PO_4P^-) of the study sites were 0.105 - 0.152 mg/L in January, 0.25 - 0.28 mg/L in April and 0.12 - 0.18 mg/L in July. Although the amount of PO_4P^- was 0.105 - 0.28 mg/L that were higher than the values of WHO (0.01 mg/L) and EPA (0.05 mg/L). Based on the result, the water body of the Lake was unpolluted. Ramachandra and Ahalya (2001) and Goel (2008) stated that the natural non-polluted waters have insignificant quantities of phosphorus and rarely found in high concentration in freshwater.

The sulphate levels of the study sites were 0.055- 0.070 mg/L in January, 0.152 - 0.172 mg/L in April and 0.051-0.058 mg/L in July. The concentration of sulphate (0.051-0.172 mg/L) was lower than the standard value (250 mg/L) which cannot give the offensive taste. High amounts of various sulphate salts may give drinking water an offensive taste. High concentration of sulphate may interfere in the efficiency chlorination in some water supplies. Also sulphate salts may increase the corrosive properties of water Pulz (2004).

Chloride levels of the study sites were ranged between 19.996 - 49.99 mg/L and lower than the guideline values of WHO (2017). According to Chandra *et al.* (2012) the concentration of chloride was normally low and the high concentration of chloride is considered to be an indication of pollution due to high organic waste of animal origin that it was natural surface water.

According to the calculation of Water Quality Index (WQI), the physicochemical parameters values of all stations in April were higher than that of all stations in other months but these values were values were not very differences. According to the WHO (2017), except the amount of turbidity and orthophosphate (PO_4P^-) of Aung Mingalar Lake were slightly exceed than the standard values, the rest of parameters were lower than the standard values. However, after the calculation of WQI the water quality of Aung Mingalar Lake is more than the Grading- F (above 150) was noted. Therefore, the excess amount of turbidity and orthophosphate (PO_4P^-) the water in the Lake unpleasant smell needed proper treatment before use.

Conclusion

Although most of the physicochemical parameters of water in this research were within the range of guideline values, it is not enough for determining the best water quality. It is concluded that the water condition of the lake is needed proper treatment before use for drinking various purposes of resident. This research will give some information about water quality and the methods for calculation of water quality index in the basis of physicochemical parameter is necessary for evaluating of accurate water quality.

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