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Department of Higher Education
Taunggoke University

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Editorial Board

Taunggoke University Research Journal

Vol. 2, No. 1, 2020

Table of Contents

၁၂ ရာစုမှ ၁၃ ရာစုအတွင်း မြန်မာဝေါဟာရများမှ အနက်ဆန့်ကျင်မှုသဘော

တင်တင်ထွန်း*

စာတမ်းအကျဉ်း

ဤစာတမ်းသည် ၁၂ ရာစုမှ ၁၃ ရာစုအတွင်းမြန်မာဝေါဟာရများမှ အနက်ဆန့်ကျင်မှု သဘောကို လေ့လာတင်ပြထားသောစာတမ်းဖြစ်ပါသည်။ အနက်ဆန့်ကျင်မှုသဘောကို အနောက်တိုင်းပညာရှင်တို့က ၂၀ရာစုတွင်မှစနစ်တကျ ပုံဖော်လေ့လာနိုင်ခဲ့သော်လည်း မြန်မာ ဘာသာစကားပညာရှင် ဒုတိယကျော်အောင်စံထားဆရာတော်က ၁၈ရာစုကတည်းကပင် ပီပြင်စွာထုတ်ဖော် ပြနိုင်ခဲ့ပါသည်။ ထိုပညာရှင်တို့၏ သီအိုရီအယူအဆများကိုအခြေခံ၍ ၁၂ ရာစုနှင့် ၁၃ရာစုရှိ မြန်မာတို့၏စာပေအဆင့်အတန်းကို ဖော်ထုတ်ကြည့်လိုသည့် ရည်ရွယ် ချက်ဖြင့်လေ့လာထားခြင်းဖြစ်ပါသည်။ ဘာသာစကားတိုင်းတွင် ပုံမှန်တွေ့ရမြဲဖြစ်သော သွင်ပြင်လက္ခဏာတစ်ရပ်ဖြစ်သည့် အနက်ဆန့်ကျင်ခြင်းသဘောနှင့် အနက်ဆန့်ကျင်မှု အမျိုး အစားများကို အခန်းကဏ္ဍများ ခွဲခြားတင်ပြထားပါသည်။

သော့ချက်ဝေါဟာရများ – ကျောက်စာ၊မင်စာရှိဝေါဟာရများ၊ ဆန့်ကျင်မှုအနက် ရှိသော စကားလုံးတွဲများ။

နိဒါန်း

ဤစာတမ်းသည် ၁၂ရာစုမှ ၁၃ရာစုအတွင်း မြန်မာဝေါဟာရများ၏ အသုံးအနှုန်းပေါင်း များစွာထဲမှ အနက်ဆန့်ကျင်မှုရှိသော ဝေါဟာရများကို လေ့လာတင်ပြထားသောစာတမ်း ဖြစ်ပါသည်။ ဘာသာစကားတစ်ခုသည် အနက်အဓိပ္ပာယ်ရှိသည့်အတွက် ဘာသာစကားအဖြစ် အသက်ဝင်နေခြင်းဖြစ်သည်။ ဘာသာစကားထဲမှ အနက်အဓိပ္ပာယ်ကိုနုတ်ပယ်လိုက်မည် ဆိုလျှင် အသံမည်ကာမတ္တတို့သာကျန်နေမည်ဖြစ်သည်။ ဘာသာစကားအတွင်း၌ရှိသော ဝေါဟာရ များသည်လည်း တစ်ခုနှင့်တစ်ခုကွန်ယက်သဖွယ် အနက်ဖွဲ့ယှက်လျက်ရှိသည်။ ထိုသို့ဖွဲ့ယှက်မှု များကြောင့် ဝေါဟာရများတိုးပွားလာသည်။ ဝေါဟာရ တိုးပွားလာသလို အနက်အဓိပ္ပာယ်လည်း တိုးပွားလာတတ်သည်။ ထိုတိုးပွားလာသော ဝေါဟာရများတွင် အနက်အဓိပ္ပာယ်တူညီသော ဝေါဟာရများရှိသကဲ့သို့ မတူညီသောဝေါဟာရများလည်းရှိပါသည်။ ယင်းတို့အနက်မှ အနက် အဓိပ္ပာယ်မတူညီသောဝေါဟာရ(တစ်နည်းအားဖြင့်) ဆန့်ကျင်ဘက်အနက်ရှိသော ဝေါဟာရများ အကြောင်းကို လေ့လာသွားမည်ဖြစ်ပါသည်။ ထိုသို့လေ့လာရာ၌ အပိုင်း(၂)ပိုင်း ခွဲထားပါသည်။ အနက်ဆန့်ကျင်ခြင်း သဘောတရားသီအိုရီများနှင့် အနက်ဆန့်ကျင်မှုဖြစ်ရသည့် အကြောင်း အရင်းများဖြစ်ပါသည်။ အလေ့လာခံစကားလုံးနှင့် ဝေါဟာရအသုံးအနှုန်းများကိုမူ ရှေးဟောင်း မြန်မာကျောက်စာများ ပထမတွဲ၊ ဒုတိယတွဲ၊ တတိယတွဲတို့မှ အဓိကထုတ်နုတ် လေ့လာပါသည်။ ထိုဝေါဟာရများကိုတင်ပြရာတွင် မူရင်းကျောက်စာအရေးအသားအတိုင်း တင်ပြထားပါသည်။

အနက်ဆန့်ကျင်ခြင်း

ဘာသာစကားသည် လူအချင်းချင်းအပြန်အလှန်ဆက်သွယ်ရာတွင် အဓိကကျသော ဆက်သွယ်ရေး ပစ္စည်းတစ်မျိုးဖြစ်သည်။ ဆက်သွယ်ရေး၏အစိတ်အပိုင်းတစ်ရပ်အဖြစ် အသုံးပြုကြရာတွင် ယင်းတို့၏ရုပ်သွင်သာမက၊ အနက်အဓိပ္ပာယ်သည်လည်း အရေးပါလှသည်။ ဘာသာစကားတစ်ခု

* ကထိက၊ဒေါက်တာ၊မြန်မာစာဌာန၊တောင်ကုတ်တက္ကသိုလ်

အတွင်းရှိစကားလုံးများ၏ အနက်အဓိပ္ပာယ်ကိုလေ့လာရာတွင် အဓိပ္ပာယ်တူစကားလုံးများရှိသည့် နည်းတူ အနက်အဓိပ္ပာယ်ချင်းဆန့်ကျင်သည့် အနက်ဆန့်ကျင်စကားလုံးများ၏ အခန်းကဏ္ဍ မှာလည်း အရေးပါကြောင်း တွေ့ရှိရသည်။

အတ္ထဗေဒပညာရှင်များသည် စကားလုံးတို့၏အနက်ဆန့်ကျင်မှုသဘောကို သိရှိထားကြ သော်လည်း ကျယ်ကျယ်ပြန့်ပြန့်လေ့လာခဲ့ခြင်းမရှိခဲ့ရာမှ ၂၀ရာစုနောက်ပိုင်းတွင်မှ အနက် ဆန့်ကျင်မှုသဘောသဘာဝများကို အာရုံစိုက်လေ့လာခဲ့ကြသည်။ အနက်ဆန့်ကျင်မှုသည် ဘာသာစကား၏ အရေးပါသည့်အစိတ်အပိုင်းတစ်ရပ်ဖြစ်ကြောင်းကို ခေတ်သစ်အတ္ထဗေဒ ပညာရှင် ပါလ်မာက

> “အနက်ဆန့်ကျင်မှုသည် ပုံမှန်လည်းဖြစ်သော အလွန်လည်းသဘာဝကျသော ဘာသာစကား၏လက္ခဏာတစ်ရပ်ဖြစ်သည်” (Palmer, 1976,37) ဟုဆိုပါသည်။

မြန်မာဘာသာစကားတွင် အနက်ဆန့်ကျင်စကားလုံးများပေါကြွယ်လှရာ ကုန်းဘောင်ခေတ် ဒုတိယကျော်အောင်စံထားဆရာတော်က ပဋိပက္ခဝေါဟာရများဟုသတ်မှတ်လေ့လာခဲ့သည်။ မြန်မာ အတ္ထဗေဒပညာရှင် မောင်ခင်မင်(ဓနုဖြူ)ကလည်း အနက်ဆန့်ကျင်စကားလုံးများ၏ သဘော သဘာဝကို အောက်ပါအတိုင်း ရှင်းလင်း ဖော်ပြထားပါသည်။

> “အကျဉ်း–အကျယ်ကဲ့သို့အဓိပ္ပာယ်ဆန့်ကျင်သောစကားမျိုးကိုဆန့်ကျင်ဘက်စကား ဟုခေါ်ပါသည်။” (ခင်မင်၊ မောင်(ဓနုဖြူ)၊ ၁၉၉၇၊ ၂၂၁)

ဟူ၍မြန်မာအတ္ထဗေဒအစဉ်အလာနှင့်ခေတ်သစ်အတ္ထဗေဒ လေ့လာမှုတို့၏သဘောကို အကျဉ်းချုပ် တင်ပြထားပါသည်။

အနက်ဆန့်ကျင်မှုအမျိုးအစားများ

အနက်ဆန့်ကျင်ခြင်းသည် ဘာသာစကားများတွင် ပုံမှန်တွေ့ရသောသွင်ပြင်လက္ခဏာ တစ်ရပ် ဖြစ်ပြီး အခြားအတ္ထဗေဒဆက်နွယ်မှုများကဲ့သို့ပင် အမျိုးအစားနှင့်အဆင့်များကွဲပြားနိုင်ပါသည်။ အတ္ထဗေဒပညာရှင်များက (၃)မျိုးခွဲခြားပြကြသည်။ ယင်းတို့မှာ

(၁) နယ်ပယ်ခြားနားမှု ပြတ်သားသောအနက်ဆန့်ကျင်မှု

(၂) အရည်အသွေးအဆင့်ဆင့် ကွဲပြားမှုရှိသောအနက်ဆန့်ကျင်မှု

(၃) အပြန်အလှန်ဆက်သွယ်မှုရှိသော အနက်ဆန့်ကျင်မှု ဟူ၍ဖြစ်သည်။

နယ်ပယ်ခြားနားမှုပြတ်သားသောအနက်ဆန့်ကျင်မှု

နယ်ပယ်ခြားနားမှုပြတ်သားသော အနက်ဆန့်ကျင်မှုဟူသည် စကားလုံးတစ်လုံးနှင့်တစ်လုံး အဓိပ္ပာယ်နယ်ပယ်ချင်းပြတ်ပြတ်သားသားရှိသည့် အနက်ဆန့်ကျင်မှုမျိုးဖြစ်ပါသည်။ ထိုစကားလုံး မျိုးကိုနှစ်ခုယှဉ်၍အသုံးမပြုနိုင်ချေ။ ထိုစကားလုံးမျိုးတွင် ကြားအဆင့်၊ အလယ်အဆင့်ဟူ၍လည်း မရှိချေ။ ယင်းတို့သည်အခိုက်အတန့်သဘောမဆောင်ဘဲ ပုံသေသဘောဆောင်သောကြောင့် တစ်ခုဟုတ်လျှင်ကျန်တစ်ခုမဟုတ်ဟု အပြတ်ပြောနိုင်ပါသည်။ ထို့ကြောင့်ယင်းတို့ကိုနယ်ပယ်ချင်း ခြားနားသော အနက်ဆန့်ကျင်မှုဟုဆိုခြင်းဖြစ်သည်။ ထိုဆန့်ကျင်မှုမျိုး၌ နှစ်မျိုးထပ်မံခွဲခြား နိုင်ပါသည်။ ယင်းတို့မှာ

(၁) စကားနှစ်လုံးရှိသောအနက်ဆန့်ကျင်စကားလုံးများ

(၂) စကားနှစ်လုံးထက်ပိုသောအနက်ဆန့်ကျင်စကားလုံးများ တို့ဖြစ်သည်။

စကားနှစ်လုံးရှိသောအနက်ဆန့်ကျင်စကားလုံးများသည် စကားနှစ်လုံးတွင် အဓိပ္ပာယ်နှစ်မျိုး ရှိနေပြီး ယင်းတို့မှာ တစ်မျိုးနှင့်တစ်မျိုးအဓိပ္ပာယ်ချင်းပြတ်သားစွာ ဆန့်ကျင်ခြားနားသော စကားလုံးမျိုးလည်း ဖြစ်ပါသည်။ တစ်ခုမှန်လျှင်ကျန်တစ်ခုကမှားမည်ဟုဆိုလိုခြင်းဖြစ်သည်။ ထိုသဘောကို အတ္ထဗေဒ ပညာရှင် ဒေါက်တာခင်အေးက –

> "နယ်ပယ်ချင်းပြတ်ပြတ်သားသား ကွဲပြားသည့်အတွက် တစ်လုံးကမှန်နေလျှင် နောက်တစ်လုံးကမှားပြီး တစ်လုံးကမှားနေလျှင် နောက်တစ်လုံးက မှန်ကန်မည် ဖြစ်သည်။ လူတစ်ယောက် 'သေသည်'ဆိုသည်မှာမှန်လျှင် 'ရှင်သည်'မှာ မှားမည်ဖြစ်သည်။ 'ရှင်သည်'မှာမှန်လျှင် 'သေသည်'ဆိုသည်မှာ မှားမည်ဖြစ်သည်။ သေလျှင်မရှင်ပါ။ ရှင်လျှင်မသေပါ။ ထိုဆန့်ကျင်ဘက်စကားနှစ်လုံးကြားတွင် သေလည်းမသေ၊ ရှင်လည်းမရှင်ဟူသော အခြေအနေမျိုးမရှိနိုင်ပါ။ (ခင်အေး၊ ဒေါက်တာ၊ ၂၀၀၄၊ ၁၄၄)

ဟူ၍ ရှင်းပြထားပါသည်။

အေဒီ ၁၂–၁၃ ရာစုအတွင်း မြန်မာဘာသာစကားရှိ စကားနှစ်လုံးတွဲအနက် ဆန့်ကျင်မှု ရှိသော ဝေါဟာရများကို ပုဂံကျောက်စာများတွင် အတန်အသင့်တွေ့ရပါသည်။ သာဓကအားဖြင့်

ဩင် (အောင်) (ပုံ၊ ၇၉/ခ၊ ၃) ယှဲ့ (ရှုံး) (ပုံ၊ ၇၉/ခ၊ ၅)

ဟူ၍ဖြစ်ပါသည်။ ပုဂံခေတ်တရားစီရင်ရေးတွင်သုံးသည့် ထိုစကားလုံးတွဲတွင် 'အောင်' ဟုဆိုလျှင် 'မရှုံး'ဟုလည်းကောင်း၊ 'ရှုံး'ဟုဆိုလျှင် 'မအောင်'ဟုလည်းကောင်း အနက်ရကြောင်း ကျောက်စာပါ အကြောင်းအရာများအရသိရပါသည်။ ထိုစကားနှစ်လုံးသည် ပြတ်ပြတ်သားသား အနက်ဆန့်ကျင် ကွဲပြားလျက်ရှိနေရပါသည်။

၁၂–၁၃ ရာစုမြန်မာကျောက်စာ၊ မင်စာများတွင်တွေ့ရလေ့ရှိသည့် ထိုကဲ့သို့သောအနက်ဆန့်ကျင်စကားလုံးအချို့မှာ

သိယ် (သေ) – ရှင် (ပုံ၊ ၁၆၄၊ ၁၄)

ကာန် (ကန်း) – မြင် (စဉ်၊ ၅၄၀၊ ၉၅)

မွေခြောက် (မြေခြောက်) – မွိယ်စိမ် (မြေစိမ်း) (ပုံ၊ ၂၂၂/က၊ ၆)

ယောက်ယာ (ယောကျ်ား) – မိယ်မ (မိန်းမ) (ပုံ၊ ၁၇၊ ၁၇) တို့ဖြစ်သည်။

အေဒီ ၁၂–၁၃ ရာစု မြန်မာဘာသာစကားတွင် တွေ့ရှိရသည့်ထိုကဲ့သို့ နယ်ပယ်ခြားနားမှု ပြတ်သားသော အနက်ဆန့်ကျင်စကားလုံးများတွင် နာမ်စကားလုံးများပါဝင် သကဲ့သို့ ကြိယာစကားလုံးများလည်းပါဝင် ကြောင်းတွေ့ရှိရပါသည်။

စကားနှစ်လုံးထက်ပိုသောအနက်ဆန့်ကျင်စကားလုံးတွင်မူ စကားတစ်လုံးကမှန်သည်ဆိုလျှင် ကျန်စကားလုံးများ အားလုံးမှားသည်ဟုဆိုနိုင်သော်လည်း စကားတစ်လုံးမမှန်ဟုဆိုကာမျှနှင့် ကျန် စကားလုံးများတွင် မည်သည်ကဟုတ်မှန်ကြောင်း အသေအချာမဆိုနိုင်ပေ။ ယင်းတို့သည် စကား နှစ်လုံးတွဲ၏ အနက်ဆန့်ကျင်မှုနှင့်အခြေခံသဘောချင်းတူသော်လည်း အစုဝင်နှစ်ခုထက် ပိုနေသဖြင့် ထိုသို့ကွဲပြားချက်များဖြစ်ပေါ်လာရခြင်းဖြစ်သည်။

စကားနှစ်လုံးထက်ပိုသော အနက်ဆန့်ကျင်စကားလုံးစုတို့ကို ဒုတိယကျော်အောင်စံထား ဆရာတော်က "နှစ်ပါးမကရှိသောဝေါဟာရ" အဖြစ်ရည်ညွှန်းလျက် 'ဖြူ–ညို၊ နီ–ဝါ၊ စိမ်း–ပြာ'ဟူသော အရောင်ပြဝေါဟာရများဖြင့် သာဓကပြထားသည်။

"ဖြူ၏ဟူလျှင် မည်ဟူသောအနက်သာမပြီးမူ၍ မနီ၊ မဝါ၊ မစိမ်း၊ မပြာဟူ၍ မဖြူသည်မှတစ်ပါး အနက်လေးပါးလုံးပြီးရာခဲသောကြောင့် အလျဉ်းရှိ၏၊ မဖြူရာ၌လည်းညို၏ဟူသော အနက်သာမပြီးလင့် နီ၏ဝါ၏စသော အနက်လေးပါးလျဉ်းဖွယ်ရှိ၏" (ကျော်အောင်စံထားဆရာတော် (ဒုတိယ)၊ ၁၉၉၆၊ ၁၄၈)

ဟုမိန့်ဆိုထားပါသည်။ အေဒီ ၁၂–၁၃ ရာစုမြန်မာဘာသာစကားတွင်လည်း ထိုအနက် ဆန့်ကျင်မှုမျိုးကို တွေ့မြင်နိုင်ပါသည်။ သာဓကအားဖြင့်

နိယ် (နေ့) ည နံနက် (ပုံ၊ ၄၂၊ ၂၂)

ဟူသောစကားသုံးလုံးတွင် 'နေ့'မဟုတ်လျှင်'ည'လည်းဖြစ်နိုင်သလို၊ 'နံနက်'လည်း ဖြစ်နိုင်ပေသည်။ 'ည'မဟုတ်လျှင် 'နေ့'သော်လည်းကောင်း 'နံနက်'သော်လည်းကောင်းဖြစ်နိုင်သေးသည်။ နှစ်ခုထက်ပိုသောထိုကဲ့သို့သောစကားလုံးတွဲများရှိ အနက်ဆန့်ကျင်ခြင်းမှာလည်း ဘာသာစကားတစ်ခု၏ အနက်အဓိပ္ပာယ်စနစ်လေ့လာရာတွင်အလွန်အရေးပါလေသည်။ ထိုစကားလုံးများကို ဖော်ပြရာတွင် အစီအစဉ်ကျသည်များလည်းရှိ၍ အစီအစဉ်မကျသည်လည်းရှိပါသည်။ ထို့ကြောင့် ယင်းတို့ကို

(၁) စနစ်ဖြင့်ဖွဲ့စည်းထားသော အနက်ဆန့်ကျင်စကားလုံးများ

(၂) စနစ်ဖြင့်ဖွဲ့စည်းထားခြင်းမရှိသောအနက်ဆန့်ကျင်စကားလုံးများ

ဟူ၍ထပ်မံခွဲခြားနိုင်ပါသည်။ ၁၂–၁၃ ရာစုကတည်းကပင်

စနစ်ဖြင့်ဖွဲ့စည်းထားသောအနက်ဆန့်ကျင်စကားလုံးများကို ဝါစဉ်ဖြင့်စီစဉ်လေ့ရှိပါသည်။

သာဓကအားဖြင့်–

– တစ်နယ် (နေ့) သောစပါ၊ တစ်လသောစပါ၊ တစ်နှစ်သောစပါ(ပုံ ၁၃၈၊ ၂၉)

– ၇ ရက်၊ ၇ လ ၊ ၇ နှစ် (ပုံ ၃၀၅၊ ၂၃–၂၄)

– အဆ အရှာ (ရာ)၊ အဆ အထောင် (ထောင်)၊ အဆ အသောင် (သောင်း)၊ အဆ အသိန် (သိန်း) (ပုံ ၂၁၈၊ ၁၈)

– ဥခေါင် (ဦးခေါင်း) ဆင်သောတန်ဆာ၊ လည် ဆင်သောတန်ဆာ၊ ကိုဝ် (ကိုယ်) ဆင်သော တန်ဆာ၊ ခါ ဆင်သောတန်ဆာ၊ ခြိုယ် (ခြေ) ဆင်သောတန်ဆာ (ပုံ၂၇၄၊ ၃၄–၃၆)

ဟူ၍စီစဉ်ပုံမျိုးဖြစ်သည်။ အထက်ဖော်ပြပါစကားလုံးများကို အလျဉ်းသင့်သလိုစီစဉ်ထားခြင်းမဟုတ်ဘဲအစီအစဉ်မှာစနစ်ရှိကြောင်းတွေ့ရှိရသည်။ယင်းတို့ကိုကြီးစဉ်ငယ်လိုက်သော် လည်းကောင်း၊ ငယ်စဉ်ကြီးလိုက်သော်လည်းကောင်းစီစဉ်ထားသည်။ယင်းတို့တွင် နှစ်လုံးထက်ပိုသောစကားလုံးများပါဝင်နေခြင်းကြောင့် တစ်ခုမှန်လျှင်ကျန်အားလုံးမှားသည်ဟုပြောနိုင်သော်လည်း၊ တစ်ခုမှားနေလျှင်မူ မည်သည်ကမှန်ကြောင်း အတိအကျမပြောနိုင်တော့ချေ။ သို့သော်ထိုစကားလုံးမျိုးကို စနစ်တကျဖွဲ့စည်းနိုင်မှုကြောင့် စကားလုံးများ၏အနက်အဓိပ္ပာယ်သည်လည်း အဆင့်အနိမ့်အမြင့် ပုံမှန်လည်ပတ်လျက်ရှိကြောင်း တွေ့မြင်ပါသည်။

စနစ်ဖြင့်ဖွဲ့စည်းထားခြင်းမရှိသည့်အနက်ဆန့်ကျင်စကားလုံးများမှာမူ စကားများကို အလျဉ်းသင့်သလိုစီစဉ်ထားခြင်းဖြစ်ကြောင်းတွေ့မြင်ရပါသည်။ သာဓကအားဖြင့်–

– ရှယ်ပုရှာ ၊ ငယ်ပုရှာ ၊ ကိယ်ပုရှာ ၊ ကျောက်ပုရှာ(ပုံ ၃၀၈၊ ၁၇–၁၈) (ရွှေဘုရား)၊ (ငွေဘုရား)၊ (ကြေးဘုရား)၊ (ကျောက်ဘုရား)

– ပန်တျာ၊ပန်ပု(ပန်းပု)၊ ပန်ခီ(ပန်းချီ)၊ ပန်ဖဲ (ပန်းပဲ)၊ပုရန်(ပန်းရန်)(ပုံ ၆၈၊ ၂၂)

– ပုဆိုဝ် (ပုဆိုး)၊ ရုယ် (ရွှေ)၊ ငယ်(ငွေ)၊ တန်ဆာ (ပုံ ၂၈/က၊၁၆–၁၇)

– အမိဖုရာ (မိဖုရား)၊ မိသင်၊ မောင်မ၊ မင်ညီ၊ မင်သာ (ပုံ ၁၉၄၊ ၄၃)

ဟုစီစဉ်ပုံမျိုးဖြစ်သည်။ယင်းတို့သည်စနစ်ဖြင့်ဖွဲ့စည်းထားခြင်းမရှိဟုဆိုသော်လည်းအမျိုးအစားချင်းဆင်တူရာကိုသာ စုစည်းနိုင်ကြောင်းလည်းတွေ့မြင်ရပါသည်။ အစားအသောက်ဆိုင်ရာ ဝေါဟာရစာရင်းတွင် သာသနာရေးဆိုင်ရာဝေါဟာရဖြစ်သည့် 'ဘုရား'ကိုလည်းကောင်း၊ အုပ်ချုပ်ရေးဆိုင်ရာဝေါဟာရဖြစ်သည့် 'မှူးမတ်'ကိုလည်းကောင်း ထည့်သွင်း၍မစုစည်းနိုင်ချေ။

စနစ်ဖြင့်ဖွဲ့စည်းထားသည်ဖြစ်စေ၊အလျဉ်းသင့်သလိုဖွဲ့စည်းသည်ဖြစ်စေ စုစည်းမှုအစီအစဉ်သည်နယ်ပယ်အတိအကျကိုလိုက်၍လည်းကောင်း၊ ခေတ်ကာလကိုလိုက်၍လည်းကောင်း အပြောင်းအလဲအတန်အသင့်ရှိနိုင်ပါသည်။ မျက်မှောက်ခေတ်မြန်မာဘာသာစကားတွင် ခရမ်းချဉ်သီးကို 'ဟင်းသီးဟင်းရွက်'စာရင်းတွင်ထည့်သော်လည်း အချို့နိုင်ငံများတွင် 'သစ်သီး'စာရင်းတွင် ထည့်သွင်းလေ့သည်။ မြန်မာဘာသာစကားစနစ်အတွင်း၌ပင် ပန်းဆိုလျှင်အပွင့်ပါသည့် အပင်ကိုဆိုလိုသော်လည်း သပြေပန်းမှာမူစကားလုံးဖွဲ့စည်းပုံအားဖြင့်သာ'ပန်း'ပါဝင်ပြီး၊ တင်စားအနက်(တစ်နည်းအားဖြင့်) အပေါ်ယံအနက်အားဖြင့်သာ ပန်းဟုဆိုသော်လည်း အတွင်းအနက်အားဖြင့်မူ အရွက်သာဖြစ်ကြောင်း မြန်မာတို့ သဘောပေါက်ထားပြီးဖြစ်သည်။

စနစ်ဖြင့်ဖွဲ့စည်းထားသောအနက်ဆန့်ကျင်စကားလုံးနှင့် စနစ်ဖြင့်ဖွဲ့စည်းထားခြင်း မရှိသောအနက်ဆန့်ကျင်စကားလုံးတို့မှာ သဘောသဘာဝချင်းအတူတူပင်ဖြစ်သော်လည်း အနက်အဓိပ္ပာယ်ဖွဲ့စည်းမှုတွင် ခြားနားမှုရှိကြောင်းတွေ့မြင်ရပါသည်။

အရည်အသွေးအဆင့်ဆင့်ကွဲပြားမှုရှိသောအနက်ဆန့်ကျင်မှု

ဤစကားလုံးမျိုးသည်အစွန်းနှစ်ဖက်ရှိသော ဆန့်ကျင်ဘက်စကားလုံးမျိုးပင်ဖြစ်ပါသည်။ ယင်းတို့သည်ဂုဏ်အရည်အသွေးအဆင့်အမျိုးမျိုးကွဲပြားနိုင်သဖြင့် ကြားအဆင့်များအလယ်အလတ်အဆင့်များရှိတတ်ပါသည်။ ထိုအစွန်းနှစ်ဖက်အကြားတွင် နှိုင်းယှဉ်မှုသဘောများ ပါဝင်နေခြင်းလည်းဖြစ်ပါသည်။ တစ်ခုကတစ်ခုထက်ပိုခြင်း တစ်ခုကတစ်ခုအောက်လျော့ခြင်း သဘောများဖြင့် နှိုင်းယှဉ်သည့်သဘောဖြစ်ပါသည်။ ထိုစကားလုံးများ၏ ထင်ရှားသောလက္ခဏာ ရပ်များမှာ ကြားအဆင့်များရှိခြင်း၊စံတစ်ခုကို သတ်မှတ်၍နှိုင်းယှဉ်ရခြင်း စကားတစ်လုံးကို ပင်တိုင်ထား၍သုံးခြင်းတို့ဖြစ်သည်။

ကြားအဆင့်များနှိုင်းယှဉ်ရာတွင်ဂုဏ်အရည်အသွေးအတိုင်းအတာပေါ်တွင်မူတည်၍ ကွဲပြားသဖြင့်အလယ်အလတ်ဖြစ်သော အရည်အသွေးအဆင့်ဆင့်ရှိရမည်သာဖြစ်ပါသည်။ "ကောင်း–ညံ့" ဟူသောစကားလုံးတွဲတွင် 'သင့်'ဟူသောကြားအဆင့်အရည်အသွေးတစ်ရပ်ရှိရန် လိုအပ်ပါသည်။ 'ပူ–အေး'ဟူသောစကားလုံးတွင် 'နွေး'ဟူသောကြားအဆင့်အရည်အသွေးတစ်ရပ်ရှိရန် လိုအပ်ပါသည်။ သို့မှသာ အရည်အသွေးအဆင့်ဆင့်ကွဲပြားမှုကို သရုပ်ဖော်နိုင်မည်ဖြစ်ပါသည်။

အရည်အသွေးအဆင့်ဆင့်ကွဲပြားမှုရှိသောအနက်ဆန့်ကျင်မှု၏ အခြားလက္ခဏာ တစ်ရပ်မှာ 'စံ'တစ်ခုခုဖြင့်အသုံးပြုရခြင်းဖြစ်ပါသည်။ စံအဖြစ်သတ်မှတ်ရာတွင်လည်း နှိုင်းယှဉ်သည့် အရာဝတ္ထုအရစံချင်းကွဲပြားနိုင်ပါသည်။ စံသတ်မှတ်မှုတွင် သတ်မှတ်သူကိုလိုက်၍ဖြစ်စေ၊ အရာဝတ္ထုကိုလိုက်၍ဖြစ်စေ ပြောင်းလဲနိုင်သည့်သဘောရှိရာ ပုံသေမဟုတ်ဘဲ အခိုက်အတန့်သဘော၊ ယာယီသဘောဆောင်ပါသည်။ နှိုင်းယှဉ်သည့်အခိုက်အတန့်အတွက်သတ်မှတ်ထားသည့် သတ်မှတ်ချက်မျိုးဟုလည်းဆိုနိုင်ပါသည်။ လူတစ်ရာသည်အိမ်တစ်အိမ်သို့ လာရောက်သည့်ဧည့်သည်အတွက် အလွန်များသောအရေအတွက်ဖြစ်ပါသည်။ သို့သော်ဘေလုံးပွဲသို့လာသော

ပရိသတ်အတွက်မူအလွန်နည်းသောအရေအတွက်ဖြစ်ပါသည်။ စံချင်းခြားနားမှုကြောင့်ဖြစ်ပါသည်။ ရည်ညွှန်းပြောဆိုသည့်အကြောင်းအရာနှင့် အချိန်ကာလကိုလိုက်၍ စံထားမှုမှာလည်းခြားနားနိုင်ပါသည်။ သတ်မှတ်သည့်စံကိုလိုက်၍ ပြောင်းလဲနိုင်ပါသည်။ ထိုကဲ့သို့နှိုင်းယှဉ်သဘောဖြင့် စံသတ်မှတ်မှုသဘောကို ဒုတိယကျော်အောင်စံထား ဆရာတော်က –

> "တိုသောဝတ္ထုသည် ထို့အောက်တိုသောဝတ္ထုနှင့်စံသော် အရှည်မည်၏ ရှည်သောဝတ္ထု သည် ထို့ထက်ရှည်သောဝတ္ထုနှင့်စံသော် အတိုမည်၏"

(ကျော်အောင်စံထားဆရာတော် (ဒုတိယ)၊ ၁၉၆၆၊ ၁၅၀) ဟုမိန့်ဆိုခဲ့ပါသည်။

'တစ်ပေ'သည်အပ်နှင့်စံထိုးသော်ရှည်၏၊ ဝါးလုံးနှင့်စံထိုးသော်တို၏၊ ထိုစကားလုံးမျိုးသည် စံတစ်ခုခုဖြင့်သုံးသည့်အခိုက်အတန့်ပေါ်တွင်မူတည်၍ အနက်အဓိပ္ပာယ်သက်ရောက်ကြောင်း ရှင်းပြထားပါသည်။

အရည်အသွေးအဆင့်ဆင့်ကွဲပြားသည့်အနက်ဆန့်ကျင်မှု၏ နောက်လက္ခဏာတစ်ရပ်မှာ စကားနှစ်လုံးတွင်တစ်လုံးကိုအများအားဖြင့်ပင်တိုင်ထား၍သုံးခြင်းဖြစ်သည်။ စကားတစ်လုံးကို ပင်တိုင်ထား၍အသုံးပြုရာတွင်လည်း အကျဉ်း–အကျယ်၊ အတို–အရှည်၊ အနိမ့်–အမြင့်တို့၌ အကျယ်၊အရှည်၊ အမြင့်တို့ကိုသာ ပင်တိုင်ထား၍ရည်ညွှန်းပြောဆိုလေ့ရှိပါသည်။ သာဓကအားဖြင့်

– မင်းအခန်းဘယ်လောက်ကျယ်လဲ

– ဒီဝါးလုံး ဘယ်လောက်ရှည်လဲ

– ဒီတိုင်ရဲ့အမြင့်က ဘယ်နှပေလဲ

စသည်ဖြင့်စံတစ်ခုခုဇဟိုပြု၍မေးမြန်းရာ ဖြေဆိုသူကလည်း "၁၀ပေကျယ်တယ်၊ အရှည် ၃ပေလောက်ပဲရှိမယ်၊ အမြင့်ကဖပေပါ"စသည်ဖြင့်အတိုင်းအတာပမာဏအတွက် စံတစ်ခုကိုသာ ရည်ညွှန်းပြီးမေးသည့်ဖြေသည့်သဘောကို တွေ့မြင်ရပါသည်။

အေဒီ ၁၂–၁၃ ရာစုမြန်မာဘာသာစကား၏အနက်ဆန့်ကျင်မှုစနစ်တွင်လည်း ထိုသဘောကိုပင် မြင်တွေ့ရပါသည်။ ပုဂံကျောက်စာများတွင်တွေ့ရှိရသည့် အရည်အသွေး အဆင့်ဆင့်ကွဲပြားသော အနက်ဆန့်ကျင်စကားလုံးများမှာ

– သွင်ကြီး (သခင်) သွင်လတ် သွင်ငယ် (ပုံ ၁၂၅/ခ၊ ၂၁–၂၂)

– ရှိယ်အစန်(ရှေးအစဉ်) ယခု နောင် (ပုံ ၂၁၆/က၊ ၉)

– နံနက် နိယ်တက် နိယ်လွယ် ညနိယ် ည (ပုံ ၄၂၊ ၂၂)

(နံနက်) (နေတက်) (နေ့လွဲ) (ညနေ) စသည်ဖြင့်တွေ့ရသည်။ ရှိယ်အစဉ်နှင့်နောင်ဟူသော ဆန့်ကျင်ဘက်အချိန်ကာလနှစ်ခုကြားတွင် ယခုသည်အလယ် အလတ်အဆင့်ရှိပါသည်။

ဤသို့သောအနက်ဆန့်ကျင်စကားလုံးတို့မှာ ရှေ့တွင်ဖော်ပြခဲ့သော နယ်ပယ်ခြားနားမှုပြတ်သားသောအနက်ဆန့်ကျင်စကားလုံးတို့ကဲ့သို့ ဆန့်ကျင်မှုနယ်ပယ်ကို အပြတ်မခွဲနိုင်ကြောင်း တွေ့ရှိရသည်။ ထို့ကြောင့်လည်း အဆိုပါအနက်ဆန့်ကျင်စကားလုံးများတွင် အရည်အသွေး အဆင့်ဆင့်ကွဲပြားရသည် ဟုဆိုရခြင်းဖြစ်သည်။

အပြန်အလှန်ဆက်သွယ်မှုရှိသောအနက်ဆန့်ကျင်မှု

ဤအနက်ဆန့်ကျင်မှုတွင် စကားလုံးတွဲတို့သည် အပြန်အလှန်ဆက်သွယ်သည့် သဘော ရှိသည်။သို့သော်စကားတွဲပါစကားနှစ်လုံးတို့၏ရှေးရှုရာလမ်းကြောင်းချင်းမှာမူ ဆန့်ကျင်ဘက် သဘောဆောင်သည်၊ယင်းတို့၏အနက်အဓိပ္ပာယ်သည် ပြောင်းပြန်ဆန့်ကျင်ခြင်းဖြင့် အပြန်အလှန် ဆက်စပ်နေကြသည်။ ထိုသဘောကို အတ္ထဗေဒပညာရှင် ဂျွန်လိုင်းယင်းက–

> "အချို့သောအနက်ဆန့်ကျင်စကားလုံးတို့သည် တစ်ဖက်နှင့်တစ်ဖက်အပြန်အလှန် ဆက်သွယ်မှုရှိကာ အပြန်အလှန်သုံး၍ရသည်။ မြင့်–နိမ့်၊ ရောင်း–ဝယ်၊ ကျား–မ၊ ရောက်–ထွက်၊ဘယ်–ညာ၊ရှေ့–နောက်စသည့်စကားလုံးတွဲမျိုးသည် အပြန်အလှန် ဆက်သွယ်မှုရှိ၍ အပြန်အလှန် သုံးနိုင်သည်" (Lyons, 1977, 270-271) ဟုရှင်းပြထားပါသည်။

အေဒီ ၁၂–၁၃ ရာစုမြန်မာဘာသာစကားရှိ အပြန်အလှန်အနက် ဆက်သွယ်မှု သဘော ရှိသောအနက်ဆန့်ကျင်စကားလုံးများကို ပုဂံကျောက်စာများတွင်တွေ့မြင်ရပါသည်။ ယင်းတို့သည် မြန်မာဘာသာစကားအတွင်း တွဲဖက်သုံးနေကျစကားလုံးများဖြစ်ပြီး 'ကောင်း–ဆိုး'နှင့် 'ကောင်း–မကောင်း'ကဲ့သို့အငြင်းသဘောဖြင့် အနက်ဆန့်ကျင်ခြင်းမျိုး မဟုတ်သော်လည်း တွဲလုံး စကားလုံးနှစ်ခုမှတစ်ခုမဟုတ်လျှင် အခြားတစ်ခုဟူသောဆက်စပ်မှုမျိုးဖြင့် အနက်ဆန့်ကျင်ခြင်းမျိုး ဖြစ်သည်ကို အောက်ပါသာဓကများအရ သိရှိနိုင်ပါသည်။

စုန် ⟷ ဆန် (မနူဟာဘုရားကျောက်စာ၊ ၂၄)

လွှတ် ⟷ ဘံ (ဖမ်း) (ပုံ ၁၇၀၊ ၃၊ ၂၈)

မိုဝ် (မိုး) ⟷ မွေ (မြေ) (ပုံ ၉၀၊ ၃)

(အတွင်း) အတွင် ⟷ အပ (ပုံ၁၄၅၊၇–၈)စသည့်စကားလုံးတွဲများသည် တစ်ခုနှင့်တစ်ခုရှေ့ရှုရာလမ်းကြောင်းချင်းဆန့်ကျင်လျက်ရှိကြသော်လည်း အဆက်အစပ်ရှိပုံကို အောက်ပါသာဓကတွင်မြင်နိုင်ပါသည်။

"ရောင် ရယ် ဝယ် သော မွိယ်" (ပုံ ၈၊ ၂၁)

ဟူ၍ 'ရောင်းဈေး – ဝယ်ဈေး' 'ရောင်းလိုက် – ဝယ်လိုက်' စသည်ဖြင့် 'ရောင်း' နှင့် 'ဝယ်' တို့ အပြန်အလှန်သုံးနိုင်သည့်သဘောကို တွေ့မြင်နိုင်ပါသည်။ ထို့အတူ 'အထက်–ညြက်' 'အရှိယ်–အနောက်' 'တောင်–မွောက်' 'လက်ဝယ်–လက်ျာ' 'အတွင်–အပ' စသည့်စကားလုံးများမှာမူ တည်နေရာချင်းဆန့်ကျင်နေကြောင်းနှင့် အပြန်အလှန်ဆက်စပ်နေကြောင်း တွေ့မြင်နိုင်ပါသည်။

ထို့အတူ 'အဖေ–အမေ' 'သား–သမီး' 'မောင်–နှမ' 'ညီ–အစ်ကို' 'လင်–မယား' 'ဆရာ–တပည့်' စသည့်စကားလုံးများမှာမူ ဆက်သွယ်မှုအရ တစ်နည်းနည်းဖြင့်အနက် ဆန့်ကျင် သည်ကို တွေ့မြင်ရပါသည်။ 'ဆရာ–တပည့်' မှာလုပ်ငန်းသဘောအရ သင်ကြားသူနှင့် အသင်ခံသူဟူ၍ အနက်ဆန့်ကျင်နေသည်။ 'သား–သမီး''မောင်–နှမ' တို့မှာမူ လိင်အရ အနက်ဆန့်ကျင်မှုဖြစ်သည်။ 'ညီ–အစ်ကို''ညီ–အစ်မ' တို့မှာလိင်တူပြီး အကြီးအငယ် အရ အနက်ဆန့်ကျင်မှုဖြစ်သည်။ သို့သော် ယင်းတို့သည် အပြန်အလှန်ဆက်သွယ်မှုရှိသော ဝေါဟာရများဖြစ်ကြပါသည်။

'မ'ဖြင့်ယှဉ်တွဲ ရသောအနက်ဆန့်ကျင်စကားလုံးများ

အတ္ထဗေဒပညာရှင်အချို့က အနက်ဆန့်ကျင်မှုနှင့်ပတ်သက်၍ အထက်ဖော်ပြပါယူဆချက် (၃)ခုကို အဓိကထား လေ့လာခဲ့ကြသော်လည်း မြန်မာဘာသာစကားပညာရှင် ဒုတိယကျော်အောင်စံထား ဆရာတော်က

> "ပဋိပက္ခဝေါဟာရနှစ်ပါးမရှိရာနှိုက်ကား 'သိ၏၊ မြင်၏'ဟူသောအနက်ကို 'မသိ၊ မမြင်'ဟူ၍ 'မ' အက္ခရာဖြင့်မြစ်သော်သာ ပဋိပက္ခအနက်ဖြစ်သောဝေါဟာရဖြစ်၏ 'မ' အက္ခရာဖြင့်မမြစ်မူ၍ ပဋိပက္ခအနက်ရကောင်းသော ဝေါဟာရလျှင်းဖွယ်မရှိ။"

(ကျော်အောင်စံထားဆရာတော် (ဒုတိယ)၊၁၉၆၆၊၁၄၈) ဟုမိန့်ဆိုထားပါသည်။

မြန်မာဘာသာစကားတွင်ပင်ကိုသဘာဝအတိုင်းဖြစ်သည့် အနက်ဆန့်ကျင်စကားလုံးများ ရှိသကဲ့သို့ စကားလုံးတစ်ခု၏ရှေ့၌ အငြင်းစကား 'မ'ထည့်၍ အနက်ဆန့်ကျင်မှု ပြုခြင်းမျိုးလည်းရှိပါသည်။ ဆန့်ကျင်ဘက်စကားတွဲမရှိသောစကားလုံးများကို ရှေ့မှ'မ' အက္ခရာယှဉ်တွဲအသုံးပြုပါက အနက်ဆန့်ကျင်သည့်သဘောဆောင်လေ့ရှိပါသည်။ထို့အပြင်ထို'မ'ပါသည့်စကားလုံးတွဲသည်လည်း နယ်ပယ်ခြားနားမှုပြတ်သားသော သဘောကိုဆောင်ပါသည်။

ဆန့်ကျင်ဘက်စကားလုံးတွဲမရှိသော ထိ၊တွေ့၊ စားစသည်တို့ကို 'ထိ–မထိ'တွေ့–မတွေ့' 'စား–မစား'ဟူ၍'မ'တွဲသုံးနိုင်သည်။ ယင်းစကားလုံးတွဲတို့တွင်လည်း 'ထိ'ကမှန်လျှင် 'မထိ'က မှားသည်။ ထိုစကားလုံးတို့သည် ဆန့်ကျင်ဘက်အနက်နယ် ပြတ်သားသည်။ သာဓကအားဖြင့်

စေတီတည်	–	စေတီမတည်	(ပုံ ၁၉၆၊ ၂၄–၂၅)
နှစ်လိုဝ်	–	မနှစ်လိုဝ်	(ပုံ ၄၂၆၊ ၂၈–၂၉)
ပျက်	–	မပျက်	(ပုံ ၂၂၅၊ ၆–၇)

စသည်တို့ဖြစ်သည်။ ယင်းတို့သည် ကြိယာစကားလုံးများဖြစ်ပြီး 'မ'ယှဉ်တွဲလိုက်ခြင်းဖြင့် နယ်ပယ်ချင်း ခြားနားသော အနက်ဆန့်ကျင်စကားလုံးများဖြစ်သွားလေသည်။

မြန်မာဘာသာစကားရှိ အချို့စကားလုံးများတွင် မူလဆန့်ကျင်ဘက်စကားလုံးတွဲများ ရှိနှင့်ပြီး ဖြစ်သော်လည်း 'မ' ဖြင့်ယှဉ်တွဲအသုံးပြုသည်လည်းရှိသည်။ သာဓကအားဖြင့်

ခီပင် (ချီးမြှောက်) – မခီပင် (မချီးမြှောက်) (ပုံ ၂၉၀/ခ၊ ၁၅–၁၆)

ဟူ၍ကျောက်စာတစ်ချပ်တွင်လည်း 'မ' တွဲလျက်ဆန့်ကျင်ဘက်အနက်ကိုဖော်ပြသော်လည်း အခြားကျောက်စာတွင်မူ

> "ဤကောင်မှကိုဝ် နှစ်လိုဝ် ရုယ် ခီပင်ပါသောသူတဝ်တိုဝ်ကာ အကျိုဝ် ထပ်တူရစပါစိယ်သတေ၊ မနှစ်လိုဝ် ရုယ်ဖျက် သသူကာဖုန်မကြီ အသက်မရှယ်စိယ်သတေ" (ပုံ ၄၂၆၊ ၂၈–၂၉)

ဟူသောကျိန်စာအရ 'နှစ်လိုဝ်–မနှစ်လိုဝ်'နှင့် 'ခီပင်–ဖျက်' ဟူသောအနက်ဆန့်ကျင်မှု အသွင်ကွဲနှစ်မျိုး လုံးကိုတွေ့မြင်နိုင်ပါသည်။

ပုဂံမြို့လောကထိပ်ပန်ဂူဘုရားရှိ အေဒီ ၁၂–၁၃ရာစုရေးဇာတ်တော်ကြီး ဆယ်ဘွဲ့ မင်စာများမှ 'သုဝဏ္ဏသာမဇာတ်မင်စာ'နှင့် ပုဂံမြို့မင်းနန်သူရွာ ဘိုးကလုန်ဘုရားရှိ 'မင်းဖွားအို့ရောက်လွယ်သင် ကျောက်စာ'ကျိန်စာပါအနက်ဆန့်ကျင်စကားလုံးတွဲနှစ်ခုတွင် လည်း ထိုသဘောကိုတွေ့ရသည်။ မင်စာတွင် 'အမိအဖ ကာန် သော လေမြင်လာ၏' (စဉ် ၄၀၊ ၄၅၅–၄၅၆)ဟူ၍မြင်–ကာန်ဟူသော'မ'မပါသည့်အနက်ဆန့်ကျင်စကားလုံးတွဲပါ 'မြင်'ကိုကျောက်စာတွင်

"လာလတ်အံ့သော ၌မိယ်ပုံလုံမျှ ကြုံမကသော ပုရှာ ပုရှာ၏တပေသာတိုဝ်နှိုက်လျှင် လေ မဖူရမမြင်ရ စိယ်သတေ"

ဟူ၍ 'မြင်–မမြင်' ဟူသော 'မ' ပါသည့်အနက်ဆန့်ကျင်စကားလုံးတွဲမှ 'မမြင်'ကို အသုံးပြုထားသည်။ ထိုသဘောကို မျက်မှောက်ခေတ်မြန်မာဘာသာစကား၏ အဓိပ္ပာယ်စနစ်တွင်လည်း တွေ့မြင်ရပါသည်။ သာဓကအားဖြင့်

မှန် ⟷ မမှန်
မှား ⟷ မမှား
} မှန် ⟷ မှား

ပျက် ⟷ မပျက်
ကောင်း ⟷ မကောင်း
} ပျက် ⟷ ကောင်း

စသည်တို့၌ 'မှန်'၏ဆန့်ကျင်ဘက်တွင် 'မှား'ဟူသောစကားလုံးရှိသော်လည်း 'မမှန်'ဟူ၍ 'မ' အက္ခရာ သုံးခြင်းဖြင့် မမှန်နှင့်မှားတို့သည် အနက်တူဖြစ်သွားသည်။ ၁၂–၁၃ရာစုကတည်းက အသုံးတွင်ခဲ့သည့် ထိုစနစ်သည် မျက်မှောက်ခေတ်မြန်မာဘာသာစကား၏အဓိပ္ပာယ်စနစ်ကို ဆက်၍ဖြစ်ထွန်းစေခဲ့သည် ဟုဆိုအပ်ပါသည်။

ခြုံငုံသုံးသပ်ချက်

အနက်ဆန့်ကျင်စကားလုံးများသည် အနက်အဓိပ္ပာယ်ကိုကွဲပြားစွာခွဲခြားပေးနိုင်သည့်အတွက် ဘာသာစကားတိုင်းတွင် အရေးပါလျက်ရှိသည်။ နေ့စဉ်ပြောဆိုသုံးနှုန်းသည့် စကားများထဲတွင် အနက်ဆန့်ကျင်စကားလုံးများကို တွင်တွင်ကျယ်ကျယ်အသုံးပြုနေကြောင်း တွေ့နိုင်ပါသည်။ 'အေးအတူ–ပူအမျှ' 'အသွား–အလာ' 'အမှား–အမှန်' 'အဝင်–အထွက်' စသည်ဖြင့် ဆန့်ကျင်ဘက်စကားလုံးများကိုယှဉ်တွဲပြောဆိုမှုများကြောင့် အနက်ဆန့်ကျင်စကားလုံးများ၏ အရေးပါမှုကိုလည်း သိရှိနိုင်ပါသည်။ ထိုကဲ့သို့ တွဲဖက်ပြောသည့်ဝေါဟာရများသည် ဘာသာစကားတွင် ယှဉ်တွဲမှုအသားကျအနည်ထိုင်နေပြီးလည်း ဖြစ်ပါသည်။ အနက်ဆန့်ကျင်စကားလုံးများကို လေ့လာရာတွင် နယ်ပယ်ချင်းခြားနားမှုပြတ်သားသောအနက်ဆန့်ကျင်စကားများသည် တစ်ခုနှင့်တစ်ခုပြတ်သားစွာ အနက်ဆန့်ကျင်လျက်ရှိကြပါသည်။ စကားနှစ်လုံးထက်ပိုသော အနက်ဆန့်ကျင်မှုတွင်အနက်နယ်ပယ်ချင်းခြားနားမှုမပြတ်သားဟုလည်းဆိုအပ်ပါသည်။ အရည်အသွေးအဆင့်ဆင့် ကွဲပြားသော အနက်ဆန့်ကျင်စကားလုံးတွင်မူ ကြားအဆင့်ရှိနေပါသည်။ အပြန်အလှန်ဆက်သွယ်မှုရှိသော အနက်ဆန့်ကျင်စကားလုံးမှာမူ အနက်အားဖြင့်ပြောင်းပြန်အနက်ဆန့်ကျင်လျက်ရှိသော်လည်း စကားလုံးတို့မှာမူ အပြန်အလှန်ဆက်သွယ်မှုရှိကြသည်။ သို့သော်ယင်းတို့၏အနက်သဘောမှာ ပြတ်သားစွာခြားနားနိုင်ပါသည်း အချို့မှာအနက်နယ်ချင်း ပြတ်သားစွာခြားနားနိုင်သကဲ့သို့ အချို့မှာ အပြန်အလှန်ဆက်သွယ်မှုရှိနေကြောင်းလည်း တွေ့မြင်ရပါသည်။

နိဂုံး

ဆန့်ကျင်ဘက်စကားလုံးများ၏ အနက်ဆက်သွယ်မှုနယ်ပယ်မှာ သိမ်မွေ့နက်နဲမှုရှိသည်နှင့်အမျှ စိတ်ဝင်စားဖွယ်ကောင်းလှပေသည်။ မြန်မာဘာသာစကားရှိ အနက်ဆန့်ကျင်မှုရှိသော စကားလုံးများကိုလေ့လာခြင်းဖြင့် မြန်မာဘာသာစကားသည် အထူးပင်ဝေါဟာရကြွယ်ဝသည့် ဘာသာစကားဖြစ်ကြောင်း၊ အနက်ထင်ရှားမှု၊ သိမ်မွေ့နက်နဲမှုရှိသော ဘာသာစကား ဖြစ်ကြောင်း သိရှိခဲ့ရပါသည်။ ထို့ကြောင့်ပရိယာယ်အလှယ်လှယ်သုံးနိုင်သည့် မြန်မာလူမျိုးတို့၏စကားလုံး တီထွင်နိုင်မှုစွမ်းရည်ကိုလည်းချီးကျူး လေးစားလာမိစေပါသည်။

ကျေးဇူးတင်လွှာ

ဤစာတမ်းဖြစ်မြောက်ရေးအတွက်ကူညီပေးပါသော တောင်ကုတ်တက္ကသိုလ်၊ ဒုတိယပါမောက္ခချုပ် ဒေါက်တာသန်းထွဋ်လွင်၊ မြန်မာစာဌာနမှ ပါမောက္ခ(ဌာနမှူး) ဒေါက်တာသန်းထိုက်နှင့် တောင်ကုတ်တက္ကသိုလ် သုတေသနဂျာနယ်ဖြစ်မြောက်ရေးအဖွဲ့တို့ကို ကျေးဇူးတင်ရှိပါသည်။

ကျမ်းကိုးစာရင်း;

မြန်မာဘာသာ

ကျော်အောင်စံထားဆရာတော်၊ဒုတိယ။၁၉၆၆။***ဓေါဟာရဋ္ဌာပကာသနီ***၊ဒုတိယအကြိမ်။ရန်ကုန်၊လယ်တီမဏ္ဍိုင်ပုံနှိပ်တိုက်။

ခင်မင်၊ မောင် (ဓနုဖြူ) ။ ၁၉၉၇ ။ ***စကားသမ္ဗန္ဓရာ၊ စာသမ္ဗန္ဓရာ*** ။ ရန်ကုန် ။ မြကန်

ခင်အေး၊ ဒေါက်တာ ။ (၂၀၀၄) ။ ***အတ္ထဗေဒနိဒါန်း***။ရန်ကုန်။ ပညာတန်ဆောင်ပုံနှိပ်တိုက်။

ခင်အေး၊ ဒေါက်တာ ။ (၂၀၁၀) ။ ***လက်တွေ့အတ္ထဗေဒနိဒါန်း*** ။ ရန်ကုန် ။ ဒေါင်းစာပေ။

ငြိမ်းမောင်၊ဦး။၁၉၇၂ ။***ရှေးဟောင်းမြန်မာကျောက်စာများ***၊ ပထမတွဲ ။ ရန်ကုန်၊ ရှေးဟောင်းသုတေသနဦးစီးဌာန။

ငြိမ်းမောင်၊ဦး။၁၉၈၂။***ရှေးဟောင်းမြန်မာကျောက်စာများ***၊ ဒုတိယတွဲ ။ ရန်ကုန်၊ ရှေးဟောင်းသုတေသနဦးစီးဌာန။

ငြိမ်းမောင်၊ ဦး။ ၁၉၈၂။***ရှေးဟောင်းမြန်မာကျောက်စာများ***၊တတိယတွဲ။ရန်ကုန်၊ ရှေးဟောင်းသုတေသနဦးစီးဌာန။

ဆွဲ၊ဦး။၁၉၉၈။***မင်စာ(ပုဂံမင်စာစုဒေသ)စာရင်း***၊လက်နှိပ်စက်မူ။ရန်ကုန်၊တက္ကသိုလ်များသမိုင်းသုတေသနဦးစီးဌာန

မြန်မာအဘိဓာန် ။ ၁၉၉၁ ။ ရန်ကုန် ၊ ပညာရေးဝန်ကြီးဌာန၊ မြန်မာစာအဖွဲ့ဦးစီးဌာန။

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Practicing The Students "How To Write A Descriptive Text" By Using Jigsaw Method

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Abstract

This research is concerned with an investigation into the improvement of the students' writing skills in writing a descriptive text by using Jigsaw method and their responses to the use of Jigsaw method. For this research, the teacher asked the first year Physics specialization students attending at Taunggoke University (2018-2019 A-Y,second semester) to participate in the research. 20 students from section A and B offered as the participants as their wishes. The research took six weeks (1 hour per 1 period). The quantitative experimental method was used. During the research, two tests were done - pre-test and post-test including two questionnaires. By the implementation of Jigsaw method, the improvement of students' writing ability in writing descriptive texts can be seen clearly. In pre-test, grammar was poor, vocabulary was fair and idea (creative writing) was fair according to their criteria. First questionnaire was utilized after pre-test and second questionnaire was utilized after post-test. In post-test, the criteria for grammar was fair, vocabulary was fair and idea was fair. The criteria for grammar changed from poor to fair. Although the criteria for vocabulary and idea were the same in both pre-test and post-test, the scores in post-test are higher than ones in pre-test. Besides, it was found that the attitudes of the students concerning with writing ability improved in post-test than in pre-test. So, the more satisfaction of the students in their writing ability can be found in the second questionnaire than in the first questionnaire.

Keywords: *Jigsaw method, writing ability, descriptive text*

Introduction

If someone wants to be successful in learning English, he/she must master four language skills: speaking, writing, listening and reading. Listening and reading are perceptive skills and reading and writing are productive skills. Teaching productive skills are more difficult than teaching perceptive skills. So, most of the teachers often face the difficulties in teaching writing skill. Students also think that writing a descriptive text is very difficult for them. Most of the students do not want to write any descriptive text and feel that it is a burden for them. They do not have confidence to write a descriptive text as they do not have enough knowledge to create the text easily. Teaching writing skill to non-native students is a very challenging task for the teachers because developing their skill takes a long time to see the improvement. Hence, the cooperative learning method was considered to be used in teaching writing to non-native speaker (Reta Oktaviani Zahra – 2014). So, in this research, the researchers used Jigsaw technique as cooperative learning to improve the students' writing ability in writing a descriptive text.

Aims and objectives

The objectives of this research paper are

(1) to investigate the students' writing skill (especially descriptive writing) by using Jigsaw method as the cooperative learning and

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(2) to increase not only the students' knowledge of grammar, vocabulary, and creative thinking but also the teachers' teaching methods.

Literature Review

(i) Theoretical Background

Jigsaw is one of the classic cooperative learning by Kagan (1992). Jigsaw involves several steps which enable students to get new way to create a descriptive writing. Being a member of a group, the learners are able to share the knowledge of descriptive text. It is possible for them to combine various idea about descriptive text composition, such as in choosing the words of vocabulary, structuring, and other combining those ideas will create better descriptive text. (Ni Putu Ayu Dian Anggraeni & Deli Turmudi-Vol.2 No.1, April 2013).

According to Aronson (2000), Jigsaw technique is used in high schools as it is considered as the efficient way to learn the material in peers. It was chosen to have improvements in students' writing skills especially in writing descriptive texts. Jigsaw method can be regarded as an efficient way to learn the course material in a cooperative learning style which boosts listening, writing, engagement and sympathy by giving each member an essential part to participate in the activity (Aronson, 2000). To develop the skills and expertise needed to participate effectively in group activities, Jigsaw method can be used. Listening, speaking, cooperation, reflection, and problem-solving skills are focused in Jigsaw method.

According to Kessler (1992), there are four benefits of Jigsaw technique especially for second language classroom. First, students are allowed to work in groups which have different races and cultures. It is believed not only can facilitate students to gain trust and acceptance across races and cultures, but also can support minority students in achieving their academic success. Second, the technique offers a highly interactive learning experience. Third, students' cognitive skills of analysis, comparison, evaluation, and synthesis of information are demanded in using Jigsaw method and fourth, Jigsaw technique provides chances for students to promote their presentation and questioning technique to have a strong motivation to ensure that everyone in the group gets all the information in order to complete the task. (The use of Jigsaw technique in improving students' ability in writing a descriptive text by Retna Oktaviani Zahra).

In the Jigsaw Method in Cooperating Learning by Dr. Teresa Shume, Dr. Emilia Stander and Dr. Ariane Sutton. Grier, the Jigsaw method is an effective way to increase student engagement through group work that facilitates peer- to -peer learning. According to Dr. Barbara Tewksbury of Hamiton college, Jigsaw method allows to assign teams of students to investigate different aspects of the same problem or issue. Each team might, for example, analyze a different but related data set or read on different aspects or viewpoints on the same topic. Once each team remember thoroughly understands his/her team's aspect of the problem, new groups are formed, with at least are representative from each original team. Then each representative explains his/her team's aspect of the problem to the new group. By doing so, every student can learn every aspect of the problem and can use the combined information to evaluate a summary matter.

The Jigsaw Method (https://www.jigsaw.org/overview) is a teaching strategy in which the students are organized to have group work that cause student collaborate and rely on one another. This teaching is effective for accomplishing multiple tasks at one for giving students a greater sense of individual responsibility. (Teaching Strategies/ October

18/ 2010- The Teach HUB Team). During this whole process, where's the teacher? At first, the teacher facilitates the arranging of small groups (https://www.teachhub.com/classroom-management/2020/03/how-to-implement-ffective- small-group-instruction/), explaining of roles ,and timing for each portion. Here, the teacher doesn't need to give lecture or be the focal point of attention. While the students are in groups and discussing their ideas in the expert group and home group, the teacher should walk among the groups and give support or explanation where necessary. The teacher may appoint one student in each group as the "leader" who can manage time, make sure each student contributes their part, and ensure the group is accomplishing the goals. (Teaching Strategies/ October 18/ 2010- The Teach HUB Team).

(ii) Related Researches

In "The Use of Jigsaw Technique in Improving Students' Ability in Writing A Descriptive Text" by Retna Oktaviani Zahra (English Education Study Program of Indonesia University of Education), the author tried to discover whether there was improvement in the students' writing ability in writing a descriptive text after using Jigsaw method and investigate the students' responses to the use of Jigsaw method. The research used pre-test, post-test, and questionnaire of attitudes towards the Jigsaw technique as the instruments. The finding the research indicated that most of students rated the used technique moderately positive. In this research, nearly all of the students agreed that Jigsaw technique is able to improve their writing skill, their grammatical mastery, their creative thinking, their presentation skill and their confidence.

In "Improving Students' Writing Skill in Descriptive Text by Using Outdoor Activity" by Sri Suhormi, the researcher aimed to improve students' writing skill through outdoor activity. This research investigated whether or not outdoor activity can increase the students' writing content of description text of the second year of Mts Sudiram Kopeng Getasan. The researcher used the procedure consisted of planning, action, observing, and reflection. Pre-test and post-test were conducted in cycle 1, cycle 2 and cycle 3. The finding of this research was that using outdoor activity as a method can improve students' writing skill: the score of pre-test of the students (very poor) and the score of the post-test (good).The mean of post-test in cycle 2 is higher than the mean of cycle 1and the mean of post-test in cycle 3 is higher than cycle 3's.

The third previous research was conducted by Ni Putu Ayu Dian Anggraeni & Dedi Turmudi entitled "The Comparison of Students' writing descriptive text ability by using Jigsaw and Scaffolding Technique in Even Semester of Grade X State Senior High School 1 Seputh Raman (Academic Year 2012/2013), the teachers used the techniques "Jigsaw and Scaffolding" to solve three problems of the study or to know the answers like whether Jigsaw technique is effective to improve students' writing descriptive text ability; whether Scaffolding is effective to improve students' writing descriptive text ability and whether there is any significant difference of students' writing descriptive text ability by using Jigsaw and Scaffolding technique in the research. Although the researchers used difficult technique like ST, the result showed that Jigsaw is more effective to improve students' writing descriptive ability. The different scores of pre-test and post-test using Jigsaw technique. It is found that the students who were taught by using Jigsaw technique got higher score than the students who were taught by using scaffolding technique. The researcher stated that applying Jigsaw technique to improve students' writing descriptive text ability is effective; as students who get Jigsaw technique in the class are more active and there is progress in their learning achievements. In pre-test, their score is lower in writing descriptive text ability. But after treated by Jigsaw technique, there is increasing score of their writing descriptive text ability.

Research Methodology

In this research, Jigsaw method, a cooperative learning method, was used in practicing the students how to write a descriptive text effectively. 20 students from first year students specializing in Physics at Taunggoke University offered as the participants as their wishes in the research. The research instruments are pre-test, the first questionnaire, post-test and second questionnaire. The research took six weeks (1 hour per 1 period). During the research, two tests (pre-test and post-test) were done.

At the first week, the students (20 students) were asked to write a description of a person as free writing for pre-test. The first questionnaire including the questions like

1. Are you satisfied with this test?
   (a)Yes (b) No (c) Not sure
2. Did you have any difficulties in using vocabularies?
   (a)Yes (b) No (c) Not sure
3. Did you use the grammar correctly?
   (a)Yes (b) No (c) Not sure
4. Did you have any idea to organize a descriptive writing?
   (a)Yes (b) No (c) Not sure
5. Do you think you need more practice for your writing?
   (a)Yes (b) No (c) Not sure

was utilized to discover the students' attitude to pre-test. The teacher checked their answers, evaluating three facts: grammar, idea (creative thinking) and vocabulary. After their answers in pre-test were being checked, the instructor noted down the grades for the designated criteria and put them in a table. The instructor also checked their altitudes to pre-test in the questionnaire.

At the second week, the instructor elicited the facts concerning with the description of a person from the students by asking 'Wh' and 'How' questions. And then based on their answers, five main topics of descriptive writing were chosen. After that, the instructor asked the students to make small groups according to their grade in pre-test and allocated each one a number (ie. 1,2,3,4,5). This is home group. There are four home groups and five in each group.

At the third week, the instructor asked the students to find others with the same number as them and create a separate group and so five groups of four were formed. These groups are called expert groups. And the instructor asked each expert group to draw a specific topic from five main topics. The students had to think and discuss the topic they got in expert group. During the cooperative group work, the teacher provided "Wh-questions" for instance, "What's your father's interest?, How many languages can he speak?" and etc.

At the fourth week, the students from expert group were asked to return to their home groups. They had to report back what they had discussed in expert group respectively. They had to explain the topic they got ensuring that all their home group members understand each topic.

At the fifth week, the instructor asked each home group members to write a description about a person as free writing. And they exchanged their writing and did peer checking among their home groups. While they were doing peer checking, the instructor gave them some criteria for peer checking, for instance, Is this writing well-organized? After that, the instructor noted down their mistakes and gave feedback according to their mistakes.

At the sixth week, the students had to take post-test. During post-test, they were asked to write a descriptive text by giving specific topic. And the questionnaire was utilized again to know the differences of their attitudes to pre-test and post-test after using Jigsaw methods. The questions are the same ones as in the first questionnaire. The teacher checked their answers of post-test evaluating their grammar, vocabulary and idea according to the criteria like pre-test. Then the teacher checked and compared first questionnaire to second questionnaire.

Findings and Discussion

As mentioned above in Research Methodology, the researcher conducted the data with some instruments like questionnaires, pre-test and post-test.

In pre-test, the students (20) are asked to write a description of a person as free writing. And the researchers checked their answers, evaluating three facts – grammar, vocabulary, and idea (creative thinking). Their scores are graded according to the following criteria.

Score	Criteria
81-100	excellent
61-80	good
41-60	fair
21-40	poor
0-20	very poor

The students' pre-test and post-test results are shown in table 1 and 2.

Table – 1(Pre test)

Students	Grammar	Vocabulary	Idea (Creative thinking)
1	35	35	41
2	70	50	45
3	35	36	32
4	35	45	42
5	35	34	33
6	35	35	42
7	35	36	42
8	32	31	41
9	33	34	43
10	35	42	42
11	37	37	43
12	38	37	36
13	35	35	42
14	37	50	65
15	38	65	67
16	47	50	50
17	36	45	44
18	45	50	65
19	35	35	42
20	35	34	45
Average score	38(Poor)	41(Fair)	45(Fair)

Table – 2 (Post test)

Students	Grammar	Vocabulary	Idea (Creative thinking)
1	43	44	42
2	72	53	50
3	50	65	46
4	42	45	42
5	35	45	43
6	37	45	43
7	42	36	42
8	35	36	45
9	45	45	45
10	45	45	65
11	50	65	47
12	39	38	45
13	44	50	65
14	46	66	71
15	45	70	75
16	50	65	70
17	36	50	50
18	50	55	55
19	37	45	43
20	37	45	50
Average score	44(Fair)	50(Fair)	52(Fair)

In pre-test, the average score of grammar was 38 and it was graded as poor. The average score of vocabulary was 41 and graded as fair. The average score of idea was 45 and graded as fair. The highest score for grammar was 70 and the lowest score was 32. The highest score for vocabulary was 65 and the lowest score was 31. The highest score for idea (creative thinking) was 67 and the lowest score was 32.

In post-test, the average score of grammar was 44 and it was graded as fair. The average score of vocabulary was 50 and graded as fair. The average score of idea was 52 and graded as fair. The highest score for grammar was 72 and the lowest score 35. The highest score for vocabulary was 70 and the lowest score was 36. The highest score for idea was 75 and the lowest score was 42.

The result of the research shows that there is the improvement of students' achievement according to the results of the pre-test and the post-test. The criteria for grammar changed from poor to fair. Although the criteria for vocabulary and idea were the same in both pre-test and post-test, the scores in post-test were higher than ones in pre-test. So, the improvement of students' writing ability of the using Jigsaw method is proven.

On the other hand, the answers of the questionnaires conducted after pre-test and post-test can be seen in the following tables 3 and 4.

The students' attitudes to pre-test in the first questionnaire

Table-3

Students	Q1	Q2	Q3	Q4	Q5
1	Not sure	Yes	Not sure	Not sure	Yes
2	Not sure	Yes	No	Not sure	Yes
3	No	Yes	Not sure	Not sure	Yes
4	Yes	Not sure	Not sure	Yes	Yes
5	Not sure	Yes	No	Yes	Yes
6	Not sure	Yes	Not sure	Yes	Not sure
7	Not sure	No	No	Yes	Yes
8	Not sure	Not sure	Not sure	Not sure	Yes
9	Not sure	Yes	Not sure	No	Yes
10	No	Yes	Not sure	No	Yes
11	Not sure	Yes	Not sure	Not sure	Yes
12	No	Yes	Not sure	Yes	Yes
13	No	Yes	No	Yes	Yes
14	Not sure	Yes	No	Yes	Yes
15	Not sure	Not sure	Not sure	Yes	Yes
16	No	Yes	Not sure	Not sure	Yes
17	Yes	Yes	Not sure	Yes	Yes
18	Yes	Not sure	Yes	Not sure	Not sure
19	Not sure	Yes	Not sure	Yes	Yes
20	Not sure	Not sure	Not sure	No	Yes

The students' attitudes to post-test in the second questionnaire

Table-4

Students	Q1	Q2	Q3	Q4	Q5
1	Yes	Not sure	Yes	Yes	Not sure
2	Yes	Not sure	Yes	Yes	Yes
3	Not sure	Not sure	Not sure	Not sure	Not sure
4	Not sure	Yes	Not sure	Not sure	Yes
5	Yes	Yes	Not sure	Yes	Yes
6	Yes	Yes	Yes	Yes	No
7	Yes	Yes	No	Yes	Yes
8	Yes	Yes	Not sure	Yes	Yes
9	Yes	Yes	Not sure	Yes	Yes
10	Yes	No	Not sure	Yes	Yes
11	Yes	Yes	Not sure	Yes	Yes
12	Not sure	No	Yes	Yes	Not sure
13	Yes	Not sure	Not sure	Yes	Yes
14	Yes	Not sure	Not sure	Yes	Yes
15	Yes	Not sure	Yes	Yes	Yes
16	Yes	Not sure	Not sure	Yes	Yes
17	Yes	Yes	Not sure	Yes	Yes
18	Yes	Yes	Not sure	Yes	Yes
19	Yes	Not sure	Not sure	Yes	Not sure
20	Not sure	No	Not sure	Not sure	Not sure

According to table 3 and 4, it was found that the attitudes of the students concerning with writing ability improved (54%) in post-test than in pre-test. So, from the questionnaires utilized in this research, it can be said that the students got more satisfaction in their writing ability after using Jigsaw method.

Conclusion

This paper presents the improvement of the students' writing skills in writing descriptive text by using Jigsaw method and their responses to the use of Jigsaw method in their learning. By the implementation of Jigsaw method, the students improved their writing ability as well as their attitudes to writing a descriptive text. After using Jigsaw method, they do not think writing a descriptive text is a difficult task and they are happy with their writing text. Jigsaw method, a cooperative learning method improves their interpersonal relations and peer relations. In this research, the number of participants are

rather few because of their wishes and time limitation. It is hoped that there will be many participants in future research. The suggestion of this research is that choosing and using Jigsaw method in this research is just using an appropriate technique for an appropriate situation. This means that Jigsaw method is not the most suitable one in general situation. There are other teaching techniques good for improving four language skills.

Acknowledgements

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Geographical Study of Effective Route for Emergency Vehicles by Using Road Network in Hlaingtharya Township

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Abstract

Victims of road traffic accidents face severe health problems on-site or after the event when they arrive at hospital lately in their emergency cycle. Road accidents are a major cause of mortality worldwide with urgent action required to mitigate against the negative impacts. Network Analysis helps in identifying optimum locations for services to be provided. In the present study, hospitals and road traffic accident in the part of Yangon City area have been selected for network analysis. With the aid of Spatial Statistical Tool, the study found some evidence of significant and clustering in 2018 which suggested the presence of road accidents in Hlaingtharya Township. To demonstrate the use of shortest path, closest facility in network analysis, this paper focused on determining the optimal route between two or more destinations based on a specific travel expense. Geographic information system (GIS) software is used to determine the quickest way or shortest way between those locations. The result of analysis includes the direction and time to travel on that route.

Keyword: road accidents, shortest route, closest facility

Introduction

The Transportation System is a critical component of urban infrastructure and the lifeline of the city. It plays a key role in the economic growth of that region. An efficient route planning and accessibility facilitate sustainable development. (Aman Arora, Manish Kumar Pandey, 2011). Emergency services play a major role when accident occurs on the road network and need to save valuable human life. Most of the emergency vehicles take the patient to the hospital as fast as possible, even though they are unable to reach the hospital because of traffic congestion especially downtown urban area. The optimum route is considered as finding a route between two specific points in road network which needs minimum distance to traverse. Exploring optimum route is often used for routing of emergency vehicles such as ambulance, fire engine and police car. Geographic Information System (GIS) technology is more helpful in the planning process of urbanization. This is a key factor for applying GIS technology as a tool in supporting transportation network analysis.(Praveen Kumar Rai, Prince Kumar Singh, Abhishek Kumar Singh, Kshitij Mohan, 2013). The research work is conducted from the geographical point of view with emphasis on the spatial variation and road traffic accidents and analysis of shortest path and closest facility.

Study Area

The research paper is based on Hlaingtharya Township which is located in Northern District of Yangon Region. This area lies on the bank of the Hlaing River and the Panhlaing River. It is located between North latitudes 16° 49´ 30´ and 16° 54´, and between East longitudes 95° 59´ 30´ and 96° 06 ´ 45´. Hlaingtharya Township is situated in the western part of Yangon City.

Aim and Objectives

The main aim of this research work is to reduce the response time of emergency vehicles in road traffic accidents.

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The objectives are to find out the places where the closest hospital is located, to explore the efficient route for emergency vehicles to reach the hospital from the accident place.

Sources of Data and Methodology

The necessary facts and data are acquired from the Township General Administrative Office and field surveys. Most of the data relevant to the chosen title are acquired from No. 51, Traffic Office Station (Pazuntaung). Field observation on place of accidents was taken with GPS (Global Positioning System). In order to provide the network database, transportation information of emergency vehicles on each link was recorded based on three parameters: road length, average vehicle speed and travel time.

Modeling the shortest path in order to travel through a road network for emergency vehicles was established using GIS technology. There are geographically referenced with the help of Open Source Map, Google Earth and exported into a GIS (Geographical Information Systems, Arc Map 10.6.1). The projection system used was UTM Coordinates-Zone 47^{o} N and the selected Datum was WGS -1984.

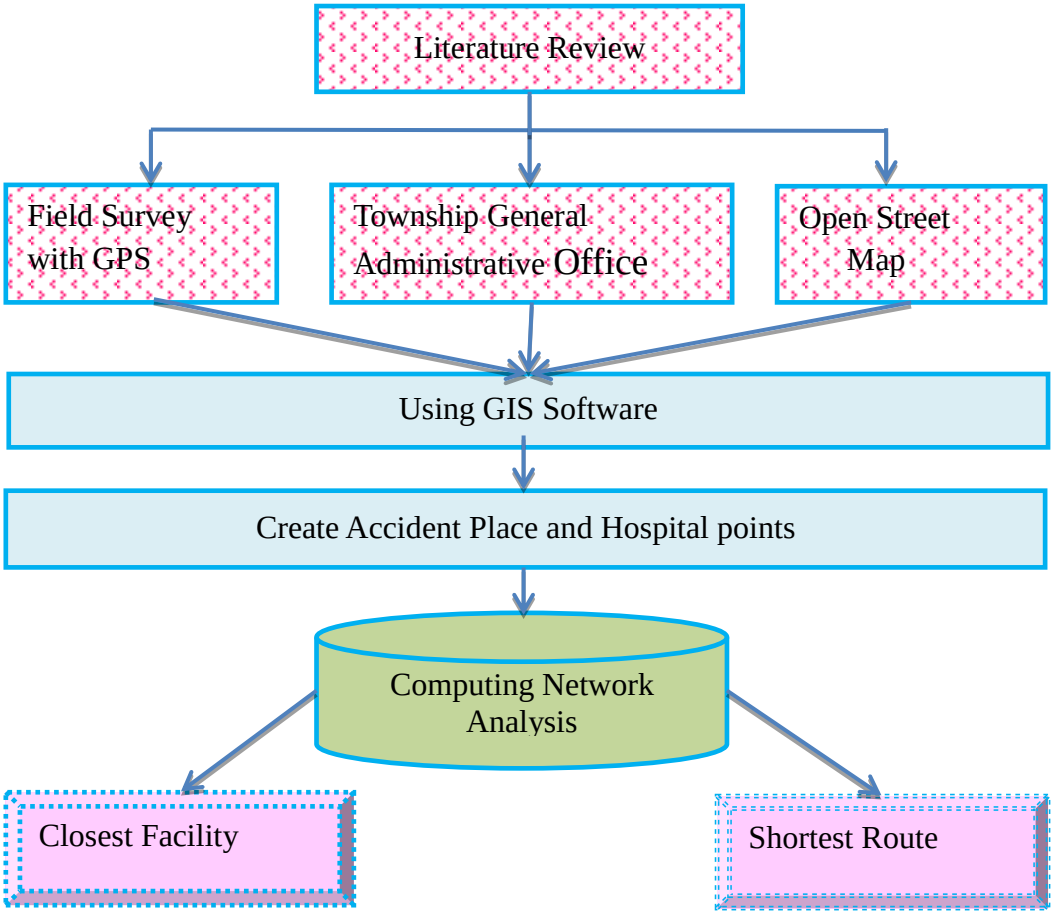

Figure 1. Conceptual Framework for Closest Facility and Shortest Route

The Determination of Accident Places in Hlaingtharya Township

In this paper, an overview of network analysis in Geographic Information System is presented from the geomorphic viewpoint. The study focuses on as collective events of spatial statistical tool, shortest route and closest facility. The accident place was regarded as the highest happening is 6 times that happened at the near Toe Chae Bus Stop on

Yangon- Pathein Road. Because there is a junction and it's quite close to the Shwethanlwin Industrial Zone.

Place of Collective Events

Within the study area, there have been 127 road accidents in 2018 which are analyzed by collective events. Analysis shows that which I count. By referring to I count, highest happening is 6 times that happened at the near Toe Chae Bus Stop on Yangon-Pathein Road. Five-time occurred at 2 places near Meekhwatzay Bus Stop on Yangon-Nyaungdone Road and Dagon Ayeyar Coach Station on Yangon-Pathein Road and four, three, two and once time at 2, 3, 23, and 48 places respectively. Five, four, three time happening places are mostly on Yangon-Pathein road and Yangon-Nyaungdone road. Figure 2.

Figure 2. Place of Collective Events in Hlaingtharya Township
Source. No. 51, Traffic Office Station (Pazuntaung).

Finding Closest Facility and Shortest Route and It's Results

In this paper, an overview of closest facility and shortest route are present from the geomorphic viewpoint. There is not considering the factors such as the number of traffic light and junction, condition of the road, and time of traffic congestion.

The spatial data of the GIS is used for creating road network. The road data is the essential information of a city's transportation road network. Road network are needed to travel emergency vehicles.

Geographical information of the road network is obtained from Open Street Map (OSM). OSM is freely supported for vector data format. Vector data is the spatial data which represent as points, lines and polygons. A point is a single node, a line is two nodes with an arc between them and a polygon is a closed group of three or more arcs. OSM data is clear and exact for calculating and processing for shortest routes. It is also easy to display in the Yangon Road Map. Figure: 3

Figure: 3 Road Network of Yangon City
Source: Open Street Map

Hospitals provide medical care to injured and sick people. To save a patient, the only way is to take the nearest hospital. Only the public hospitals are mentioned in this paper since accident cases are police cases and the patients are taken straight to the public hospitals. The locations of twelve public general hospitals are placed on the map of Yangon City. Figure: 4

Figure 4. Locations of Twelve Public Hospitals in Yangon City
Source: Open Street Map

Table 1. Locations of Twelve Public Hospitals in Yangon City

No.	Name	Road	Township
1.	East Yangon General Hospital	Merchant Road	Botataung
2.	West Yangon General Hospital	Lower Kyimyindaing Road	Kyimyindaing
3.	Yangon General Hospital	Bogyokeaungsan Road	Lanmadaw
4.	Yangon Orthopaedic Hospital	Hantharwaddy Road	Kyikyindaing
5.	Thingangyun Sanpya Hospital	Kyaikkasan Pagoda Road	Thingangyun
6.	South Okkalapa Women and Children Hospital	Myittar Road	South Okkalapa
7.	North Okkalapa General Hospital	Maydarwi Road	North Okkalapa
8.	Waibargi General Hospital	Dhamathukha Street	North Okkalapa
9.	Thamaine General Hospital	Yangon Insein Road	Mayangone
10.	Insein General Hospital	Mingyi Road	Insein
11.	Shwepyithar General Hospital	Nawarat Street	Shewpyithar
12.	Hlaingtharya General Hospital	Yangon-Pathein Road	Hlaingtharya

Source:GoogleEarthMap

The closest facility solver measures the distance and travel time between patients and hospitals and determines which are nearest to one another and also displays the best routes between them. The results of closest facility are three from the accident place to the nearest hospitals. There are Hlaingtharya General Hospital, Insein General Hospital and Thamine General Hospital. Figure 5.

Figure 5. Closest Facility from Accident Place to Hospitals
Source: Open Street Map

Shortest Route Analys is from one location to another location at emergency time and very common in urban areas. In this paper, finding shortest route from the accident place to the hospitals is very helpful in saving the travelling time. Average vehicles speed was calculated based on 40 km per hour because it's not allowed to drive over 50 km per hour in the downtown urban area.

Firstly, Hlaingtharya General Hospital is the closest from the accident place. The distance is about 2 miles and the direction start at accident place go to the southeast on Yangon-Pathein Road as far as Boaungkyaw Road and then turn left on go along this road and turn right go straight on Yangon- Nyandon Road get to the Hlaingtharyar General Hospital at traveling time is about 5 minute. Figure 6.

Figure 6. Shortest Route from Accident Place to Hlaingtharya General Hospital
Source: Open Street Map

Secondly, Insein General Hospital is the second closest from the accident place. The distance is about 5.3 miles and the direction start at accident place, go to the southeast on Yangon- Pathein Road as far as Boaungkyaw Road and then turn left on go along this road and turn right go straight on Yangon- Nyandone Road across the Aungzayya Bridge and go as far as the Insein Park and then turn left on Mingyi Road, get to the Insein General Hospital at traveling time is about 13 minute. Figure 7.

Figure 7. Shortest Route from Accident Place to Insein General Hospital
Source: Open Street Map

Thirdly, Thamaine General Hospital is the third closest from the accident place. The distance is about 5.4 miles and the direction start at accident place, go to the southeast on Yangon- Pathein Road go straight along this road and across the Bayintnaung Bridge and, go up this road to the Junction Thamaine and then turn left on Insein Road, get to the Thamaine General Hospital at traveling time is about 13 minute. Figure 8.

Figure 8. Shortest Route from Accident Place to Thamane General Hospital
Source: Open Street Map

Finally, in this paper the additional computing of the shortest route from accident place to Yangon General Hospital, which is the most of the injured patients in a road accident directly go to there.

The shortest route of distance between accident place to Yangon General Hospitals is about 8.9 miles and the direction starts at accident place go to the east on Yangon-Pathein Road, go straight along this road and across the Bayintnaung Bridge and go up

this road to the Junction of Bayintnaung and then turn right on Bayintnaung Road and then go as far as the junction of Narnattaw Road and Pyay Roadget and turn right on Pyay Road go along this road to the Bogyokeaungsan traffic light and then turn left on Bogyokeaungsan Road and get to the Yangon General Hospital at traveling time is about 21 minute. Figure 9.

Figure 9. Shortest Route from Accident Place to Yangon General Hospital

Source: Open Street Map

Discussion

This paper intended to present a method that can be used for accident management, through collection and analysis of accident data and including the viability of emergency vehicles. Accident place is defined in a GIS system and analysis of collective events was highlighted. Together with the location of hospital, the catchment areas and access to hospital was also defined for the area of study. The results of closest facility are three from the accident place to the nearest hospitals. There are Hlaingtharya General Hospital, Insein General Hospital and Thamine General Hospital. The distance and travel time are about 2 miles and 5 minute, 5.3miles and 13 minute, and 5.4 miles and 13 minute respectively. Most of the injured patients in a road accident directly go to Yangon General Hospital which is the distance and travel time is about 8.9 miles and 21 minute.

Conclusion

The study of this paper has been done with the help of field survey with GPS and OSM using GIS. GIS application for analyzing effective route to hospitals and recommending suitable hospitals for accident emergencies is developed. The proposed system uses shortest route to calculate the shortest distance from accident place to the nearest hospitals and closest facility to recommend the victims of road traffic accident that can attend to the suitable hospital. With real time location tracking, the system will drastically increase the survival rate of an accident victim by providing timely emergency aid. The system is flexible to other emergencies such as fire outbreak, and other medical emergencies. Location of nearest hospitals was computationally analyzed using Google Map and Open Street Map in real time.

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Changes of Administration in Rakhine

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Abstract

This paper deals with changes of administration in Rakhine. Rakhine chronicles and stone inscriptions described about the administration of Rakhine Kings from the first *Vesali* period to the last king *Mahathamada* in *Mrauk U* period. After the First Anglo-Myanmar War, Rakhine was placed under the rule of Governor General of India. In the post independence period, Rakhine is one of the divisions constituted in the Union of Myanmar. Based on primary sources and secondary sources, this paper attempts to point out the changes of administration in Rakhine.

Key words: administration, governor, district, town, ward, village

Introduction

Arakan (Rakhine) is one of the seven states constituted in the Union of Myanmar. It is situated between Burma (Myanmar) on the east and Bangladesh on the west. Rakhine is bordered on the north by the People's Republic of Bangladesh and Chin State, on the east by the Magway Region and Bago Region, on the south by the Ayeyarwady Region and on the west by the Bay of Bengal. Rakhine State is a narrow slip of coastal region interested with flows of rivers, valleys and blue mountain ranges. Having area of 14,200.1 square miles, it consists of five districts, twenty townships and 1041 village tracts and the population is 3,188,807 according to the 2014 census. Most of the people living in Rakhine State are Rakhines. There are Chins who occupy the hill area of Myebon, Yanbye, Ann and Taunggoke townships. Many hill tribes interposed with the Rakhines in the region are Mros (or) Khamis. Thets, and Daingnets (also known as Chakma), live on mountain ranges in the west and north of subway plain. Many other nationals like Bama, Kamans, and Bengalis are indigenous to a country called Rakhine, Rakhine Pray, a traditional Buddhist nation, which forms Union of Myanmar. People of Rakhine have their own administration system. They practiced monarchy system. There were changes in administration in colonial period and post independence periods. This paper deals with changes of administration in Rakhine.

Changes of Administration in Rakhine

As tribes founded villages on the family basis, the system of rule by a headman also emerged. Villages serve as the basis structures for administrative, political as well as military affairs. Even before the Bagan period, each village had their own representative heads that were known as "*Min*". As strong villages took over weak villages, larger units

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of districts, countries and towns arose, eventually, resulting in emergence of states.[1] Strong kings became emperor by defeating other kings who were weaker. For instance, when the king of Bagan became an emperor, he was recognized by all Myanmar.[2] Rakhine chronicles and stone inscriptions described the ruling system practiced from first *Vesali Kyaukhlekhar* period of the first part of 4th century to the last king of *Mahathamada* in *Mrauk U* period. They had had hereditary system and fighting for throne among royal ties were hardly found. At the coronation ceremony after being traditional procedures, the king to be had to take an oath which mentioned that he from *Mrauk U* period held their coronation ceremonies at the peculiar building situated in the precinct of *Shitthaung* pagoda.[3]

According to the difficulties of transportation in those days, governors in remote area had their authorities to minister to the administrative affairs. They, however, had an important obligation which was collecting soldiers and food when the king wanted. The governors in the far eastern and the far western areas had full authority like a king and even some had been permitted to adorn the consecrated crown. [4] Normally, Rakhine dynasty deserved the system of hereditary in appointing governors or Feudal lords. When a father died, the king and his experienced ministers gathered and decided whether the son should be appointed after proclamation of royal decree. There was a daily Royal audience led by the king consisting of king, counsellors, generals of navy and army, court Brahmins and the ministers of supreme legislative body. It was a conference where affairs related to the country. And its people were discussed, cases made by the lower court of law were judged, situations of governors and *Myosas* were investigated, and transfers and appointments for officers were decided. Furthermore, there had annual conferences in which both the higher officers lived in the capital city and governors, *Myosas* and Feudal Lords from remote areas had to attend.[5] The kingdom of *Mrauk U* is stated in appendix I.[6]

In *Mrauk U* period (AD. 1430-1784), to hold annual conference, the specific building was made at the east of the palace, about two miles away, in the shape of Mount Meru and its surrounding four islands, called *Taung-Myintomo-Nan*, the southern palace of Meru. It was also built a conference hall used for mainly religious affairs, attended by Venerable *Sayadaw* of disciplines or code of conduct and minister of religious affairs. The hall was named as the northern palace of Meru. In Rakhine history, kings and ministers practiced their respective percepts. Men of wisdom and ministers had chances to complain about royalties and even the king. For taxes and revenues, the natives had to pay five Kyats each year for a big house and two and half Kyats for a small house. However, businessmen had to pay ten Kyats each year as income tax for a big house and five Kyats for a small house. Cultivators or farmers had to pay three Kyats for a farm and no revenue for soldiers because of king's services. [7] Governors and *Myosas* had authorities to give judgment and administration by following to precedents at the capital. But no one had

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[1] Dr. Toe Hla,"***Rural Scio-Economic life in Konbaung Era" (1752-1885***), Yangon, Universities Press , 2004.p.1

[2] Dr. Than Tun, "***The early History of Myanmar",*** Studies in Burmese History Number one, Yangon, Maha Dagon Sarpay Press, 1969, p.139

[3] ***Nationalities of traditions and customs (Rakhine),*** Myanmar Socialist Lan Zin party, January 1976.p.138 (Hereafter cited as Nationalities and Customs)

[4] Ibid.p.139

[5] Ibid.p.140

[6] See Appendix I.

[7] ***Nationalities and Customs***, p.140

authority to penalize for death sentence except the king.[1] There had four courts of law at the four cardinal points of the palace where a judge called as *Pyisoegyi*- administrator of country and his assistant called as *Taraswe*-relative of law –had to sit for disputes of assault, breaking a promise, ownership of home and land, *Pyisoegyi* and *Taraswe* had been permitted to judge not only criminal cases but also civil law cases. If the plaintiff and the accused satisfied with the judgment, they had to pay *Pyisoegyi* and *Taraswe* some money as a fee by the losing party in a lawsuit-*kunphoe*. However, any reason concerned with king and others was not permitted for fee of payment. When a case judged by *Pyisoegyi* and *Taraswe* was incomplete it was sent to an office of tribunal that consisted of four ministers. Even it was disagreed, the case was decided by the king, at last, and the elder prime ministers.[2]

Thamada Raja, the last independent sovereign of Rakhine ascended the throne in AD 1783. The following year, when *Bodawpaya* was king of Myanmar, made war on Rakhine. The end of the Rakhine kingdom came on the 2 January 1785 by which Rakhine became Myanmar territory.[3] Under Myanmar rule Rakhine was divided into the *Myowuns*. *Mrauk U Wun* (Maha Mingyi Kyaw Swa), *Thandway Wun* (Nay Myo Thiha), *Yanbye Wun* (Nay Myo Nanda Kyaw Htin) and *Maunnaung Wun* (Yaisat Kyaw Khaung).[4] Under Myanmar rule, Rakhine was governed by four *wuns* who were appointed by the king from among higher officials at the capital. He had full civil, judicial, military and fiscal powers and was directly responsible to the king. His assistants were a *sayedawgyi* or secretary, a *sitke* or military commander who was also a senior magistrate with subordinate governors: *Myothugyi* and *Taikok*. Under the latter were *Thugyis* who were in charge of 32 clearly defined tracts called *taiks*.[5] According to Yandanbo, where a treaty was signed on 24 February 1826 by which Rakhine and Tanintharyi became British territory.[6] Two corps were raised in 1826 for the purpose of performing police duties in Rakhine. One was called the Rakhine provincial Battalion and was recruited in Chittagong, the other known as *Mugh* levy was recruited from *Mughs.* From 1825, the year in which Rakhine had been annexed following the First Anglo-Myanmar War, British had been made the administrative responsibility of the Governor General of India; in 1862, however, British Burma was made a province of India. Consequently, from that date till 1897, it was administered by a Chief Commissioner and thereafter by a Lieutenant Governor assisted by a legislature of nine nominated members, five of whom were officials. This administrative set-up continued to be in existence till the year 1923. In 1935, the British parliament passed the Government of Burma Act.[7]

This Act came into force in 1937 which finally affected the separation of Myanmar from India and conferred on Myanmar a very large measure of autonomy. Although the defense of Myanmar and the control of the armed forces as well as foreign affairs were still under the direct charge of the Governor, the subjects of law and order and finance were placed in charge of Ministers, who were chosen from among the members of the

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1 Ashin Kawisarsa, ***Dhanyawaddy Ayedawbon***, Yangon, Herald Steam Press, 1787. p.31

2 ***Nationalities and Customs***, p.142

3 Ma Kyan, "***Quest of History and Other Papers*** ", Yunkyaishet Sarpay Press, second print, July 2007, p.3

4 Maung Maung Tin , "***Konbaung khit Mahayazawintawgyi***",Vol.II,Yangon.BE.1329,p.365-7

5 W.B Tydd, ***Burma Gazetteer Sandoway District***, Vol.A, Rangon, Govt-Printing,Burma 1912,p.48

6 R.B Smart, ***Burma Gazetteer Akyab District***, Vol. A, Rangoon, Govt-Printing and Stationary, Union of Burma 1954, p.34

7 Lieut-colonel. N.N.Madan, "***The Arakan Operation" (1942-45),***printed.S.N.S.N Guha Ray at Sree Samaswaty Press Calcutta, 9 June 1954, p. 5

legislature. The Myanmar were at first indifferent to the deceleration of war in 1939.[1] In fact, the *Thakhin* Party took advantage of this situation and fortified its resolve to secure the freedom of Myanmar by force while the British were carrying on the war in the west. In furtherance of this policy Young Barmans were sent to Japan in 1941 to get training in fifth-column and sabotage activities. On 14 April 1942, Myanmar was annexed by the Japanese occupation forces. In accordance with the Aung San–Attlee Agreement of January 1947, elections for a Constituent Assembly were held and won by the Anti-Fascist People's Freedom League (AFPFL) with a large majority. On 4 January 1948 Myanmar became a fully independent state.[2] After independence of Myanmar, Rakhine was a division in the Union of Myanmar.[3] In March 1974 by a new constitution, a council of state and a People's Assembly, the *Pyithu Hluttaw* were introduced and a unitary state stipulated. On 15 December 1974 Rakhine was one of the seven states in Union of Myanmar.[4] At present day, the Union of Myanmar has an administrative structure, a regional basis as State/ Division, District, Township, and Ward/Village Levels. The Ward/Village Level are the unit of local administration. On 24 December 2012, further administrative changes were made in Rakhine. As *Mrauk U* district were newly created, there are five districts and twenty townships up to the present[5]. Up to date the Districts of Rakhine is stated in Appendix II.[6] Having area of 14,200.1 square miles, it consists of five districts, twenty townships and 1041 village tracts and the population is 3,188,807 according to the 2014 census.[7] The population of Rakhine State is stated in Appendix III.[8] Only when the state's political, economic and social objectives are not at these levels where is a successful implementation of a modern peaceful and developed state.

Conclusion

The village served as the basis for the country's polities, administration and military. In Rakhine chronicles and stone inscriptions described the ruling system practiced from first *Vesali* period of the first part of 4th century, to the last king of *Mahathamada* in *Mrauk U* Period. They had had hereditary system and fighting for throne among royal ties were hardly found. Under Myanmar rule Rakhine was governed by four *wuns* who was appointed by the king from among higher officials at the capital. He had full civil, judicial, military and fiscal powers and was directly responsible to the king. From 1825, the year in which Rakhine has been annexed following the First Anglo-Myanmar War, British had been made the administrative responsibility of the Governor General of India; in 1862, however, British Burma was made a province of India. After Independence of Myanmar, Rakhine was a division in Union of Myanmar. According to 1974 a new constitution, on 15 December 1974 Rakhine is one of the seven states

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1 Daw Ni Ni Myint***, Myanmar Two millennia: An Excursion through History***, Universities Historical Research Centre, Yangon,2000, p.3

2 ***"Rakhine State Gazetteer***", Vol. I, Sittwe, Rakhine State People Council, 1984. p.104

3 Ibid. p.105

4 ***The Socialist Republic of the Union of Myanmar Constitution***, Myanmar Socialist Lanzin Party, Yangon, 1973, p.21

5 ***Statement on subdivision in Rakhine State***, Ministry of Home Affairs, Republic of the Union of Myanmar, 24 December 2012 (Rakhine State)

6 See Appendix II.

7 The 2014 Myanmar Population and Housing Census-The Union Report, May 2015 (Web)

8 See Appendix III.

constituted in the Union of Myanmar. On 24 December 2012 further change in the administration of Rakhine occurred *Mrauk U* district was nearly created. These are five districts, twenty townships and 1,041 village tracts in Rakhine State.

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Tydd. W.B ***Burma Gazetteer Sandoway District***, Vol. A, Rangoon, Govt. Printing, Burma,1912

Appendix I

The Kingdom of Mrauk U

Source: Conraet Decker & Wouter Schouten, (1661-1680), De bandel of reede voor de stadt Arakan, Asia, Burma, Rakhine

https://www.catawiki .com/1/29224483

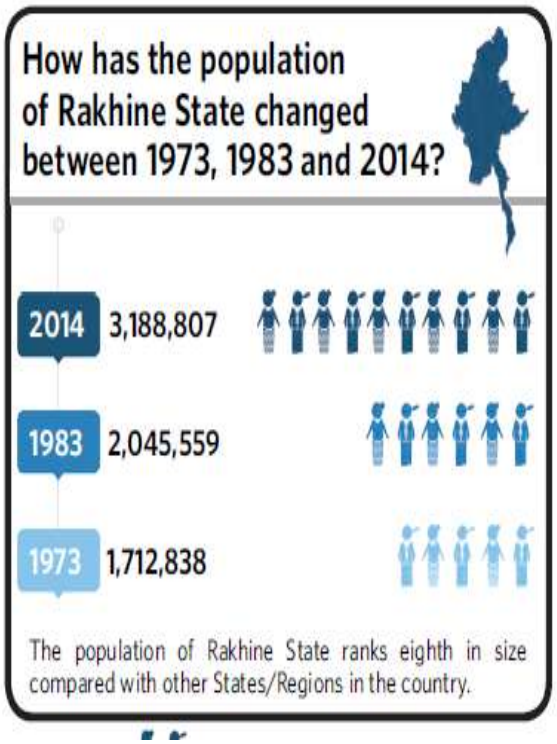
Appendix II

Rakhine State by Districts and Townships

Source: The 2014 Myanmar Population and Housing Census, Rakhine State Report, Census Report Volume 3 – K, Department of Population, Ministry of Immigration and Population, Office No. 48, Nay Pyi Taw. May, 2015. www.dop.gov.mm

Appendix III

The population of Rakhine State



The 2014 Myanmar Population and Housing Census

Rakhine State Figures at a Glance[1]

Number of Districts	5
Number of Townships/Sub-townships	20
Total Population	3,188,807[2]
Population Male	1,526,402 (47.87%)
Population Female	1,662,405 (52.13%)
Percentage of urban population	17.0%
Area (Km2)	36,778.1
Population density (per Km2)	86.7
Median age	26.0

Source: The 2014 Myanmar Population and Housing Census, Rakhine State Report, Census Report Volume 3 – K, Department of Population, Ministry of Immigration and Population, Office No. 48, Nay Pyi Taw. May, 2015. www.dop.gov.mm

The Role of "Moral Obligation" in Myanmar Society

Tun Pa May [Ä]

Abstract

This paper is an attempt to solve the problem why the conceptual study of "moral obligation" should be accepted and practiced as a basic moral foundation in Myanmar society today. The solution will be proved by the principle of reciprocity with reference to relation of parents and children, teachers and pupils, husband and wife that make advantageous to moral growth. In Myanmar society, "moral obligation" is the primary factor and moral rules. A critical study of the duty of parents and children will be undertaken to demonstrate this point. The research methods used in this paper are the descriptive and evaluative methods. This paper contributes to understanding the awareness of "moral obligation" for application to the human relationship in every society.

Key words: (1) moral obligation (2) principle of reciprocity (3) moral rules

Introduction

This paper will be emphasized on the fundamental code of conduct in Myanmar society. The significance of Myanmar culture is that equality of responsibilities and rights of both parents and offspring are provided. Myanmar is a country that lies between the two cultural giants of Asia 'China and India'. Historically and Geographically Myanmar has cultural relation with both Chana and India. It might say that Myanmar may adopt some Chinese cultural components and philosophical phenomena as well as some Hindu cultural factors especially the classical legal codes. The nature of family relationship plays an important role in Indian society as well as in Chinese society.

Based on doing research of the concept of duty and responsibility in the relationship of family and social system, it will be contributed that some social phenomena in Myanmar cultural society is different from either Western culture or Eastern culture like Chinese, Japan and Korea in the formation of family. In Eastern culture especially Chinese and Indian societies, duties of son and daughter of a family laid down as basic duty. In Western culture, fourth factor of Ten Commandments, "Honor Your Father and Mother" is obviously expressed. Hence, in Western culture to revere parent is considered as the basic duty of human. In the formation of family in Western culture, a housewife must adopt the name of his spouse so also the sons and the daughters. There are no such hereditary names in Myanmar.

In Indian society, as in Chinese, Korean and Japanese society, there have been basic principles concerning family obligation. The caste system is exercised mostly in India not preserve bloodlines and to extend and promote it. Every family group attempts with great effort to fulfill this goal. In this society, the wife must serve the family of her husband as in China, Korea and Japan. They have to give birth and raise the children and serve the members of the husband's family. The children must be given the family name of the husband. They are considered descendants of the father's lineage and not of the mother. The caste system does not give young people freedom to choose spouses because of the caste system.

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Due to the above mention customs and traditions, in Chinese, Korean and Indian society, parents prefer to have a son rather than a daughter. Daughters of those communities serve and support their husband's families but cannot take care of their own families from which they have descended unlike sons. Hence, in Chinese and Indian societies father and son are more important than those of daughter and mother.

In Myanmar society, husband, wife, and their offspring enjoy a large extent of freedom in building a family. The aim in setting up a family is not to upgrade and improve the husband's bloodline but to promote their own family. There is no discrimination against caste or gender. The role of husband is identified with the name "Guardian of the house" (အိမ်ဦးနတ်), which includes house, wife, the children and jeweler. According to a Myanmar saying, သားကြီးတော့အား သမီးကြီးတော့ထီး (*tha ghi tagh are, the me ghi tagh htee*) when a son becomes grownup he is a strength for family and when a daughter becomes grownup she is a umbrella of loving-kindness for a family. Hence, it can be said that in a family in Myanmar society both son and daughter have equality and freedom by their skill and status.

The Impact of Buddha's Philosophy in Myanmar society

Since Myanmar has been widely influenced by Buddhism, most Myanmar is Buddhists which is in turn, influence Myanmar culture. Buddhism has no discrimination of caste, gender, wealth, or race. The value of man is determined systematically by phases of Five Precepts, Eight Precepts and Nine Precepts. In Myanmar society, these rules are most basic criteria by to judge an individual as good or bad morally. There are obligations for everybody to fulfill according to their station in life. If they are not delinquent, there will be no danger because of neglected responsibilities; otherwise unpleasant situations such as negligence, resentment, assault, offence, conflict are inevitable among people. To increase loving-kindness, sympathetic mood, compassion and harmony people, that is, to be able to live happily, the Buddha laid down social obligations for everybody.

In the *Mingala Sutta* and the *Sigalovada Sutta*, responsibilities of parents and sons and daughters are laid down to be followed but are not commandment. *Sigalovada Sutta* can be seen as the central social outlook of Buddhism. Responsibilities of parents, and offspring, teacher and disciple are laid down in the *Sigalovada Sutta* and the consequences of adhering or not adhering to them are also given. *Sigalovada Sutta* means the discourse preached by Buddha to a young man name *Singala*. In this *Sutta*, the Buddha explained the social duties for all human beings and they include the duties of parents, the duties of sons and daughters etc. If one fails to observe these duties one encounters a declination in prosperity in addition to the misfortune of being reborn in woeful abodes after death. If one observes these duties one, enjoys prosperity and high dignity in the present life and one will be reborn in the pleasant abodes after death. All human beings should observe these social duties with due respect and firm conviction.

Five Kinds of Duty for Parents

To dissuade children from evil (မကောင်းမြစ်တာ)

Parents should prevent their offspring from wrong doing in their own interest. According to the *Lokaniti*, (သားကိုငယ်ကမဆုံးမလျှင်၊ မိဘတလည်ရန်သူမည်၏)[1] Thu Ka's *Lokaniti*, 1994 p-28. If parents do not impart instruction from young, parents can be regarded as enemy.

To persuade children to do good (ကောင်းရာညွှန်လတ်)

In anticipation of the children's future well-being, parents must give them good guidance. It is especially necessary for parents to keep abreast with the ever changing and developing world. Hence, parents must have up-to-date knowledge to pass along to their children while training them to distinguish between right and wrong. This is the first responsibility of parents, but for parents to dissuade children from evil they must watch their children to see if they are on the right track or not. This will enable parents to help children mend their ways.

To instruct the children in the arts and sciences (အတတ်သင်စေ)

This responsibility is the most significant one of all responsibilities of parents. According to stanza 23 of, the Wiseman Section of *Lokaniti*, friendship is not equal in value to knowledge.[2] (Thu Ka's *Lokaniti*, 1994 p-32). In order to obtain a brighter future life; parents see that children keep good company. It is extremely necessary for the parents to give children a good education for their life long journey. According to stanza 4 of, the Wiseman Section of *Lokaniti*, there is nothing equal to learning. Thieves cannot steal learning. In this world, learning is a friend and mate. It carries happiness to the next life.[3] (Thu Ka's *Lokaniti*, 1994 p-15). According to stanza 18 of, the Wiseman Section of *Lokaniti*, a mother is an enemy; a father is an enemy wherefore? Because their offspring, being uneducated in their youth, are as unbecoming in an assembly as cranes among swans.[4] (Thu Ka's *Lokaniti*, 1994 p-27). If children are lacking in formal education, parents are obliged to arrange something for them to gain an honest livelihood by giving them capital or training for a job. When they are skilled in doing some kind of job, they can survive anywhere at any time. Money and property may be lost in fire, flood; because of thieves, enemies, one's own foolishness mismanagement. The best way for them is to gain good education or training for a job.

Hence "providing of right education for the children with true compassion by parents," is a principle to be exercised through the ages. In the case of education, it means not only for the welfare in life, but also for the social and moral well-being.

To hand over their rightful inheritance (ပေးဝေန်းရင်း)

According to the advice given by the lord Buddha in *Singalovada* discourse, handing over the inheritance or investment to the children is the fourth responsibility of parents. Investment means not only the wealth but also wisdom or knowledge. Though wealth can be perished at any time, knowledge lasts forever, so parents should give knowledge or education. According to stanza 36 of, the Wiseman Section of *Lokaniti*, they who, being of little knowledge, are full of youth and beauty and have a noble lineage, do not appear to advantage; like the butte frondosa, they are without fragrance.[5] (Thu Ka's *Lokaniti*, 1994 p-43). Men are foolish in cherishing the gay blossoms of the palas tree, fair to see, but without scent. A bad person, though decorated, remains the same as cow dung, which, though it be fertilizing, does not become pleasing. A boat without any one to steer it will wander away without direction, so there must be steersman. In the same way, parents are as important as the steersman, for the children on their way through life.

As mentioned above, parents should dissuade children from evil, persuade children to do good, instruct them in arts and sciences, and at the proper time hand over to children their inheritance.

To give them in suitable marriage (ထိမ်းမြားခြင်းလျှင်)

Arranging a suitable marriage for one's and daughter is the parents' responsibility. In Indian culture, there is caste system and tradition of guarding their own blood line. However, this responsibility of parents, according the advice given by the Lord Buddha, has nothing to do with Hindu caste system. In ancient times parents took full responsibility for arranging a suitable marriage including the right spouse. This is no longer the case in modern liberated times. Nevertheless it still remains a duty of parents to advise their children to choose their life parents wisely and well. On the side of the children, they should pay heed to the advice given by parents. Therefore, it is important for the parents to guide the life of children with love and right will.

Five Kinds of Duty for Sons and Daughters

To minister to his parents by supporting them (ကျွေးမွေးမပျက်)

The happiness of parents when a child is born, is beyond description, and the baby is nursed with tender care, and stool are cleared without the least complaint or disgust, and they are always anxious to provide the best of health, education, wealth and so on for their child, they nurture their child age, as babies and tend to admonish them for their own good. They never complain about going to the aid of their children when they are in financial, social or legal difficulties. They are ready to protect and care for their loved ones at the risk of their own lives, their property and health. The kindness and love of parents are so much and great that they cannot be repaid in full.

Children are greatly indebted to parents for their life and well-being. Hence, they should take care of the parents in their twilight years. It is children duty to take care of their parents when they grow old and retire from work. In Myanmar society, those who practice Buddhism and believe in its basic principle, the Law of *Kamma*, know that if they take care their parents with good will, they will gain merit. According to the Law of *Kamma*, children who take care of their parents with love and affection earn merit for the parents as well as future life. Law of *Kamma*, and Law of Reciprocity together with compassion, good will and sympathy play a very important role in the Myanmar way of thinking. So, one of the responsibilities of children, "A child should minister to his parents by supporting", is as a good tradition to nurture and practice in any age or, any society. It should be developed and extended as a basic principle.

To minister to his parents by being dutiful (ဆောင်ရွက်စီမံ)

This second responsibility of children is as important as the first. Just as parents perform nourish, educate, and care for their children, children in turn should do whatever is necessary for the parents when they are aged. This can be considered as the reverse of parents responsibilities. By doing so, children can preserve the pride of their family generation by generation. These two responsibilities are related with the third one "a child should minister to his parents by being worthy of his or her in heritance."

Thinking of their indebtedness to parents' children should help their parents with housework and look after them in illness, and even if they cannot give them material support, at least they should be concerned about their spiritual welfare and should obey and behave respectfully towards them so that they can live happily for the rest of their life. If they do so, they will gain the praise of their parents and their neighbors. That home in which they live will be blessed with prosperity and happiness, peace and harmony.

To minister to parents by being worthy of his or her inheritance (မွေခံထိုက်စေ)

Sons and daughters have a responsibility to be worthy of their parents' inheritance by obeying them and gratifying them by achieving success and happiness in their own lives. As far as good parents are concerned; they are always anxious to give a good education to their sons and daughters so that they can move in the highest society, and they, by making sacrifices, bring their children up well even if they are poor. When they see that their sons and daughters have great success in life, they are very happy. Good parents do not nurture their children in the hope of gaining profit from them as if they were investing money, but sons and daughters, should not be reluctant to support or to look after parents when they earn enough money. According to stanza 52 of, The Goodman Section of *Lokaniti*, bad is the speech of one who has a vile mother, bad the conduct of one who has vile father; but he who has a father and mother both vile, his speech as well as his conduct is bad.[6] (Thu Ka's *Lokaniti*, 1994 p-57). And Vice Versa, in stanza 53, good is the speech of an excellent mother, good is the conduct of one who has an excellent father; but he who has a mother and father both excellent, his speech as well as his conduct is good.[7] (Thu Ka's *Lokaniti*, 1994 p-57).

For this reason, as children adopt the heritage of parents whether it is good or bad they should be in good manner. For the children side, they should be worth of adopting the heritage of parents. So, for the betterment of society this responsibility, "they must obey their parents and make themselves worthy of the parents' heritage" must be regard as basic principle.

To minister to parents by offering alms in honor of departed relatives (လှူမျှဝေ၍)

Sons and daughter have a responsibility to offer alms for their departed parents and must share merit with them. According to Buddhism, one's mind-process continues to the next life so long as one does get rid of craving. Those, who have right view, believe in the consequences of their own good or bad deeds, are endowed with right conduct in body, speech, thought, and do not affront the noble ones, are reborn in a heavenly or human abode after they pass away. They enjoy their life there in accordance with goods they did their previous life.

The donor can get five results from offering his donations. These are as follows; the donor is loved by other people, good or noble people will come to him, he is certainly going to the heavenly planes after death. So, everybody should offer alms to other people and then he should share merit with departed ones. According to stanza 37 of, the Wise man Section of *Lokaniti*, "the son of a man of low origin becomes a king's minister, a fool's son a learned man, a pauper's son a millionaire: do not, therefore, despise men"[8] (Thu Ka's *Lokaniti*, 1994 p-43). By this stanza, son and daughter can be higher than parents in their life, so with this view that wealth and good deeds they possess can be shared in both in present life and next life, a basic principle must be laid down.

To minister to parents by preserving the family lineage (စောင့်လေမျိုးနွယ်)

They must maintain their parents' properties, their parents' nationality, their parents' religious duties, and try to straighten their parents' religious view if they have a wrong view. They must also maintain the good name of their parents and their lineage. As the *Singalovada Sutta* means the discourse preached by the Buddha which shows the social rules of conduct, the aim and objects it should be understand clearly. Buddha does not accept the caste system of Indian culture, so, preserving the family lineage, one of the responsibilities of children does not refer to the caste system and it just refers to safeguard the family lineage.

In Myanmar society, the social responsibilities presented here cannot be made into social duties of Myanmar society yet and they are still responsibilities. These responsibilities must be transformed into social duties so that they will become strong social principles of Myanmar society. Moreover, there are four Cardinal Values (*Brahma Vihara*) or sublime states of mind that are to be nurture by all Buddhists. These virtues are *Metta* (loving-kindness), *Karuna* (compassion), *Mudita* (joy in another's good fortune), and *Uppekha* (equanimity). Out of four, if the two virtues *Metta* and *Karuna* are kept in mind when parents' responsibilities are performed, children will more deeply appreciate the loving-kindness of parents and realize the responsibilities. On the part of children if five responsibilities are performed keeping the *Metta* and *Karuna* in mind, parents can live in secure life when they are in old age.

For these reasons, by looking after children with *Metta* and *Karuna* of parents, vice versa, protecting parents with *Metta* and *Karuna* of children, Law of Reciprocity is manifested in Myanmar society. In this case, to be transmitted the good tradition, one who is parents and child at the same time is more important. For instance, a man still has parents and at the same time he is married and has children, so he is both parent and child. He is most responsible person in transmitting the good tradition of relation of parents and children. He must understand and can practice the social responsibilities with *Metta* and *Karuna* as the basic guidance so that he may be the model for new generation and they can appreciate deeply them in their attitude. So, social responsibilities of Myanmar society may develop as social duties and they will become moral obligations. In this developing process, responsibilities of parents and children play an important role. By fulfilling the respective responsibilities with heart and soul, other social responsibilities such as responsibilities of husband and wife, employee and employer and teacher and pupil may be prospered more and more.

Finally, it is important for the parents to guide and instruct with *Metta*. It is also important for the children to adopt *Metta* of parents with appreciatively. It can be considered as preserving the Principle of Reciprocity, which is significant feature of Myanmar. In this way, the problem "why the conceptual study of "moral obligation" should be accepted and practiced as a basic moral foundation in Myanmar society today" have already been proved by the principle of reciprocity.

Conclusion

In this paper, the responsibilities of parents and children are presented as the basic important principles in society. Family is the most fundamental unit of a society. The basic moral principle can be extended to a society and to a culture. Afterwards it may be extended to global culture. The moral principles are gradually changed and for these circumstances of the age, they will become better or appropriate for the social development. In this case the important and fundamental thing is man's attitude. Man can create fine environment and his attitude is able to accomplish betterment society. In Myanmar culture, the family is intimately associated with by feeling of love and duty that the young grow up to be good citizens naturally and the old grow old gracefully. This acceptance is nothing but beauty and happiness in the family life.

Parents are foremost educator of children. Teachings of parents' seep into the delicate heart of children. Conduct and manner of parents is guidance and leader and model for children. Thus, good or bad of parents reflecting in their behaviors attitudes and these behaviors can easily infect children. For this reason, parents should take care their

attitudes and behavior to be good idea for children. Moreover, they have to do try to cultivate their good personality not only for themselves but also for their children. For this purpose, religious teachings and exemplar are best guidance and effective way for such culture. A significant feature of Myanmar's families has been the freedom of the individual. The Myanmar's families are loosely knit by love and respect, not welded together by power. The father is the acknowledge head of the family, but when he is absent or gone, it is a mother who takes over. Sons and daughters are under the care of parents before marriage. On them also, the power rests lightly, and it is more in the nature of filial love and duty. A child grows old slowly in the family in Myanmar culture. He or she may become an adult and a father or a mother, but in the eyes of the parent he or she remains a child.

Most Myanmar is Buddhists. Buddhism teaches that it is virtuous and good to respect the Buddha, the *Dhamma*, the *Sangha*, the teachers and the parents, and this lesion sinks deeply into the conscious of every Buddhist since the young. The parents encourage their children to the good Buddhists. According to both Myanmar culture and Myanmar traditional thought, parents are model for their children. As the parents' behavior and attitude influence the children mostly, the five responsibilities of parents and the five responsibilities of children bind the family system. The emphasis within family life in Buddhist ethics rest upon the proper roles and responsibilities that characterize the husband-wife and the parent-child relationship. Husbands and wives are to cultivate respect, honor, and faithfulness towards one another. Parents are responsible for inculcating Buddhist ethics and practices in their children are expected to be obedient and to preserve the traditions of the family. Apart from those discussed here, there is four sublime state of mind or (*brahma-vihara*): *Metta, Karuna, Mudita and Upekkha*. Those four Sublime states of mind also can be called four virtues of Myanmar Buddhist society and are included in family responsibilities. Parents raise their children with absolute loving-kindness, *Metta*, and they are in sympathetic joy, *Mudita* in children's success, welfare and happiness. On the side of the children, they take care parents with *Metta* and *Karuna*. So, Myanmar traditional thought recognizes that in peace and well family life both parents and children admitted the *Metta*, loving-kindness, and *Karuna*, equanimity. This is the significant feature and criterion of Myanmar culture. To be a peace and prosperous every society, it is important to practice *Metta* and *Karuna* by all man. Moreover, to become families of dutiful to the responsibilities of parents and children is more important because they can point out the "moral obligation" for all human being.

Therefore, this paper contributes the conceptual study of "moral obligation" that should be accepted and practiced as a basic moral foundation in Myanmar society today. I think that the conception of "moral obligation" in Myanmar can be applied to the human relationship in every society. Thus, the conception of "moral obligation" in Myanmar can be applied effectively in social function of every society and it is also a fun which can rectify the progression and digression of history.

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မြန်မာဘာသာကိုးကားကျမ်း

သုခ (၁၉၉၄)၊ **လောကနီတိ**၊ ပါရမီစာပေ၊ အမှတ်၂၃၀၊ ၂၉ လမ်း၊ ရန်ကုန်မြို့။

Adherence to three Gems (*Saraṇagamana*) and Buddhism

Aye Myat Thu[1] ,Win Win Khaing[2]

Abstract

Saraṇagamana (Adherence to three Gems- *Buddha*, *Dhamma* and *Saṁgha*) is very important for Buddhists and has vital role in genuine Buddhist living. In Adhering to *Saraṇagamana*, the worship of *Buddha*, *Dhamma* and *Saṁgha* through comprehensive understanding on the meaning and attributes of these three things and strong belief on them can be recognized as genuine *Saraṇagamana* otherwise it can cause fade of it if there is doubt on the existence and attributes of them. In this study, the essence of genuine *Saraṇagamana* is described in detailed explanation with the reference of various literature sources such as Buddhist *Pāli* Canons, commentaries and others. The main objective of this study is to remove the misconceptions of majority of traditional Buddhists on *Saraṇagamana* through comprehensive explanation. In this study, the types of *Saraṇagamana*, the requirements for adhering *Saraṇagamana*, the factors for damaging *Saraṇagamana*, the reasons for fading *Saraṇagamana* and the benefits of strong and firmed *Saraṇagamana* will be presented to promote the propagation of Buddha *Sāsana* and increase of genuine Buddhists.

Keywords: *Buddha, Dhamma, Saṁgha,* attributes,

Introduction

Saraṇagamana is the lifeblood of Buddhist. Laymen and the worship of three Gems- *Buddha, Dhamma and Saṁgha* through strong faith and comprehensive understanding can be called as genuine one. It is also the origin of layman life as Buddhists and means the wholesome consciousness that arises on the strong faith and worshipping of Three refuge and this type of consciousness is faith and respect on three gems rather than ordinary ones. In taking refuge of three gems, those who deeply respect on them through strong belief and wisdom can be assumed as the genuine laymen of Buddhism. The laymen must have the strong belief that three Gems can remove all dangers and misfortunes and as a result, there is rise of wisdom that three Gems are the real refuges through this belief. Three times recitation for taking refuge of three Gems is meant for deep commitment. There are two types of *Saraṇagamana*; mundane and supra mundane ones. Mundane type of *Saraṇagamana* can enhance freeing of fear, clearness of mind and prosperity in current life and existence in blissful planes in next lives while the supramundane type can result attainment of *Nibbāna*.

Study area

The study areas are Taunggoke University library and the library of the oriental studies department, Taunggoke University ,Rakhine State.

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Aim and Objectives

Aim

The aim of this paper is to express the importance of *Saraṇagamana* for the Buddhist.

Objectives

1. To express authenticity of being *Saraṇagamana*.

2. To submit the facts that make *Saraṇagamana* destroy.

3. To be the authentic Buddhists.

Materials and method

All of the datas and materials concerned with this paper were collected from the books in *Pāli, Aṭṭhakathā* of the libraries and descriptive method is applied to provide the paper.

The meaning of *Saraṇagamana*

Saraṇagamana is a combined Pali word and consists of two parts; *Saraṇa* and *Gamana*. The first part means worship (PMD.1009,1957) and the latter means adherence or taking refuge (PMD.618 ,1975). Therefore, *Saraṇagamana*, as the whole word, means adherence or taking refuge as a form of worship. In other words, it means the thing that can protect from the dangers of fear, worries, physical and mental pains. Three Gems got their name as *Saraṇa* due to the attributes that can destroy all pains or sufferings and can lead to happiness and being well off (Achepyu. 13¸1973).

In the time of *Gotama Buddha*, the very first persons adhering to *Saraṇagamana* were two merchants; *Taphussa* and *Bhallika*. After passing forty-nineth days of enlightenment, on the day in which Buddha finished the meditation, the two merchants from *Okkalapa* gave snacks for alms to the Buddha and adhered to two Gems (*Saraṇagamana*) by telling that they would become the close laymen of Buddha and asked for Buddha to recognize as His genuine disciples for life long duration. These two merchants were the first person who took *Dwevacika Saraṇagamana* (two Gems) in the world and *Buddha Sāsana*. At that time, Buddha was freshly in Buddhahood after enlightenment and even the first sermon was not delivered and therefore, the two merchants could take refuge on *Buddha* and *Dhamma* only not on *Saṁgha* due to the lack of emergence of *Saṁgha* society. Due to these reasons, these two people got the title of supreme persons in taking refuge in *Buddha Sāsana* (Vi.iii.3,(2005).

In the same way, the first person who firstly took *Tevacika* (three Gems) *Saraṇagamana* in this world is a rich man, father of youth, *Yasa* (A.i.27, 1959). His mother, *Sujata* and his ex-wife were also the first laywomen who took *Tevācika Saraṇagamana* (Vi.iii.23,2005). *Sujāta*, mother of *Yasa* held the supreme title among the laywomen who took refuge to three Gems in this *Buddha Sāsana* (A.i.27,1959).

Procedures for Adherence to three Gems

If anyone wants to take *Saraṇagamana*, he must recite the *Pāli* words of "*Buddhaṁ saranaṁ gacchāmi*- I take refuge to *Buddha, Dhammaṁ saranaṁ gacchami* – I take refuge to *Dhamma* and *Samghaṁ saraṇaṁ gacchami* – I take refuge to *Saṁgha*" for three times. In real sense, *Saraṇagamana* means the wholesome consciousness which arises when someone took refuge on *Buddha*, *Dhamma* and *Saṁgha* as things of worship.

In taking *Saraṇagamana,* one must have the attitude in which one sacrifices to three Gems, relies, adheres as close disciples and respects on them(It.A.214, 1958).

Attributes of three Gems

The Pāli word, *Ratana* (Gems in English) gets its name due to the attribute of causing pleasant feeling. In a Pali verse, the definition for Ratana can be described as "*Cittakataṁ mahagghataṁ atulaṁ dullabha dassanaṁ.*" If this verse was translated to Burmese, the words mean that *Ratana* (gems) are that things which can cause please of mind, is valuable, incomparable and hard to find (Sn.A.i.272,1959). Buddha had preached in *Santara vagga* of *Aṅguttara Nikaya* that there are two types of Gems in this world; mundane gems and supramundane ones. Mundane gem relates to physical properties while the latter is concerned with pleasant *Dhamma* (A.i.93, 2005). *Buddha* had also preached that among these two types, the supramundane type is superior to the other and is the three Gems, *Buddha, Dhamma* and *Saṁgha* (Sn.302,1961). All gems have their own attributes each and nine for *Buddha*, six for *Dhamma* and nine for *Saṁgha* respectively.

Nine Attributes of *Buddha*

Arahaṁ-	the Worthy One to be worshipped by humans, spirits and Brahmas.
Sammā sambuddho-	the Fully-self-enlightened One who knows all *Dhammas.*
Vijjā Caraṇa Sampanno-	the Wisdom-practice-endowed One.
Sugato -	the Well-goer (or the Well-speaker) .
Loka Vidū -	the three types of World-knower.
Anuttaro Purisa Damma Sārathi-	the Peerless Man-tamer who tamed to those were worthy to be tamed.
Satthā Deva Manussānaṃ -	the Teacher of Deities-and-Humans .
Buddho -	the Awakened (or Enlightened) One who had insight on four ultimate truths.
Bhagavā -	the Blessed One who have six kinds of attributes.

Six Attributes of *Dhamma*

Svakkhāta -	*Dhamma* (is) well-expounded by the Blessed One at the beginning, middle and the end. (*Svākkhāto=su+ākkhāto* = well declared, well expounded).
Saṃdiṭṭhika (*Saṃ-diṭṭhi-ika*)-	Self-experience-worthy for those who practice *Dhamma* without waiting for next life.
Akālika (a-kāla-ika)-	In-no-time-beneficial (*kāla*=time) for those who practice Dhamma (no need to wait for the time of benefits and immediate result).
Ehipassika (ehi-pass-ika)-	Come-see-worthy to be tested for the results for those who practice *Dhamma* (worthy of "come and see") (*ehi*=come).

Opaneyyika(upa-neyya-ika)-	Carrying-along-with-worthy in mind for every (*neyya*=to be carried).
Paccattaṃ veditabbo viññūhī -	Worthy of being known by the wise individually. (*Paccattaṃ*=separately,individually; *veditabbo*=being known; *viññū*=a wise man).

Nine Attributes of *Saṁgha*

Suppaṭipanna -	Well-practicing (is) the Buddha's disciple-order. [The Buddha's disciples are practicing well in terms of *Sīla* (morality), *Samādhi* (concentration) and *Paññā* (wisdom).]
Ujuppaṭipanna -	Straight-practicing of three practices (is) the Buddha's disciple-order.
Ñāyappaṭipanna -	*Ñāya*-practicing (is) the Buddha's disciple-order. ["*Ñāya*" literally means what to be realized. It refers to *nibbana*. So, the whole sentence means: "the Buddha's disciples are practicing for the attainment of *nibbana*."]
Sāmīcippaṭipanna -	Respectably Practicing (is) the Buddha's disciple-order. [They are practicing to be worthy of respect]
Āhuneyya -	*Āhuna*-worthy.["*Āhuna*" is a gift brought from far away]
Pāhuneyya -	*Pāhuna*-worthy. *["Pāhuna*" is a gift prepared for an honorable guest]
Dakkhiṇeyya -	*Dakkhiṇa*-worthy. ["*Dakkhiṇa*" is the gift donated to a holy person for the sake of one's dead beloved.]
Añjalikaraṇīya -	*Añjalikaraṇa*-worthy. *["Añjalikaraṇa*" is the respectful hand-gesture. It is to put two hands face to face on one's forehead or chest.]
Anuttaraṁ puññakkhettaṁ lokassa-	The unsurpassable best merit-field on earth to do wholesome things .(A.i.223,1959).

Types of *Saraṇagamana*

In *Adhikara vagga* of *Aṅguttara Nikaya*, Buddha had preached that there were two types of *Saraṇagamana*; mundane and supramundane ones. The former is one in which worldly people adhere to three Gems with strong faith while the latter is related to the taking of refuge on three Gems by the noble persons such as stream-enterers and once-returners etc(A.A.ii.17,1958).

Loki Saraṇagamana (mundane type) is the direct concentration on the attributes of Buddha, *Dhamma* and *Saṁgha* through removing the causal factors of fading *Saraṇagamana* in order to make *Saraṇagamana* genuine. *Lokuttara Saraṇagamana*

(supramundane type) is the genuine one because it is the state of noble persons who see and know the ultimate truths.

There are some factors that can cause fading of *Saraṇagaman*a although there is taking refuges to three Gems and are as follow;

(1) Not knowing the attributes of three Gems.
(2) Being doubtful on three Gems.
(3) Wrong perception on the attributes of three Gems as not real attributes (Sar.ṭ.i.421,1960).

There are two conditions that can ruin the taking of *Saraṇagamana* although it has been taken and are as follow;

(1) The breakage of *saraṇagamana* with sin.
(2) The breakage of *saraṇagamana* without sin.

The first condition means

(a) the worshipping of other people and religions rather than three Gems.
(b) the taking this person or religion as his teacher and rely.
(c) the adhering and becoming pupils of this person.
(d) the thinking to make paying homage to other people and religions since that day.

The second condition means the disappearance and breakage of *Saraṇagamana* when there is death of a person who adhered three Gems(D.A.i.209,1956).

Type of paying homage worthy to be said as *Saraṇagamana* or not

When a person pays homage to three Gems for taking refuge them, *Saraṇagamana* might be accomplished only if he pays homage to them with genuine belief and faith. Paying homage with fear, being relatives and being teacher are not worthy to be said as true *Saraṇagamana.* Therefore, if a person who had taken *Saraṇagamana* pays homage to any person as relative or teacher or being fearful not on the true belief, his taking *Saraṇagamana* had not broken down. However, if other persons from other religion or persons with wrong view are worshipped as noble and worthy to be offered one, there is breakage of *Saraṇagamana* that he had taken. Therefore, breakage of *Saraṇagamana* can occur based on the attention and attitude in which a person perceived as noble and worthy one(D.A.i.207,1956).

Benefits of *Saraṇagamanas*

Mundane *Saraṇagamana* can give benefits of prosperity in current life and existence in blissful planes in next life. In *Saraṇanisakka Sutta* of *Mahavagga Samyutta, Buddha* had preached that one can be free from existence in woeful planes and can lead to become one of the noble persons such as stream-enterer, once-returner and arahants if he had taken refuge to three Gems through strong and indestructible belief and faith (S.iii.328,1991). Mundane type of *Saraṇagamana* can lead to exist in blissful planes and there, it can enhance the benefits as follows;

(1) having long life in terms of Nat.
(2) having beautiful or handsome physical appearance in terms of Nat.
(3) being happiness and pleasure in terms of Nat.

(4) having abundant followers in terms of Nat.
(5) having influence and authority in terms of Nat.
(6) having superior visible form of Nat.
(7) having superior sound of Nat.
(8) having superior smell of Nat.
(9) having superior taste of Nat.
(10) having superior contact pleasure of Nat.

These above ten benefits were preached to King *Sakka*, king of celestial beings (Nats) by Venerable *Mogglāna* in order to know that benefits of *Saraṇagamana* can be superior to other Nats (S.ii,463,19920).

The story of Venerable *Saraṇagamaniya* can reveal that *Saraṇagamana* can lead to ten great benefits in many lives of a person. In the time of *Anomadassi Buddha*, he could not make monkhood although he wanted to because he must look after and take care his blind parents and therefore, he took *Saraṇagamana* under Venerable *Nisabha*, the chief disciple of Buddha (right side). At the time of death, his mind firmly concentrated in his *saraṇagamana* and had reborn in *Tavatimsā* Heaven. After death from this life, eighty times as King *Sakka*, seventy-five times as universal monarch, countless times as emperor are occurred till the last life of a rich man in *Savatthi* city. At the age of seven, while he took *Saraṇagamana* under an arahant, he remembered the taken *Saraṇagamana* which was from the time of hundred thousand *kappa* age and had attained *Vipassanā* insight and became *arahant*. Buddha had ordinated him and got the title of *Tisaraṇagaminiya thera* due to the result of taking *Saraṇagamana*. Therefore, the person who took *Saraṇagamana* firmly would enjoy the existence in blissful planes and eight effects can be obtained and are as follows;

(1) the worshipping of others in every life.
(2) having sharp intelligence and wisdom in every life.
(3) having favor by humans and Nats in every life.
(4) having incomparable wealth and prosperity.
(5) having golden physical appearance in every life.
(6) having admiration by others in every life.
(7) having string and long-lasting friendships.
(8) being famous and popular (AP.i.3,2010).

Discussion and Conclusion

In Myanmar society, which is composed of majority *Therevada Buddhists*, there are not only genuine *Buddhists* but also traditional ones. Although they are named as *Buddhists*, there are many types of worship in religious sense according to traditional cultures and customs. Also, there are debates on taking and breakage of *Saraṇagamana* that it is wrong if a dead person is taken to *Saraṇagamana*. In relation to animism, the worship or giving alms to Nat in order to obtain prosperity in current life cannot be assumed as breakage of *Saraṇagamana* because Buddha had preached in *Aparihaniya sutta* that there is no breakage of taking refuge to three Gems if anyone pay respect and donate to shrine of Nats in traditional way and it was one of the factors for prosperity of kingdoms and nations. Otherwise, if anyone worships Nats denying three Gems, there will be breakage of *Saraṇgamana*. A dead person cannot make *Saraṇagamana* but the remaining persons can take three Gems as refuge. If a dead person is reborn in celestial planes or hell or human realm, there will be no possible benefits of *Saraṇagamana*. However, if this person is reborn as *peta* near the place of merit, sharing of merit and enjoying the benefits of *Saraṇagamana* can be possible. It is the wrong view that a dead

person can enjoy the benefits of *Saraṇagamana* and cannot be reborn in woeful planes if he was taken to *Saraṇagamana.*

Genuine worship is very important for Buddhists and it is not enough just belief on three Gems on order to have genuine *Saraṇagamana* of them. The next need is analytical capability or wisdom. If a person is weak in wisdom and strong in belief, he might worship other persons or religions rather than three Gems and *Buddhism* in superior status or the same respect. The mutual balance in belief and wisdom can enhance the genuine worship and *Buddhists.*

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ဟုတ်စိန်၊ ဦး၊ ပါဠိ – မြန်မာအဘိဓာန်၊ ရန်ကုန်၊ ဒေးလီးဂေဇက်စာပုံနှိပ်တိုက်(ပထမအကြိမ်)၊ (၁၉၇၅)။

ကမ်းနားဂိုဏ်းဆရာတော်များ၊ အခြေခံဗုဒ္ဓဘာသာ ဒုတိယအဆင့်ရန်ကုန်၊ဝဇီရာရောင်စုံပုံနှိပ်တိုက် (၁၉၇၃)။

Preliminary Phytochemical Investigation and Antioxidant Activity in Fruit-husk of *Nypa fruticans* Wurmb. (Da-ni)

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Abstract

The present study concerned with the phytochemical investigation of fruit-husk of *Nypa fruticans* Wurmb. by test tube method. The preliminary phytochemical tests revealed the presence of steroids, terpenoids, glycosides, phenolic compounds, organic acid, saponins, carbohydrate, flavonoids and reducing sugar but cyanogenic glycosides, alkaloid, α-amino acid, tannis and starch were absent in selected sample. Moreover, the antioxidant activity of water extract and ethanol extract from the fruit-husk of *Nypa fruticans* were carried out by using the DPPH (1,1-diphenyl-2-picrylhydrazyl) free radical scavenging assay according to the spectrophotometric method. From the observation, the radical scavenging activity (IC_{50}) values were found to be 3.54 μg/mL for ethanol extract and 5.11μg/mL for water extract. Ethanol extract showed higher in antioxidant activity of fruit-husk of *Nypa fruticans* than that of water extract. Thus, the extracts of fruit-husk of *Nypa fruticans* could be used as a natural antioxidant.

***Keywords*:** antioxidant activity, phytochemical, DPPH, *Nypa fruticans* Wurmb.

Introduction

Phytochemical is a natural bioactive compound found in plants, such as vegetables, fruits, medicinal plants, flowers, leaves and roots that work with nutrients and fibers to act as a defense system against disease or more accurately, to protect against disease. Phytochemicals are divided into two groups, which are primary and secondary constituents; according to their functions in plant metabolism. Primary constituents comprise common sugars, amino acids, protein and chlorophyll while secondary constituents consist of alkaloids, terpenoids and phenolic compounds and many more such as flavonoids, tannis and so on (Krishnaiah *et al*. 2007).Antioxidants are found in certain foods and may prevent some of the damage caused by free radicals by neutralizing them. These include the antioxidant vitamins (e.g vitamins A, C, E and mineral copper, zin and selenium) and phytochemical antioxidants (e.g poly phenols and carotenoids). Antioxidants are an inhibitor of the process of oxidation, even at relatively small concentration and thus have diverse physiological role in the body. Antioxidant constituents of the plant material act as radical scavengers, and help in converting the radicals to less reactive species. A variety of free radical scavenging antioxidants is found in dietary sources like fruits, vegetables and tea, etc. Antioxidants are also widely used as ingredients in dietary supplements in the hope of maintaining health and preventing diseases such as cancer and coronary heart disease. In addition to these uses of natural antioxidants in medicine, these compounds have many industrial uses, such as preservatives in food and cosmetics and preventing the degradation of rubber and gasoline. (Bjelakovic, *et al*., 2007).

One of the most common useful palms in the mangrove forests of Southeast Asia is nipa, *Nypa fruticans* Wurmb. (family Arecacea). It is widely distributed in India, Myanmar, Thailand, Malaysia, Indonesia, Borneo, Philippines, Ryukyu Islands, New Guinea, the Solomon Islands and northern Australia. *Nypa*, known by different vernacular

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names such as Nipa Palm (Philippines), Mangrove or Nipah palm (Malaysia), “chak” and “at-ta” in Thailand, “dua la” and “duamuoc” in Vietnam, “dani” in Myanmar and “atap palm” in Singapore (Baja-Lapis *et al*. 2004).The inflorescences of flowers produce a fibrous chestnut-brown fruit and form a large spherical infructescence. There are air cavities in the seed coat and fruits are fibrous. The fruits are normally dispersed by means of water (FAO, 2001).

Nipa palm is utilized by humans for several purposes, traditionally and medicinally. The leaves have traditionally been used for roof thatching and parts are used for making umbrellas, raincoats, hats, mats, brooms, baskets, cigarette wrappers, ropes, and as a source of fuel wood. Parts of the palm like young shoots, decayed wood, and the burned roots and leaves are also used as traditional medicinal remedies for the treatment of headaches, toothaches, and herpes (Ame *et al*.2011). The petals of the flower can be brewed to make an aromatic tea. The immature fruits are white translucent and hard jelly-like. Called attap chee, they are a common ingredient in local desserts (Theerawitaya *et al*.2014). Nipa shoot biomass was also utilized as a potential adsorbent for removing and recovering heavy metal ions such as Pb^{2+} and Cu^{2+} from aqueous solution (Wan Ngah&Hanafiah 2008; Wankasi *et al*. 2006). This palm is found in Nat- Maw stream near the Taunggoke University. Hence, the objective of the present work is to investigate the preliminary phytochemicals and antioxidant activity of *Nypa fruticans* (fruit-husk).

(a) *Nypa fruticans* (b) fruit bunch

Figure 1. *Nypa fruticans* plant and its fruit bunch

Materials and Methods

Sample Collection and Preparation

The mature fruits of *Nypa fruticans* Wurmb. (Figure 1) were collected from Nat-Maw village, Taunggoke Township, Rakhine State, Myanmar in August, 2020. This sample is confirmed at Botany Department from Taunggoke University. The fresh fruits were cleaned by washing with tap water and air-dried. The dried fruit-husk samples (Figure 2) were grounded into powder using an electric blender. And then these powdered samples were kept in the sealed air-tight containers to prevent moisture changes and other contamination. It was then used without further purification or refining.

Figure 2. Fruit-husk of *Nypa fruticans*

Determination of Phytochemical Constituents

Preliminary phytochemical investigation was carried out according to the standard procedures. These are briefly described below.

Test for alkaloids

Dried powdered sample (3 g) was boiled with 50 mL of 1% hydrochloric acid for about 10 min and allowed to cool and then filtered. The filtrate was divided into four portions and tested separately with Mayer's reagent, Dragendorff's reagent, Wagner's reagent and sodium picrate solution. Observation was made to see the coloured precipitates, indicating the presence of alkaloids (Trease and Evons, 1980).

Test for α – amino acids

Dried powdered sample (3 g) was boiled with 50 mL of distilled water for 10 min and filtered. A few drops of filtrate were spotted on a filter paper using a capillary tube, allowed to dry and sprayed with ninhydrin reagent. The filter paper was dried at room temperature and then kept in an oven at 110 °C for a few minutes to see if pink or violet coloured spot appeared indicating the presence of α- amino acids (Marini-Bettolo, *et. al.*, 1981).

Test for carbohydrates

Dried powdered sample (3 g) was boiled with 50 mL of distilled water for about 20 min and filtered. 5 mL of filtrate was placed into a test tube and a few drops of 10% α-naphthol were added and shaken. The test tube was inclined at an angle of 45° and about 1 mL of concentrated sulphuric acid was slowly introduced along the inner side of the test tube to see a red ring formed between the two layers that indicate the presence of carbohydrates (Shriner, *et. al*., 1980).

Test for cyanogenic glycosides

Dried powdered sample (3 g) was mixed with 50 mL of distilled water in boiling tube. Then about 5 drops of concentrated sulphuric acid was added and sodium picrate paper was trapped in the neck of the test tube by means of a cork. The resulting mixture was heated by using a spirit burner. Observation was made to see if the paper turned brick red which indicated the presence of cyanogenic glycosides (Trease and Evans, 1980).

Test for flavonoids

Dried powdered sample (3 g) was socked in 50 mL of ethanol for about 6 h and filtered. A piece of magnesium turning and a few drops of concentrated hydrochloric acid were added into 5 mLof ethanol extract to see if pink colour appeared, indicating the presence of flavonoids (Robinson, 1983).

Test for glycosides

About 3 g of powdered sample was soaked in 50 mL of ethanol for 6 hours and filtered. 5 mL of filtrate were taken and treated with a few drops of 10 % lead acetate solution. If white precipitate were formed, it was noticed as the presence of glycosides (Marini-Bettolo, *et. al.*, 1981).

Test for organic acids

Dried powdered sample (3 g) was boiled with 50 mL of distilled water for about 10 min and filtered. 5 mL of filtrate was placed into a test tube and a few drops of bromocresol green indicator solution to see deep-blue colouration appeared which indicated the presence of organic acid (Robinson, 1983).

Test for phenolic compounds

Dried powdered sample (3 g) was soaked in 50 mL of ethanol for 10 minutes and filtered. 5 mL of filtrate were taken and treated with a few drops of freshly prepared 10 % ferric chloride solution. The change of deep blue colour of solution indicated the presence of phenolic compounds (Marini-Bettolo, *et. al*., 1981).

Test for reducing sugar

About 3 g of powdered sample was boiled with 50 mL of distilled water for about 10 min and filtered. The resultant solution was boiled with Benedict's reagent for two minutes to see the formation of green colour, on cooling down the solution indicating the presence of reducing sugar (Tin Wa, 1972).

Test for saponins

Dried powdered sample (3 g) was put into the conical flask followed by the addition of distilled water and the mixture was vigorously shaken for a few minutes. Observation was made to see producing of permanent frothing (Tin Wa, 1972).

Test for starch

Dried powdered sample (3 g) was boiled with 50 mL of distilled water for about 10 min and filtered. 5 mL of filtrate were taken and treated with a few drops of iodine solution to see appearing if blue colouration which indicated the presence of starch (Robinson, 1983).

Test for steroids

Dried powdered sample (3 g) was soaked in 50 mL of petroleum ether (60-80 °C) for about 6 h and filtered. 3 drops of acetic anhydride and 1 drop of concentrated sulphuric acid were added to 5 mL of petroleum ether extract and recorded the observed colour. If the colour changed to blue or greenish blue or green, the steroids were present (Tin Wa, 1972).

Test for tannins

Dried powdered sample (3 g) was boiled with 50 mL of distilled water for about 10 min and filtered. 5 mL of water extract were taken and treated with a few drops of gelatin and 2 % NaCl. Observation was made to see white precipitates were formed; then the presence of tannins (Tin Wa, 1972).

Test for terpenoids

Dried powdered sample (3 g) was soaked in 50 mL of chloroform for about 6 h and filtered. 3 drops of acetic anhydride and one drop of concentrated sulphuric acid were added to 5 mL of chloroform extract and recorded the observed colour. Red or pink colouration indicated the presence of terpenoids (Tin Wa, 1972).

Preparation of Aqueous and Ethanolic Extracts

30 g of the dried powdered sample was separately percolated with 300 mL of 95 % ethanol in sterile reagent bottle and allowed to stand for one week and filtered. This procedure was repeated for three times. The combined filtrates were concentrated by evaporation using a glass beaker in a water bath to get soluble extract. In addition, aqueous extracts of samples were prepared by boiling 30 g of sample with 100 mL of distilled water for six hours and filtered. It was repeated three times and the filtrates were combined followed by removal of the water to give aqueous extract. Each extract was dried at desiccator under vacuum and stored in refrigerator for the screening of antioxidant activity.

Antioxidant activity (DPPH free radical scavenging assay)

The antioxidant activity of the fruit-husk extracts was evaluated using the DPPH(1,1-diphenyl-2-picrylhydrazyl) free radical scavenging assay. In this experiment, the antioxidant activity was studied on 95 % ethanol extract and aqueous extract from selected samples**.**

DPPH radical scavenging activity was determined by UV spectrophotometric method. In brief, 60 µM solution of DPPH in ethanol was prepared. And then, the sample solution of two extracts in ethanol was prepared at different concentration by using serial dilution method. The control solution was prepared by mixing 1.5 mL of 60 µM DPPH solution and 1.5 mL of 95 % ethanol . The sample solution was also prepared by mixing thoroughly 1.5 mL of 60 µM DPPH solution and 1.5 mL of test sample solution. The mixture solutions were shaken vigorously and allowed to stand at room temperature for 30 minutes. After 30 minutes, the absorbance of these solutions was measured at 517 nm by using UV-1800 spectrophotometer in the Chemistry Department, Taunggoke University. Reference standard compound being used was ascorbic acid and experiment was done in triplicate. Absorbance measurement values for each solution so obtained were used to calculate percent inhibition of oxidation by the following equation and then IC_{50} (50 % inhibitory concentration) value were also calculated by linear regressive excel program.

Percent Inhibition (IC_{50}) = [($A_{control} - A_{sample}$) / $A_{control}$] x 100

Results and Discussion

Preliminary Phytochemical Investigation of *Nypa fruticans* fruit-husk extract by Test Tube Method

Preliminary phytochemical analysis was performed in order to know different types of chemical constituents present in the fruit-husk of *Nypa fruticans*. The results of phytochemical screening are shown in Table 1.

In this investigation, steroids, terpenoids, glycosides, phenolic compounds, organic acids, saponins, carbohydrates, flavonoids and reducing sugar were found to be present in

the fruit-husk of *Nypa fruticans*. However, cyanogenic glycoside, alkaloids, α-amino acid, tannis and starch were not observed according to the standard procedure. On the basis of phytochemical analysis, many bioactive compounds present in the fruit-husk and may recover the disorder of diseases.

Table .1 Results of Phytochemical Investigation on *Nypa fruticans* fruit-husk

Sr. No.	Tests	Extract	Test Reagent	Observation	Remark
1.	Alkaloids	1% HCl	Mayer's reagent Wagner' reagnt Dragendorff's reagent Sodium picrate	No White ppt No Reddish-brown ppt No Orange ppt No Yellow ppt	_ _ _ _
2.	α-amino acids	H_2O	Ninhydrin reagent	No Violet spot	_
3.	Carbohydrate	H_2O	10% α-naphthol & conc:H_2SO_4	Red ring	+
4.	Cyanogenic glycosides	H_2O	Sodium picrate paper	No brick red	_
5.	Flavonoids	EtOH	Mg turning &conc: HCl	Pink colour	+
6.	Glycosides	EtOH	10% lead acetate	White ppt	+
7.	Organic acid	H_2O	Bromocresol green	Blue colour	+
8.	Phenolic compounds	EtOH	10 % $FeCl_3$	Dark-green colour	+
9.	Reducing sugar	H_2O	Benedict's reagent	Green colour	+
10.	Saponins	H_2O	Distilled water	Frothing	+
11.	Starch	H_2O	Iodine solution	No blue colour	_
12.	Steroids	PE	Acetic anhydride & conc: H_2SO_4	Greenish blue colour	+
13.	Tannins	H_2O	1 % Gelatin & 2 % NaCl	No white ppt	_
14.	Terpenoids	$CHCl_3$	Acetic anhydride& conc:H_2SO_4	Pink colour	+

(+) presence, (-) absence

Antioxidant Activity in the fruit-husk of *Nypa fruticans* by DPPH free radical scavenging assay method

Antioxidant activity of fruit-husk of *Nypa fruticans* was studied by using DPPH free radical scavenging assay method. Table (2) showed % Inhibition of different extracts of *Nypa fruticans* fruit-husk. IC_{50} values were obtained 4.99, 3.54 and 5.11 (µg /mL) for standard ascorbic acid, ethanol extract and water extract respectively. Since the lower IC_{50} showed the higher the free radical scavenging activity. The ethanolic extract of fruit-husk of *Nypa fruticans* Wurmb. was found to be more effective than water extract in free radical scavenging activity. So, it can be clearly seen that the antioxidant activity of ethanolic extract was better than that of the standard ascorbic acid value. Moreover, IC_{50} value of water extract was nearly equal to the standard ascorbic acid as shown in figure 3.

Table.2. % Inhibition of Different Extracts of *Nypa fruticans* Fruit-husk Compared with Standard Ascorbic Acid

Extracts	% Inhibition in different concentrations (µg/mL)					IC_{50} (µg/mL)
	3.125	6.25	12.5	25	50	
EtOH	49.81	51.33	54.71	64.57	73.97	3.54
Water	49.20	50.46	53.08	55.59	60.39	5.11
Ascorbic Acid	40.25	56.53	65.12	78.44	90.54	4.99

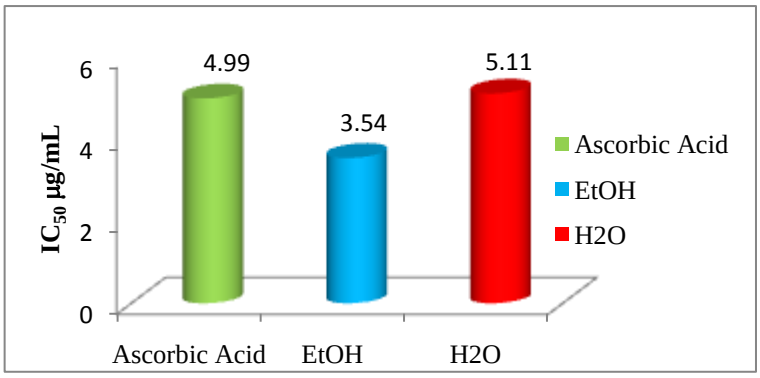

Figure 3. IC_{50} values of ethanol and aqueous extracts of *Nypa fruticans* fruit-husk compared with standard ascorbic acid

Conclusion

In this research, there were fourteen chemical tests carried out to investigate preliminary phytochemicals in fruit-husk of *Nypa fruticans*. Among them, nine phytochemicals were recorded but five phytochemicals such as alkaloids, cyanogenic glycoside, α-amino acid tannis and starch were not observed. In the presence of phytochemical compounds, the phenolic compounds could be used as an important indicator of antioxidant activity. So, it can be recommended that extracts of water and ethanol from fruit-husk of *Nypa fruticans* have a larger quantity of antioxidant activity which can stop the oxidation reaction. In conclusion, the present research work gave some information of antioxidant activity for human health and support the local indigenous medicine.

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Cayley Graphs for Some Symmetric Groups and their Alternating Groups

Thant Zin Oo [Ä]

Abstract

In this paper, the basic concepts of functions and groups are introduced. Then symmetric groups on a finite set and their alternating groups are discussed with theorems and examples. Finally, Cayley graphs for some symmetric groups and their alternating groups are also studied.

Key words: Groups, Symmetric groups, Alternating groups, Cayley graphs.

Introduction

There has been a strong relationship between group and graph theories for more than a century. One such family of graphs is constructed using groups. These graphs are called Cayley graphs. The Cayley graph is an important role to construct the symmetry of graph. In Mathematics, a Cayley graph (also known as a Cayley colour graph, Cayley diagram, group diagram, or colour graph) is a graph that encodes the abstract structure of a group. Cayley's Theorem describes the relation between groups and symmetric groups. Now, Cayley graphs for some symmetric groups and their alternating groups are studied.

1. Basic Concepts of Functions

1.1 Definitions. If X and Y are nonempty sets, a ***function***, or ***mapping*** from X into Y is a rule $f : X \to Y$ that associates with each element in X a uniquely determined element in Y. If $x \in X$, the uniquely determined element in Y that f associates to x is denoted by f(x) and is called the ***image*** of x; in this case we write $x \mapsto f(x)$ and say that x maps to f(x) under f. The set X is called the ***domain*** of f, while the set of images of elements in Y is called the **image of f** and is denoted by Imf. Thus, $\text{Im}f = \{f(x) \in Y \mid x \in X\}$.

1.2 Definitions. The mapping $f : X \to Y$ is ***onto*** or ***surjective*** if every $y \in Y$ is the image under f of some $x \in X$; that is, if and only if, given $y \in Y$, there exists an $x \in X$ such that $y = f(x)$.

A mapping $f : X \to Y$ is said to be ***one-to-one*** (written ***1-1***) or ***injective*** if for $x_1 \neq x_2$ in X, $f(x_1) \neq f(x_2)$ in Y. Equivalently, f is 1-1 if $f(x_1) = f(x_2)$ implies that $x_1 = x_2$.

A mapping $f : X \to Y$ is said to be a ***1-1 correspondence*** or ***bijective*** if f is both 1-1 and onto.

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If $g : X \to Z$ and $f : Z \to Y$, then the ***composition*** (or ***multiplication***), denoted by $f \circ g$, is the mapping $f \circ g : X \to Y$ defined by $(f \circ g)(x) = f(g(x))$ for every $x \in X$.

1.3 Definition. Let X be a nonempty set. A ***binary operation*** on X is a function from the Cartesian product $X \times X$ into X. That is, it is a rule that associates to each ordered pair (a, b) of elements in $X \times X$ a well-defined element $a * b$ in X.

1.4 Examples.(i) Let Q be the set of rational numbers. Usual addition, subtraction, and multiplication of fractions are binary operations on Q.

(ii) Let X be a nonempty set and let F(X) be the set of all functions from X into X. Function composition is a binary operation on F(X); for, if f, $g \in F(X)$, the composition $f \circ g$ is defined by setting $(f \circ g)(x) = f(g(x))$ for every element $x \in X$ and hence is a well-defined element in F(X). Thus the formula $f * g = f \circ g$ defines a binary operation on F(X).

(iii) Let X be any set and let P(X) be the set of all subsets of X. Union and intersection are binary operations on P(X); for, if A, $B \in P(X)$, both $A \cup B$ and $A \cap B$ are well-defined subsets of X. Thus, union and intersection are binary operations on P(X).

2. Basic Concepts of Groups

2.1 Definitions. A nonempty set of elements G is said to form a ***group*** if in G there is defined a binary operation, denoted by $*$ such that

(i) $a, b \in G$ implies that $a * b \in G$.
(We describe this by saying that G is closed under $*$.)

(ii) Given $a, b, c \in G$, then $a * (b * c) = (a * b) * c$.
(This is described by saying that the associative law holds in G.)

(iii) There exists a special element $e \in G$ such that $a * e = e * a = a$ for all $a \in G$.
(e is called the identity or unit element of G.)

(iv) For every $a \in G$ there exists an element $b \in G$ such that $a * b = b * a = e$.
(We write this element b as a and call it the inverse of a in G.)

A group G is said to be ***abelian*** (or ***commutative***) if $a * b = b * a$ for all a, $b \in G$.

A group G is said to be a ***finite group*** if it has a finite number of elements. The number of elements in G is called the ***order*** of G and is denoted by |G|.

2.2 Example. Let Q be the set of all rational numbers and let the operation $*$ on Q be the ordinary addition of rational numbers. Therefore, Q is a group under $*$. Note that $Z \subset Q$ and both Z and Q are groups under the same operation $*$.

2.3 Definition. Let G be a group. A ***subgroup*** H of G is a nonempty subset of G and it inherits the binary operation on G and form a group under this operation. We indicate that H is a subgroup of G by writing $H \leq G$.

2.4 Theorem. Let H be a nonempty subset of a group G. Then H is a subgroup of G if and only if the following two conditions are satisfied: (i) H is closed under multiplication; that is, if $x, y \in H$, then $xy \in H$. (ii) H is closed under inverse; that is, if $x \in H$, then $x^{-1} \in H$.

Proof: See[7].

2.5 Example. (i) Let n be an integer and let $nZ = \{nk \in Z \mid k \in Z\}$ be the set of integer multiples of n. Then nZ is a subgroup of the additive group Z of integers and that every subgroup has this form for some n.

(ii) Let G be any group. Then both of the subsets {e} and G are closed under multiplication and inverse, and both are therefore subgroup of G. We call there the trivial subgroups of G.

2.6 Definition. Let $(G, *_1)$ and $(H, *_2)$ be groups. A map $f : G \rightarrow H$ such that $f(x *_1 y)=f(x) *_2 f(y)$, for all $x, y \in G$ is called a ***homomorphism***. The map $f : G \rightarrow H$ is called an ***isomorphism*** and G and H are said to be ***isomorphic***, written $G \cong H$, if f is a homomorphism $[f(x *_1 y)=f(x) *_2 f(y)]$and f is a bijection.

2.7 Definitions. Let X be any nonempty set and let S_x be the set of all bijections from X to itself. The set S_x is a group under function composition. This group is called the ***symmetric group*** on the set X.

In the special case, when $X =\{1, 2, 3,..., n\}$, the symmetric group of degree n is also denoted by S_n. The elements of S_n are called ***permutations***. Subgroups of symmetric groups are called ***permutation groups***.

2.8 Theorem. Let S_n be a symmetric group of degree n, then $|S_n| = n!$.

Proof. See [5].

2.9 Theorem (Cayley's Theorem). If G is a finite group of order n, then G is isomorphic to a subgroup of S_n.

A finite group can be represented as a group of permutation.

2.10 Definitions. Let $\sigma \in S_n$ ***even*** (or an ***even permutation***)

$$\text{if} \left(\frac{2\sigma-1\sigma}{2-1} \frac{3\sigma-1\sigma}{3-1} \frac{3\sigma-2\sigma}{3-2} \ldots \frac{n\sigma-1\sigma}{n-1} \frac{n\sigma-2\sigma}{n-2} \ldots \frac{n\sigma-(n-1)\sigma}{n-(n-1)} \right) = 1.$$

On the other hand, we call $\sigma \in S_n$ ***odd*** (or an ***odd permutation***)

$$\text{if} \left(\frac{2\sigma-1\sigma}{2-1} \frac{3\sigma-1\sigma}{3-1} \frac{3\sigma-2\sigma}{3-2} \ldots \frac{n\sigma-1\sigma}{n-1} \frac{n\sigma-2\sigma}{n-2} \ldots \frac{n\sigma-(n-1)\sigma}{n-(n-1)} \right) = -1.$$

The definition of even or odd is written more briefly as

$$\sigma \text{ is even} \quad \text{if} \quad \prod_{i<k} \frac{k\sigma - i\sigma}{k - i} = 1,$$

$$\sigma \text{ is odd} \quad \text{if} \quad \prod_{i<k} \frac{k\sigma - i\sigma}{k - i} = -1.$$

We shall be an element in S_n is either even or odd, i.e. $\prod_{i<k} \frac{k\sigma - i\sigma}{k - i} = \pm 1.$

There is an easy way of determining whether a permutation is even or odd. If we are given a row of integers, we call the number of integers in the row smaller than the first integer, the number of inversions in the row 7, 4, 3, 2, 1, 6, 8 is 5.

2.11 Example. We can verify σ is even or odd if $\sigma = \begin{pmatrix} 1 & 2 & 3 & 4 \\ 2 & 1 & 4 & 3 \end{pmatrix}$.

Number of inversion in 2 1 4 3 = 1

1 4 3 = 0

4 3 = 1

Total number of inversion = 2

Hence σ is even.

2.12 Definition. The set of all even permutations in S_n is called the ***alternating group*** A_n. It is called the alternating group of degree n.

2.13 Theorem. Let A_n be the set of even permutations in S_n. Then A_n is a subgroup of S_n and has order $\frac{1}{2}n!$.

Proof. See [5].

3. Cycle Decompositions and Transposition Decompositions

3.1 Definitions. Let σ be a permutation in S_n. For each number i in the set {1, 2, 3,..., n}, the ***σ-orbit*** of i is the set $\mathcal{O}_\sigma(i) = \{i , \sigma(i), \sigma^2(i), ...\}$ of images of i under σ .The set $\mathcal{O}_\sigma(1)$, $\mathcal{O}_\sigma(2)$, $\mathcal{O}_\sigma(3)$, ... are called the ***orbits*** of σ.

3.2 Example. If $\sigma = \begin{pmatrix} 1 & 2 & 3 & 4 & 5 \\ 4 & 5 & 1 & 3 & 2 \end{pmatrix}$, then the orbits of σ are

$\mathcal{O}_\sigma(1) = \{1, 4, 3\} = \mathcal{O}_\sigma(4) = \mathcal{O}_\sigma(3)$ and $\mathcal{O}_\sigma(2) = \{2, 5\} = \mathcal{O}_\sigma(5)$.

3.3 Definitions. A ***cycle*** is a string of integers which represents the element of S_n which cyclically permutes these integers (and fixes all other integers).

The cycle $(a_1\ a_2\ ....\ a_m)$ is the permutation which sends a_i to a_{i+1}, $1 \le i \le m\text{-}1$ and sends a_m to a_1.

In general, for each $\sigma \in S_n$ the numbers from 1 to n will be rearranged and grouped into k cycles of the form $\left(a_1 a_2 ... a_m\right)\left(a_{m_1}+1\ a_{m_1}+2 ... a_{m_2}\right)...\left(a_{m_{k-1}}+1\ \ a_{m_{k-1}}+2 ... a_{m_k}\right)$.

We can represent this description of σ by

$$a_1 \to a_2 \to ... a_m \to a_1$$
$$a_{m_1}+1 \to a_{m_1}+2 \to ... a_{m_2} \to a_{m_1}+1$$

$$\vdots$$

$$a_{m_{k-1}}+1 \to a_{m_{k-1}}+2 \to ... a_{m_k} \to a_{m_{k-1}}+1.$$

3.4 Definitions. The ***length of a cycle*** is the number of integers which appear in it. A cycle of length t is called a ***t-cycle***.

Two cycles are disjoint if they have numbers in common. Finally, two cycles are said to be disjoint if their nontrivial orbits have no elements in common; for example, (1 2) and (3 4) are disjoint cycles of length 2 in S_4.

The product of all the cycles is called the ***cycle decomposition*** of a permutation.

3.5 Theorem. Every $\sigma \in S_n$ can be expressed as a product of disjoint cycles.

Proof. See [7].

3.6 Definition. Let $\sigma \in S_n$, $\sigma \neq e$ and let $\sigma = \sigma_1 ... \sigma_s$ be the cycle decomposition of σ. The ***cycle structure*** of σ is then defined to be the n-tuple $(c_1, c_2, ..., c_n)$ where c_s is the number of s-cycles in the cycle decomposition of σ for s = 1, 2, ..., n.

3.7 Example. The cycle structure of the permutation $\begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 \\ 4 & 5 & 6 & 1 & 2 & 3 \end{pmatrix}$ = (1 4)(2 5) (3 6) is (0, 3, 0, 0, 0, 0) while the cycle structure of $\begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ 2 & 1 & 3 & 6 & 4 & 5 & 7 \end{pmatrix}$ is (2, 1, 1, 0, 0, 0, 0). The cycle structure of the identity permutation in S_n is (n, 0, 0,..., 0).

3.8 Definition. An element $\sigma \in S_n$ is called a ***transposition*** if there exist two symbols i and j such that $\sigma(i) = j$, $\sigma(j) = i$, $\sigma(k) = k$, $k \neq i, j$, we use the notation (i j) to denote such a transposition.

3.9 Theorem. If $n \geq 2$, every permutation in S_n may be written as a product of transpositions.

Proof. See [7].

We refer to the factorization of a permutation into a product of transpositions as the transposition decomposition of the permutation. For example, (1 4 3 2)=(1 2)(1 3)(1 4) and (1 4 3 2) = (2 1 4 3) = (2 3)(2 4)(2 1) or (1 4 3 2) = (1 2)(1 3)(1 4)(1 2)(1 2).

We now have to methods for factoring a permutation: the cycle decomposition, which factors the permutation into a product of disjoint cycles that are uniquely determined, and the transposition decomposition, which factors the permutation into a product of transpositions that are not unique. The number of transposition occurring in a transposition decomposition is not uniquely determined.

4. Cayley Graphs of Some Symmetric Groups

4.1 Definitions. A ***graph*** (or ***undirected graph***) G(V, E) consists of a set V of ***vertices*** (or ***nodes***) and a set E of ***edges*** (or ***arcs***) such that each edge $e \in E$ is associated with an unordered pair of vertices. If there is a unique edge e associated with the vertices v and w, we write $e = (v,w)$ or $e = (w,v)$. In this context, (v,w) denotes an edge between v and w in an undirected graph and not an ordered pair.

A ***directed graph*** (or ***digraph***) G consists of a set V of vertices (or nodes) and a set E of edges (or arcs) such that each $e \in E$ is associated with an ordered pair (v,w) of vertices, we write $e = (v,w)$, which denotes an edge from v to w.

Let v_0 and v_n be vertices in a graph. A ***path*** from v_0 and v_n of length n is an alternating sequence of n+1 vertices and n edges beginning with vertex v_0 and ending with vertex v_n, $(v_0, e_1, v_1, e_2, v_2, ..., v_{n-1}, e_n, v_n)$, in which edge e_i is incident on vertices v_{i-1} and v_i for i = 1, 2, …,n. A graph G is ***connected*** if given any vertices v and w in G, there is a path from v to w.

4.2 Definition. A subset S of a group G is said to be a ***generating set*** for G if all elements of G can be expressed as the finite product of elements in S and their inverses.

4.3 Definition. Suppose that G is a group and let S be a subset of G such that $e \notin S = S^{-1}$ .Then the ***Cayley graph*** Cay(G, S) is defined to the graph with vertices set G and edge set $\{\{g, sg\} : g \in G, s \in S\}$.

4.4 Example. The element of symmetric group S_1 on X = {1} is $e = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$.

Then, the multiplication table for S_1 is

	e
e	e

According to this table, S_1 is a group and $|S_1|$ is 1! .

Therefore, the Cayley graph for S_1 is a point.

There are two elements in S_2: $e = \begin{pmatrix} 1 & 2 \\ 1 & 2 \end{pmatrix}$ and $\beta = \begin{pmatrix} 1 & 2 \\ 2 & 1 \end{pmatrix}$.

The multiplication table for S_2 is

	e	β
e	e	β
β	β	e

Since $e \circ \beta = \beta \circ e = \beta$, S_2 is an abelian group of order 2.

The Cayley graph for S_2 with generator β is

4.5 Example. The elements of the symmetric group S_3 on X = {1, 2, 3} are

$$e=\begin{pmatrix}1&2&3\\1&2&3\end{pmatrix},\sigma_1=\begin{pmatrix}1&2&3\\2&3&1\end{pmatrix},\ \sigma_2=\begin{pmatrix}1&2&3\\3&1&2\end{pmatrix}$$

$$\tau_1=\begin{pmatrix}1&2&3\\1&2&3\end{pmatrix},\tau_2=\begin{pmatrix}1&2&3\\2&3&1\end{pmatrix},\ \tau_3=\begin{pmatrix}1&2&3\\3&1&2\end{pmatrix}.$$

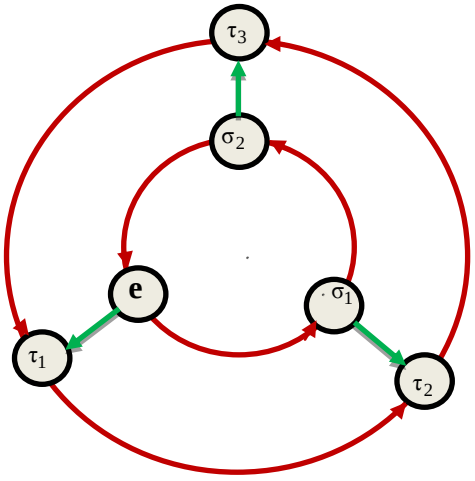
Therefore, $S_3 = \{e, \sigma_1, \sigma_2, \tau_1, \tau_2, \tau_3\}$ and the order of S_3, $|S_3|$ is 3! = 6.

The multiplication table for S_3 is

	e	σ_1	σ_2	τ_1	τ_2	τ_3
e	e	σ_1	σ_2	τ_1	τ_2	τ_3
σ_1	σ_1	σ_2	e	τ_2	τ_3	τ_1
σ_2	σ_2	e	σ_1	τ_3	τ_1	τ_2
τ_1	τ_1	τ_3	τ_2	e	σ_2	σ_1
τ_2	τ_2	τ_1	τ_3	σ_1	e	σ_2
τ_3	τ_3	τ_2	τ_1	σ_2	σ_1	e

Note that $\sigma_1 \circ \tau_1 = \tau_2$ and $\tau_1 \circ \sigma_1 = \tau_3$, so that $\sigma_1 \circ \tau_1 \neq \tau_1 \circ \sigma_1$. Therefore, S_3 is not an abelian group of order 6.

The following figure is Cayley graph for S_3 with generators σ_1 and τ_1.



4.6 Example. The elements of symmetric group S_4 on the set $X=\{1,2,3,4\}$ are

$$e=\begin{pmatrix}1&2&3&4\\1&2&3&4\end{pmatrix},\ \psi_6=\begin{pmatrix}1&2&3&4\\3&1&4&2\end{pmatrix},\ \tau_3=\begin{pmatrix}1&2&3&4\\3&2&4&1\end{pmatrix},\ \gamma_1=\begin{pmatrix}1&2&3&4\\2&1&3&4\end{pmatrix},$$

$$\psi_1=\begin{pmatrix}1&2&3&4\\2&3&4&1\end{pmatrix},\ \psi_7=\begin{pmatrix}1&2&3&4\\3&4&2&1\end{pmatrix},\ \tau_4=\begin{pmatrix}1&2&3&4\\4&2&1&3\end{pmatrix},\ \gamma_2=\begin{pmatrix}1&2&3&4\\3&2&1&4\end{pmatrix},$$

$$\psi_2=\begin{pmatrix}1&2&3&4\\3&4&1&2\end{pmatrix},\ \psi_8=\begin{pmatrix}1&2&3&4\\2&1&4&3\end{pmatrix},\ \tau_5=\begin{pmatrix}1&2&3&4\\2&4&3&1\end{pmatrix},\ \gamma_3=\begin{pmatrix}1&2&3&4\\4&2&3&1\end{pmatrix},$$

$$\psi_3=\begin{pmatrix}1&2&3&4\\4&1&2&3\end{pmatrix},\ \psi_9=\begin{pmatrix}1&2&3&4\\4&3&1&2\end{pmatrix},\ \tau_6=\begin{pmatrix}1&2&3&4\\4&1&3&2\end{pmatrix},\ \gamma_4=\begin{pmatrix}1&2&3&4\\1&3&2&4\end{pmatrix},$$

$$\psi_4=\begin{pmatrix}1&2&3&4\\2&4&1&3\end{pmatrix},\ \tau_1=\begin{pmatrix}1&2&3&4\\1&3&4&2\end{pmatrix},\ \tau_7=\begin{pmatrix}1&2&3&4\\2&3&1&4\end{pmatrix},\ \gamma_5=\begin{pmatrix}1&2&3&4\\1&4&3&2\end{pmatrix},$$

$$\psi_5=\begin{pmatrix}1&2&3&4\\4&3&2&1\end{pmatrix},\ \tau_2=\begin{pmatrix}1&2&3&4\\1&4&2&3\end{pmatrix},\ \tau_8=\begin{pmatrix}1&2&3&4\\3&1&2&4\end{pmatrix},\ \gamma_6=\begin{pmatrix}1&2&3&4\\1&2&4&3\end{pmatrix}.$$

The multiplication table for S_4 is

	e	ψ_1	ψ_2	ψ_3	ψ_4	ψ_5	ψ_6	ψ_7	ψ_8	ψ_9	τ_1	τ_2	τ_3	τ_4	τ_5	τ_6	τ_7	τ_8	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6
e	e	ψ_1	ψ_2	ψ_3	ψ_4	ψ_5	ψ_6	ψ_7	ψ_8	ψ_9	τ_1	τ_2	τ_3	τ_4	τ_5	τ_6	τ_7	τ_8	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6
ψ_1	ψ_1	ψ_2	ψ_3	e	τ_6	γ_2	τ_2	τ_4	γ_5	τ_8	ψ_7	γ_3	ψ_4	γ_1	ψ_9	γ_4	ψ_6	γ_6	τ_1	ψ_8	τ_7	τ_3	ψ_5	τ_5
ψ_2	ψ_2	ψ_3	e	ψ_1	γ_4	ψ_8	γ_3	γ_1	ψ_5	γ_6	τ_4	τ_7	τ_6	τ_1	τ_8	τ_3	τ_2	τ_5	ψ_7	γ_5	ψ_6	ψ_4	γ_2	ψ_9
ψ_3	ψ_3	e	ψ_1	ψ_2	τ_3	γ_5	τ_7	τ_1	γ_2	τ_5	γ_1	ψ_6	γ_4	ψ_7	γ_6	ψ_4	γ_3	ψ_9	τ_4	ψ_5	τ_2	τ_6	ψ_8	τ_8
ψ_4	ψ_4	τ_8	γ_3	τ_1	ψ_5	ψ_6	e	τ_6	γ_4	τ_3	γ_2	ψ_9	γ_1	ψ_1	ψ_3	γ_6	ψ_7	γ_5	τ_2	τ_5	ψ_8	ψ_2	τ_4	τ_7
ψ_5	ψ_5	γ_5	ψ_8	γ_2	ψ_6	e	ψ_4	γ_6	ψ_2	γ_1	τ_5	τ_3	τ_2	τ_8	τ_1	τ_7	τ_6	τ_4	ψ_9	ψ_3	γ_4	γ_3	ψ_1	ψ_7
ψ_6	ψ_6	τ_4	γ_4	τ_5	e	ψ_4	ψ_5	τ_7	γ_3	τ_2	ψ_3	γ_1	ψ_9	γ_5	γ_2	ψ_7	γ_6	ψ_1	τ_3	τ_1	ψ_2	ψ_8	τ_8	τ_6
ψ_7	ψ_7	τ_6	γ_6	τ_7	τ_1	γ_1	τ_4	ψ_8	ψ_9	e	γ_3	ψ_1	ψ_3	γ_4	ψ_6	γ_2	γ_5	ψ_4	ψ_2	τ_2	τ_8	τ_5	τ_3	ψ_5
ψ_8	ψ_8	γ_2	ψ_5	γ_5	γ_3	ψ_2	γ_4	ψ_9	e	ψ_7	τ_8	τ_6	τ_7	τ_5	τ_4	τ_2	τ_3	τ_1	γ_6	ψ_1	ψ_4	ψ_6	ψ_3	γ_1
ψ_9	ψ_9	τ_2	γ_1	τ_3	τ_8	γ_6	τ_5	e	ψ_7	ψ_8	ψ_4	γ_2	γ_5	ψ_6	γ_4	ψ_1	ψ_3	γ_3	ψ_5	τ_6	τ_1	τ_4	τ_7	ψ_2
τ_1	τ_1	ψ_4	τ_8	γ_3	γ_1	τ_4	ψ_7	γ_2	τ_5	ψ_3	τ_2	e	ψ_2	τ_6	τ_7	ψ_5	ψ_8	τ_3	ψ_1	ψ_6	ψ_9	γ_6	γ_4	γ_5
τ_2	τ_2	γ_1	τ_3	ψ_9	ψ_1	τ_6	γ_2	ψ_6	τ_7	γ_3	e	τ_1	τ_8	ψ_5	ψ_8	τ_4	τ_5	ψ_2	ψ_4	ψ_7	ψ_3	γ_5	γ_6	γ_4
τ_3	τ_3	ψ_9	τ_2	γ_1	γ_5	τ_7	ψ_3	ψ_4	τ_6	γ_4	ψ_5	τ_5	τ_4	e	ψ_2	τ_8	τ_1	ψ_8	ψ_6	γ_6	γ_2	ψ_1	ψ_7	γ_3
τ_4	τ_4	γ_4	τ_5	ψ_6	ψ_7	τ_1	γ_1	γ_5	τ_8	ψ_1	τ_7	ψ_2	e	τ_3	τ_2	ψ_8	ψ_5	τ_6	ψ_3	γ_3	γ_6	ψ_9	ψ_4	γ_2
τ_5	τ_5	ψ_6	τ_4	γ_4	ψ_9	τ_8	γ_6	ψ_3	τ_1	γ_2	τ_3	ψ_5	ψ_8	τ_7	τ_6	e	ψ_2	τ_2	γ_5	ψ_4	γ_1	ψ_7	γ_3	ψ_1
τ_6	τ_6	γ_6	τ_7	ψ_7	γ_2	τ_2	ψ_1	γ_4	τ_3	ψ_4	ψ_8	τ_8	τ_1	ψ_2	e	τ_5	τ_4	ψ_5	γ_3	ψ_9	γ_5	ψ_3	γ_1	ψ_6
τ_7	τ_7	ψ_7	τ_6	γ_6	ψ_3	τ_3	γ_5	γ_3	τ_2	ψ_6	ψ_2	τ_4	τ_5	ψ_8	ψ_5	τ_1	τ_8	e	γ_4	γ_1	ψ_1	γ_2	ψ_9	ψ_4
τ_8	τ_8	γ_3	τ_1	ψ_4	γ_6	τ_5	ψ_9	ψ_1	τ_4	γ_5	τ_6	ψ_8	ψ_5	τ_2	τ_3	ψ_2	e	τ_7	γ_2	γ_4	ψ_7	γ_1	ψ_6	ψ_3
γ_1	γ_1	τ_3	ψ_9	τ_2	τ_4	ψ_7	τ_1	ψ_5	γ_6	ψ_2	ψ_6	ψ_3	ψ_1	ψ_4	γ_3	γ_5	γ_2	γ_4	e	τ_7	τ_5	τ_8	τ_6	ψ_8
γ_2	γ_2	ψ_5	γ_5	ψ_8	τ_2	ψ_1	τ_6	τ_5	ψ_3	τ_1	ψ_9	ψ_4	γ_3	γ_6	ψ_7	ψ_6	γ_4	γ_1	τ_8	e	τ_3	τ_7	ψ_2	τ_4
γ_3	γ_3	τ_1	ψ_4	τ_8	ψ_2	γ_4	ψ_8	τ_2	ψ_6	τ_7	ψ_1	ψ_7	γ_6	γ_2	γ_5	γ_1	ψ_9	ψ_3	τ_6	τ_4	e	ψ_5	τ_5	τ_3
γ_4	γ_4	τ_5	ψ_6	τ_4	ψ_8	γ_3	ψ_2	τ_3	ψ_4	τ_6	γ_5	γ_6	ψ_7	ψ_3	ψ_1	ψ_9	γ_1	γ_2	τ_7	τ_8	ψ_5	e	τ_1	τ_2
γ_5	γ_5	ψ_8	γ_2	ψ_5	τ_7	ψ_3	τ_3	τ_8	ψ_1	τ_4	γ_6	γ_4	ψ_6	ψ_9	γ_1	γ_3	ψ_4	ψ_7	τ_5	ψ_2	τ_6	τ_2	e	τ_1
γ_6	γ_6	τ_7	ψ_7	τ_6	τ_5	ψ_9	τ_8	ψ_2	γ_1	ψ_5	γ_4	γ_5	γ_2	γ_3	ψ_4	ψ_3	ψ_1	ψ_6	ψ_8	τ_3	τ_4	τ_1	τ_2	e

So, S_4 is a non-abelian group of order 24 because $\psi_1 \circ \tau_1 \neq \tau_1 \circ \psi_1$.

Therefore, the multiplication tables show the group is an abelian or not.

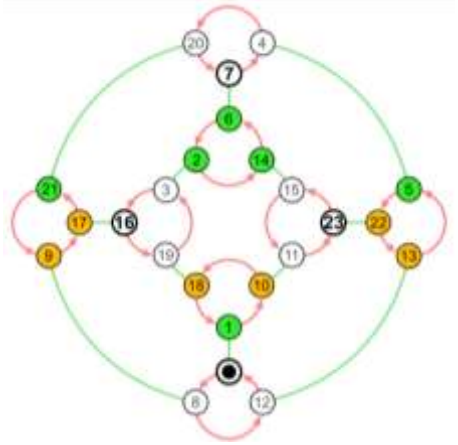
4.7 Theorem. S_n is a finite group of order n! and is non-abelian if $n > 2$.

Proof. See [5].

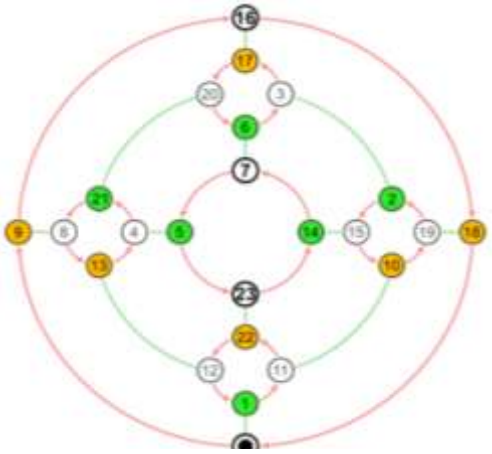
4.8 Example. The following table is representation of permutations of S_4 and following figures are some Cayley graphs for S_4:

Permutations of S_4	Represented symbols	Cycles
1 2 3 4	●	(-)
2 1 3 4	1	(1 2)
1 3 2 4	2	(2 3)
3 1 2 4	3	(1 3 2)
2 3 1 4	4	(1 2 3)
3 2 1 4	5	(1 3)
1 2 4 3	6	(3 4)
2 1 4 3	7	(1 2)(3 4)
1 4 2 3	8	(2 4 3)
4 1 2 3	9	(1 4 3 2)
2 4 1 3	10	(1 2 4 3)
4 21 3	11	(1 4 3)
1 3 4 2	12	(2 3 4)
3 1 4 2	13	(1 3 4 2)
1 4 3 2	14	(2 4)
4 1 3 2	15	(1 4 2)
3 41 2	16	(1 3)(2 4)
4 31 2	17	(1 4 2 3)
2 3 4 1	18	(1 2 3 4)
3 2 4 1	19	(1 3 4)
2 4 3 1	20	(1 2 4)
4 2 3 1	21	(1 4)
3 4 2 1	22	(1 3 2 4)
4 3 2 1	23	(1 4)(2 3)

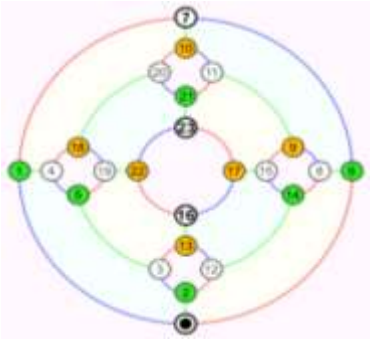
Cayley Graph for S_4 with generators 1, 8 or (1 2), (2 3 4).



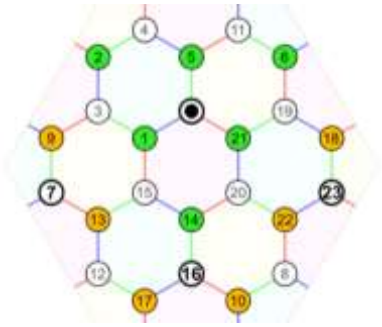
Cayley Graph for S_4 with generators 1, 9 or (1 2), (1 4 3 2).



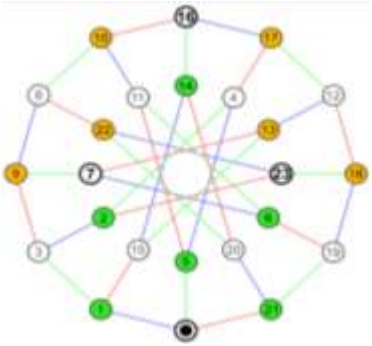
Cayley Graph for S_4 with generators 1, 2, 6 or (1 2), (2 3), (3 4).



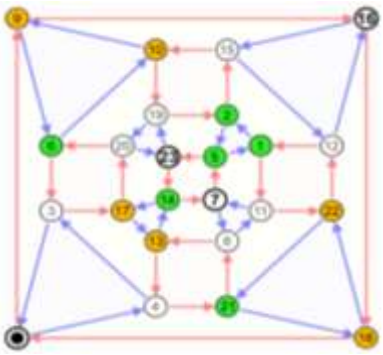
Cayley Graph for S_4 with generators 1, 5, 21 or (1 2), (1 3), (1 4).



Cayley Graph for S_4 with generators 1, 2, 6 or (1 2), (2 3), (3 4).



Cayley Graph for S_4 with generators 4, 9 or (1 3 2), (1 4 3 2).



5. Cayley Graphs of Some Alternating Groups

5.1 Example. The even permutation of S_1 on X = {1} is $e = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$.

Therefore,

	e
e	e

is a multiplication table for A_1 and $|A_1| = 1$.

Note that A_1 is the same group as S_1.

5.2 Example. There are two elements in S_2: $e = \begin{pmatrix} 1 & 2 \\ 1 & 2 \end{pmatrix}$ is an even permutation and $\beta = \begin{pmatrix} 1 & 2 \\ 2 & 1 \end{pmatrix}$ is an odd permutation. Therefore, $A_2 = \left\{ \begin{pmatrix} 1 & 2 \\ 1 & 2 \end{pmatrix} \right\}$.

The multiplication table for A_2 is

	e
e	e

Thus, Cayley graphs for A_1 and A_2 are a point.

5.3 Example. The even permutations of S_3 on X = {1, 2, 3} are

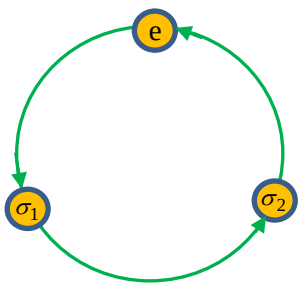
$$e = \begin{pmatrix} 1 & 2 & 3 \\ 1 & 2 & 3 \end{pmatrix}, \sigma_1 = \begin{pmatrix} 1 & 2 & 3 \\ 2 & 3 & 1 \end{pmatrix}, \sigma_2 = \begin{pmatrix} 1 & 2 & 3 \\ 3 & 1 & 2 \end{pmatrix}.$$

Then A_3 = {e, σ_1, σ_2} and the order of A_3, $|A_3|$ is $\frac{1}{2}3! = 3$.

The multiplication table for A_3 is

	e	σ_1	σ_2
e	e	σ_1	σ_2
σ_1	σ_1	σ_2	e
σ_2	σ_2	e	σ_1

The Cayley graph for A_3 with generator σ_1 is



5.4 Example. The even permutations of S_4 on the set X = {1, 2, 3, 4} are

$$e=\begin{pmatrix}1&2&3&4\\1&2&3&4\end{pmatrix},\ \tau_1=\begin{pmatrix}1&2&3&4\\1&3&4&2\end{pmatrix},\ \tau_5=\begin{pmatrix}1&2&3&4\\2&4&3&1\end{pmatrix},$$

$$\psi_2=\begin{pmatrix}1&2&3&4\\3&4&1&2\end{pmatrix},\ \tau_2=\begin{pmatrix}1&2&3&4\\1&4&2&3\end{pmatrix},\ \tau_6=\begin{pmatrix}1&2&3&4\\4&1&3&2\end{pmatrix},$$

$$\psi_5=\begin{pmatrix}1&2&3&4\\4&3&2&1\end{pmatrix},\ \tau_3=\begin{pmatrix}1&2&3&4\\3&2&4&1\end{pmatrix},\ \tau_7=\begin{pmatrix}1&2&3&4\\2&3&1&4\end{pmatrix},$$

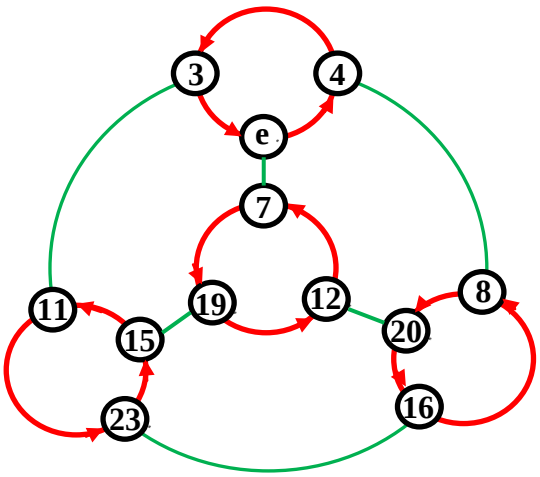
$$\psi_8=\begin{pmatrix}1&2&3&4\\2&1&4&3\end{pmatrix},\ \tau_4=\begin{pmatrix}1&2&3&4\\4&2&1&3\end{pmatrix},\ \tau_8=\begin{pmatrix}1&2&3&4\\3&1&2&4\end{pmatrix}.$$

The multiplication table for A_4 is

	e	ψ_2	ψ_5	ψ_8	τ_1	τ_2	τ_3	τ_4	τ_5	τ_6	τ_7	τ_8
e	e	ψ_2	ψ_5	ψ_8	τ_1	τ_2	τ_3	τ_4	τ_5	τ_6	τ_7	τ_8
ψ_2	ψ_2	e	ψ_8	ψ_5	τ_4	τ_7	τ_6	τ_1	τ_8	τ_3	τ_2	τ_5
ψ_5	ψ_5	ψ_8	e	ψ_2	τ_5	τ_3	τ_2	τ_8	τ_1	τ_7	τ_6	τ_4
ψ_8	ψ_8	ψ_5	ψ_2	e	τ_8	τ_6	τ_7	τ_5	τ_4	τ_2	τ_3	τ_1
τ_1	τ_1	τ_8	τ_4	τ_5	τ_2	e	ψ_2	τ_6	τ_7	ψ_5	ψ_8	τ_3
τ_2	τ_2	τ_3	τ_6	τ_7	e	τ_1	τ_8	ψ_5	ψ_8	τ_4	τ_5	ψ_2
τ_3	τ_3	τ_2	τ_7	τ_6	ψ_5	τ_5	τ_4	e	ψ_2	τ_8	τ_1	ψ_8
τ_4	τ_4	τ_5	τ_1	τ_8	τ_7	ψ_2	e	τ_3	τ_2	ψ_8	ψ_5	τ_6
τ_5	τ_5	τ_4	τ_8	τ_1	τ_3	ψ_5	ψ_8	τ_7	τ_6	e	ψ_2	τ_2
τ_6	τ_6	τ_7	τ_2	τ_3	ψ_8	τ_8	τ_1	ψ_2	e	τ_5	τ_4	ψ_5
τ_7	τ_7	τ_6	τ_3	τ_2	ψ_2	τ_4	τ_5	ψ_8	ψ_5	τ_1	τ_8	e
τ_8	τ_8	τ_1	τ_5	τ_4	τ_6	ψ_8	ψ_5	τ_2	τ_3	ψ_2	e	τ_7

So, the order of alternating group of degree 4 is $\frac{1}{2}4!=12$.

Cayley Graph for A_4 with generators 4, 7 or (1 2 3), (1 2)(3 4).



Cayley graphs of symmetric groups and alternating groups are connected graphs.

Conclusion

In this paper, Cayley graphs for some symmetric groups and their alternating groups are discussed. By using Cayley graphs, symmetry of the graphs are expressed. Moreover, Cayley graphs are very useful for geometric group theory and spectral graph theory. Interconnection networks based on Cayley graphs of permutation groups are also applications for Cayley graphs .

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Species Composition and Habitat Utilization of Avifauna in Taunggoke Environs of Rakhine State

Thandar Aung[1], Soe Myint Khine[2], Khin Win Thein[3]

Abstract

The study was conducted to know the species composition and habitat utilization of avifauna in Taunggoke environs. Two days per fortnight visit was conducted from June 2018 to February 2019. Point count method and Line transect method were used for population and habitat uses of birds species and block count method were used for estimating the crowded birds species. During the study period a total of 65 species belonging to 43 genera, 31 families under 14 orders were recorded. Among them, ten migratory bird species, 55 resident bird species were observed. Of the recorded species, *Anhinga melanogaster* (Oriental darter), *Psittacula alexandri* (Red-breasted parakeet), *Psittacula finchii* (Grey-headed parakeet) belong to the near-threatened species, while one endangered species *Haliaeetus leucoryphus* (Pallas's Fish Eagle) was identified from the area according to IUCN Redlist 2017. The study site II was recorded as the maximum number of species followed by site III, IV, V and I in the present study. The present study will fill the gap of the southern part of Rakhine State avifaunal diversity.

Keywords: species composition, habitat types, avifauna, endangered species, near-threatened species**.**

Introduction

Birds are one of the most widely distributed animal taxa, living in diverse landscapes across continents. They show a substantial variety of distribution patterns and often prefer to live in heterogeneous environments. Birds generally colonize in an area with suitable resources for their survival (Veech *et al.* 2011).

Birds are habitat specific and some can occupy more than one habitat type, because land uses changes and most of the birds have been displaced from their original habitats (Burgess *et al*., 2002).

Many birds species migrate locally or over long distances, to avoid diverse conditions or in search of food. There are a number of seasonal immigrant that breed outside the territory, mostly in the Palearctic region beyond Himalayas in central and northern Europe. The winter migrants are the ducks, geese, cranes, swallows, flycatchers and finches (Ali and Ripley, 1987).

Taunggoke experience high temperature and abundant rainfall. Taunggoke Township is made up of a variety different ecosystems and natural features including primary forest, secondary woodland, scrub lands, active agricultural land, orchard land, human habitation area, mangrove forest and tidal rivers etc. (Myanmar Environment Institute, 2017).

The objectives of the study are:

-to record the species composition of bird in study area.

-to observe their habitat uses in study area.

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Materials and Methods

Study area

Taunggoke Township situated in the western coastal region of Myanmar and administratively under Rakhine State, Thandwe District and situated between North Latitude 18˚ 38' 34.32" and between East Longitude 94˚ 22' 33.91" was chosen as the study area.

Study period

The study period lasted from June 2018 to May 2019.

Study design

Bird watching time was spent at morning 7:00 to 12:30 am and evening 3:00 to 5:30 pm. All observations were made using a pair of binoculars (magnification 8 x 42), a digital camera (Nikkon P900) and a telescope. Field observation was conducted by two days per fortnight visit during study period. Recorded birds species was identified the standard guide books by Smythies, 1953 and Robson, 2015. Five habitat types were investigated in study area namely open water, tree and shrubs, tall grass, paddy field and mangrove.

Bird census techniques

Point count method and Line transect method (Bibby *et al*., 2001) were used for the bird number estimation and related features. Block count method for estimating the crowded bird species. The maximum number of individuals of each species in all trips of study period was taken for the population abundance. All the recorded data were noted with respective data forms in field.

Fig. 1 Map of the study area. (GIS)

A. Open water

B. Trees & shrubs

C. Tall grass

D. Paddy field

Mangrove

Plate 1. Study sites

Results

During the study period, a total of 65 species belonging to 43 genera, 31 families and under 14 orders were recorded. Of the total recorded birds, ten were migratory species and the remaining 55 were resident bird species. 61 species are of the least concerned category and three species namely *Anhinga melanogaster* (Oriental darter), *Psittacula alexandri* (Red breasted parakeet), *Psittacula finchi* (Grey headed parakeet) belong to the near-threatened species, while one endangered species *Haliaeetus leucoryphus* (Pallas's Fish Eagle) were identified from the area according to IUCN Redlist 2017 (Table 1, Plate 2). The order Passeriformes was the most representative, with 33 species (51%), belonging to 18 genera and 14 families were observed while order Podicepideformes, Gruiformes, Ciconiiformes and Apodiformes were found as single species each (Table 1,2). The study site II (Tree & shrubs) n=54 were observed the highest bird species followed by site III (Tall grass) n=41, site IV (paddy field) n=30, site V (mangrove) n= 27 and site I (open water) n=27 (Table 3,4, Fig. 2). Among the recorded species 13 were water bird species and 52 species were terrestrial bird species. The peak population of individual species were found in site I (6426, 61%) followed by site II (2649, 24%), Site III (1022, 9%), Site IV (467, 4%) and Site V (282, 2%) (Table 3, 4, Fig. 3) (Plate 1).

Discussion

During the study period from June 2018 to July 2019, a total of 65 bird species belonging to 43 genera, 31families and distributed among 14 orders were recorded from the study sites.

Zaw Than Oo (2016) recorded Species composition, distribution and abundance of avian community in Myauk Oo Township of Rakhine State. Thandar Aung (2017) studied that habitat utilization and relative abundance of Avifauna in Orchard Fish farm of Maubin Township, Ayeyarwady Region. Order Passeriformes was observed in highest number in their study. It is agreed that in the present study Passeriformes is the most dominant order which including 33 species followed by Pelecaniformes 6 species, Cuculiformes and coraciiformes 4 species respectively.

Theingi Soe Myint (2018) studied that 31 species are of terrestrial and four species of water bird in Taunggoke Degree College Environs. In the present study, a total of 52 species was recorded as terrestrial birds and 13 species were water bird species found in study period. It may be assumed that Eastern three-fourths of the Taunggoke township is hilly of Rakhine Yoma. It may be the reason of rich terrestrial avifauna.

In this study tree & shrubs (Site II) was recorded as highest avifauna species because the avifauna used this habitat for their foraging ground, resting ground and nesting area. The study site I (open water) 61% were observed as highest population of individual's species because during the study period peak count of Lesser Whistling Duck was recorded in this study. It may be assumed that Ga-ru-na Dam which fresh water ecosystem provided for water bird species. In paddy field habitat, 30 species of avifauna was found. The large flocks of water birds such as egrets, herons, storks, snipes, sandpipers and lapwings are found frequently in many rice field areas around the world (Kelly *et al*., 2008). Hence, recorded bird species in this habitat was less compare other than habitat. Site V was observed as the lowest number of individual species because this mangrove area was narrow and occupying one-fifth of Taunggoke environs.


A. *Dendrocygna javanica*


B. *Tachybaptus ruficollis*


C. *Phalacrocorax niger*


D. *Anhinga melanogaster*


E. *Anastomus oscitans*


F. *Bubulcus ibis*


G. *Ardeola grayii*


H.*Gallicrex cinerea*


I. *Haliaeetus leucoryphus*


J.*Milvus migrans*


K. *Haliastur indus*


L. *Psittacula alexandri*


M. *Rhopodytes tristis*


N. *Centropus sinensis*


O. *Dicrurus leucophaeus*


P. *Oriolus chinensis*


Q. *Coracias benghalensis*


R. *Merops orientalis*


S. *Megalaima haemacepha*


T. *Dendrocitta vagabunda*


U. *Megalaima lineata*


V. *Lanius cristatus*


W. *Nectarinia asiatica*


X. *Saxicola maurus*

Plate 2. Some recorded avifauna in study area.

Table 1. Species composition of recorded avifauna in study area.

No.	Order	Family	Scientific name	Common name	Local name	CS	MS
1	Anseriformes	Dendrocygnidae	*Dendrocygna javanica*	Lesser whistling- duck	sit- sali	LC	R
2	Anseriformes	Dendrocygnidae	*Dendrocygna bicolor*	Fulvous whistling duck	sit- sali	LC	R
3	Podicipediformes	Podicipedidae	*Tachybaptus ruficollis*	Little Grebe	tan-si-hmoke	LC	R
4	Gruiformes	Rallidae	*Gallicrex cinerea*	Watercock	baung-toke	LC	R
5	Ciconiiformes	Ciconiidae	*Anastomus oscitans*	Asian openbill	hkayou-sok	LC	M
6	Suliformes	Anhingidae	*Anhinga melanogaster*	Oriental darter	u-ban	NT	R
7	Suliformes	Phalarcrocoracidae	*Phalacrocorax niger*	Little cormorant	aw-yaw	LC	R
8	Pelecaniformes	Ardeidae	*Ardeola grayii*	Indian Pond-heron	byaing-auk	LC	R
9	Pelecaniformes	Ardeidae	*Ardeola chinensis*	Chinese Pond-heron	byaing-auk	LC	R
10	Pelecaniformes	Ardeidae	*Bubulcus ibis*	Cattle egret	kywe-gyaung-byaing	LC	R
11	Pelecaniformes	Ardeidae	*Ardea alba*	Great egret	byaing-ngan	LC	R
12	Pelecaniformes	Ardeidae	*Mesophorax intermedia*	Intermediate egret	tharrawaddy byaing	LC	R
13	Pelecaniformes	Ardeidae	*Egretta garzetta*	Little egret	byaing	LC	R
14	Accipitriformes	Accipitridae	*Haliaeetus leucoryphus*	Pallas's Fish Eagle	wun-bo	EN	R
15	Accipitriformes	Accipitridae	*Milvus migrans*	Black kite	sun	LC	M
16	Accipitriformes	Accipitridae	*Haliastur indus*	Brahminy kite	sun-gaung-phyu	LC	R
17	Coloumbiformes	Coloumbidae	*Streptopelia decaocto*	Eurasian collared-dove	gyo-lin-bya	LC	R
18	Coloumbiformes	Coloumbidae	*Streptopelia chinensis*	Spotted dove	gyo-le-byauk	LC	R
19	Psittaciformes	Psittaculidae	*Psittacula alexandri*	Red-breasted parakeet	kye-kala	NT	R
20	Psittaciformes	Psittaculidae	*Psittaacula finschi*	Grey-headed parakeet	kalama kyet-tu-ywe	NT	R
21	Cuculiformes	cuculidae	*Rhopodytes tristis*	Green- billed malkoha	wapale	LC	R
22	Cuculiformes	cuculidae	*Centropus sinensis*	Greater coucal	bok	LC	R
23	Cuculiformes	cuculidae	*Centropus bengalensis*	Lesser coucal	bok	LC	R
24	Cuculiformes	cuculidae	*Eudynamys scolopaceu*	Asian koel	oak-aw	LC	R
25	Apodiformes	Apodidae	*Cypsiurus balasiensis*	Asian palm swift	mo-sa	LC	R
26	Coraciiformes	Meropidae	*Merops philippinus*	Blue-tailed bee eater	pasin-hto	LC	R
27	Coraciiformes	Meropidae	*Merops orientalis*	Little green bee eater	pasin-hto	LC	R
28	Coraciiformes	Meropidae	*Halcyon smyrnensis*	White-throated kingfisher	bein-nyin	LC	R
29	Coraciiformes	Meropidae	*Coracias benghalensis*	Indian roller	hnget-hka	LC	R
30	Piciformes	Megalaimidae	*Megalaima lineata*	Lineated barbet	hyo-gaung	LC	R
31	Piciformes	Megalaimidae	*Megalaima haemacepha*	Coppersmith barbet	hnget-padein	LC	R
32	Piciformes	Picidae	*Jynx torquilla*	Eurasian wryneck	-	LC	M
33	Passeriformes	Laniidae	*Lanius cristatus*	Brown shrike	hnget da-zat	LC	M
34	Passeriformes	Laniidae	*Lanius schach*	Long-tailed shrike	hnget da-zat	LC	R

Table 1 Continued.

No.	Order	Family	Scientific name	Common name	Local name	CS	MS
35	Passeriformes	Oriolidae	*Oriolus chinensis*	Blacked-naped oriole	hnget-shwe-wa	LC	R
36	Passeriformes	Corvidae	*Dendrocitta vagabunda*	Rufous treepie	na-hpa-gyi	LC	R
37	Passeriformes	Corvidae	*Corvus splendens*	House crow	kyi-gan	LC	R
38	Passeriformes	Corvidae	*Corvus macrorhynchos*	Large billed crow	taw kyi-gan	LC	R
39	Passeriformes	Dicruridae	*Dicrurus macrocercus*	Black drongo	lin-mi-zwe	LC	M
40	Passeriformes	Dicruridae	*Dicrurus leucophaeus*	Ashy drongo	lin-mi-zwe	LC	R
41	Passeriformes	Dicruridae	*Dicricus bottentottus*	Spangle Drongo	lin-mi-zwe	LC	R
42	Passeriformes	Dicruridae	*Dicrurus paradiseus*	Greater racket-tailed drongo	hnget-taw	LC	R
43	Passeriformes	Dicruridae	*Dicrurus remifer*	Lesser racket-tailed drongo	hnget-taw	LC	R
44	Passeriformes	Vangidae	*Tephrodornis pondicerianus*	Common woodshrike	-	LC	R
45	Passeriformes	Sturnidae	*Sturnus malabaricus*	Chestnut- tailed starling	zayet	LC	R
46	Passeriformes	Sturnidae	*Sturnus contra*	Asian pied starling	zayet	LC	R
47	Passeriformes	Sturnidae	*Acridotheres tristis*	Common myna	zayet	LC	R
48	Passeriformes	Sturnidae	*Acridotheres fuscus*	Jungle myna	zayet	LC	R
49	Passeriformes	Hirundinidae	*Hirundo rustica*	Barn swallow	pyan-hlwar	LC	M
50	Passeriformes	Hirundinidae	*Hirundo smithii*	Wire-tailed swallow	pyan-hlwar	LC	R
51	Passeriformes	Pycnonotidae	*Pycnonotus jocosus*	Red-whiskered bulbul	but-ka-lon	LC	R
52	Passeriformes	Pycnonotidae	*Pynonotus cafer*	Red-vented bulbul	but-pin-ni	LC	R
53	Passeriformes	Passeridae	*Passer domesticus*	House sparrow	sar	LC	R
54	Passeriformes	Passeridae	*Passer mantanus*	Eurasian tree sparrow	sar	LC	R
55	Passeriformes	Passeridae	*Passer flaveolus*	Plain-backed sparrow	sar-war	LC	R
56	Passeriformes	Musicapidae	*Copsychus saularis*	Oriental magpie robin	thabaike-lwal	LC	R
57	Passeriformes	Musicapidae	*Saxicola maurus*	Eastern stonechat	-	LC	M
58	Passeriformes	Musicapidae	*Saxicola caprata*	Pied bushchat	-	LC	R
59	Passeriformes	Musicapidae	*Ficedular parva*	Taiga Flycatcher	-	LC	M
60	Passeriformes	Estriididae	*Lonchura punctalata*	Scaly-breasted munia	sar-wa-di	LC	R
61	Passeriformes	Motacillidae	*Motacilla alba*	White wagtail	hmee-nyaunt	LC	M
62	Passeriformes	Motacillidae	*Motacilla flava*	Eastern yellow wagtail	hmee-nyaunt	LC	M
63	Passeriformes	Dicaeidae	*Dicaeum cruentatum*	Scarlet-backed flowerpecker	wut-yee soak hnget	LC	R
64	Passeriformes	Nectarinidae	*Nectarinia asiatica*	Purple sunbird	wut-yee soak hnget	LC	R
65	Passeriformes	Nectarinidae	*Nectarinia jugularis*	Olive-backed sunbird	wut-yee soak hnget	LC	R

CS = Conservation Status, MS = Migratory Status

Table 2 Species composition of recorded avifauna in percentages.

No.	Order	Family	Genus	Species	Percentages
1	Anseriformes	1	1	2	3%
2	Podicipediformes	1	1	1	1%
3	Gruiformes	1	1	1	1%
4	Ciconiiformes	1	5	6	9%
5	Suliformes	2	2	2	3%
6	Pelecaniformes	1	1	1	2%
7	Accipirtiformes	1	3	3	6%
8	Columbiformes	1	1	2	3%
9	Psittaciformes	1	1	2	3%
10	Cuculiformes	1	3	4	6%
11	Apodiformes	1	1	1	1%
12	Coraciiformes	3	3	4	6%
13	Piciformes	2	2	3	5%
14	Passeriformes	14	18	33	51%
	Total	31	43	65	100%

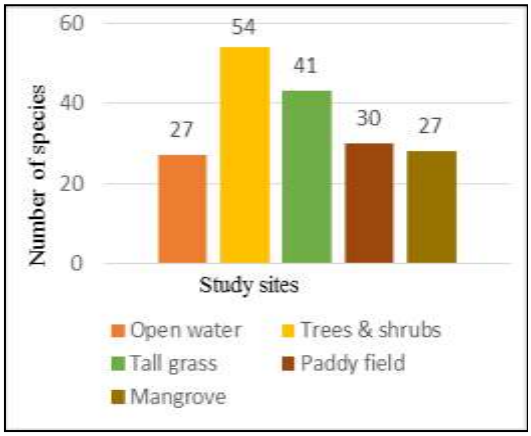

Fig.2 Habitat uses of recorded bird species.

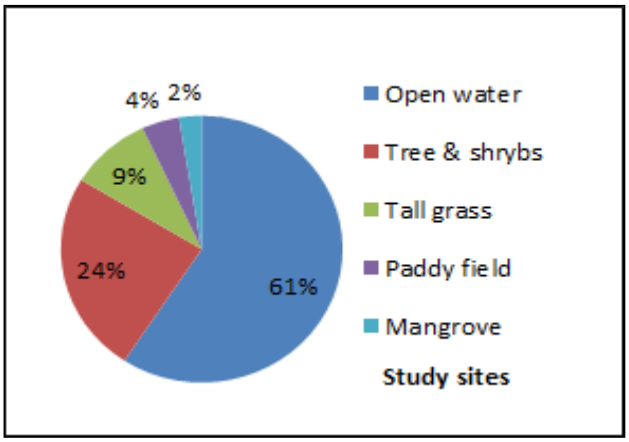

Fig.3 Habitat uses of individual bird species.

Table 3 Habitat uses of recorded bird species.

No.	Scientific name	Site I	Site II	Site III	Site IV	Site V	Total
1	*Dendrocygna javanica*	5500	1500	200	-	-	7200
2	*Dendrocygna bicolor*	500	50	50	-	-	600
3	*Tachybaptus ruficollis*	35	-	-	-	-	35
4	*Gallicrex cinerea*	-	4	12	-	-	16
5	*Anastomus oscitans*	7	3	-	-	-	10
6	*Anhinga melanogaster*	6	2	-	-	-	8
7	*Phalacrocorax niger*	22	2	5	1	-	30
8	*Ardeola grayii*	10	-	6	4	-	20
9	*Ardeola chinensis*	9	2	3	12	-	30
10	*Bubulcus ibis*	20	18	15	10	2	65
11	*Ardea alba*	25	10	23	20	5	83
12	*Mesophorax intermedia*	15	-	2	2	6	25
13	*Egretta garzetta*	35	25	10	30	5	105
14	*Haliaeetus leucoryphus*	-	-	1	-	-	1
15	*Milvus migrans*	25	10	10	30	9	84
16	*Haliastur indus*	30	-	10	20	4	64
17	*Streptopelia decaocto*	-	25	6	5	-	36
18	*Streptopelia chinensis*	-	55	80	100	35	270
19	*Psittacula alexandri*	-	35	-	18	-	53
20	*Psittaacula finschi*	-	24	-	12	-	36
21	*Rhopodytes tristis*	-	1	-	-	-	1
22	*Centropus sinensis*	-	55	25	-	1	81
23	*Centropus bengalensis*	-	10	15	-	-	25
24	*Eudynamys scolopaceu*	-	15	-	-	-	15
25	*Merops philippinus*	5	10	10	-	-	25
26	*Merops orientalis*	12	15	18	-	-	45
27	*Halcyon smyrnensis*	11	7	2	1	5	26
28	*Coracias benghalensis*	-	14	4	5	-	23
29	*Megalaima lineata*	-	8	-	-	-	8
30	*Megalaima haemacepha*	-	5	-	-	-	5
31	*Jynx torquilla*	-	1	-	-	-	1
32	*Lanius cristatus*	-	15	55	4	3	77
33	*Lanius schach*	-	3	1	-	-	4
34	*Oriolus chinensis*	-	8	-	-	-	8
35	*Dendrocitta vagabunda*	-	6	-	-	-	6
36	*Corvus splendens*	13	25	10	5	2	55
37	*Corvus macrorhynchos*	23	40	18	-	10	91
38	*Dicrurus macrocercus*	35	60	55	16	12	178
39	*Dicrurus leucophaeus*	-	2	-	-	-	2
40	*Dicricus bottentottus*	-	1	-	-	-	1

No.	Scientific name	Site I	Site II	Site III	Site IV	Site V	Total
41	*Dicrurus paradiseus*	-	1	-	-	-	1
42	*Dicrurus remifer*	-	3	-	-	-	3
43	*Tephrodornis pondicerianus*	-	4	-	-	-	4
44	*Starnus malarbarius*	-	158	35	-	-	193
45	*Sturnus contra*	-	45	15	5	3	68
46	*Acridotheres tristis*	25	160	35	30	15	265
47	*Acridotheres fuscus*	-	35				35
48	*Hirundo rustica*	30	-	136	40	45	251
49	*Hirundo smithii*	10	-	25	20	15	70
50	*Pycnonotus jocosus*	-	1	-	-	-	1
51	*Pycnonotus cafer*	-	120	35	5	50	210
52	*Passer domesticus*	-	15	20	30	15	80
53	*Passer mantanus*	-	10	12	15	8	45
54	*Passer flaveolus*	-	6	2	-	-	8
55	*Copsychus saularis*	-	1	1	-	-	2
56	*Saxicola maurus*	3		12	5	2	22
57	*Saxicola caprata*	-	1	2	-	-	3
58	*Ficedular parva*	-	1	-	-	-	1
59	*Lonchura punctalata*	-	15	-	10	7	52
60	*Motacilla alba*	3	-	-	1	2	8
61	*Motacilla flava*	2	-	-	1	1	4
62	*Dicaeum cruentatum*	-	1	-	-	-	1
63	*Nectarinia asiatica*	-	4	2	-	3	9
64	*Nectarinia jugularis*	-	2	2	-	1	5
65	*Cypsiurus balasiensis*	15	-	20	10	12	57
	Total	6426	2649	1022	467	282	10846

Table 4 Habitat utilization of recorded bird species in percentages.

No.		Site I	Site II	Site III	Site IV	Site V	Total
1	No. of species	27 (15%)	54 (30%)	41 (24%)	30 (16%)	27 (15%)	65
2	No. of individual	6426 (61%)	2649 (24%)	1022 (9%)	467 (4%)	282 (2%)	10846

Site I = Open water, Site II= Tree & shrubs, Site III= Tall grass, Site IV= paddy field,

Site V = mangrove

Conclusion

The avifaunal biodiversity of Taunggoke Environs has given good knowledge of the present status, species composition, and habitat utilization of bird species. In present study, a total of 65 bird species belonging to 43 genera, 31 families under 14 orders were recorded. Taunggoke environs is made up of different ecosystems and natural features which is an important habitat for endangered bird species and migratory species. Bird abundance was found to correlate with habitat features of the study area. The present study offers an opportunity to improve conservation of birds and their habitats for this region and to provide good data for future bird researchers. It is hoped that this region is to be ecotourism for future and will fill the gap of the Southern part of Rakhine State avifaunal biodiversity.

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Morphological and Histological Characters of *Crotalaria juncea* L.

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Abstract

The selected species of *Crotalaria juncea* L. was studied in this research paper. It belongs to the family Fabaceae and order Fabales. It is known as Paik-San-Shaw in Myanmar. This plant was collected from Hpa-an Township in Kayin State during flowering and fruiting periods. Morphological and microscopical examinations of *Crotalaria juncea* L. were conducted so as to ascertain their correct identification. Diagnostic characters indicated that they are erect, annual shrub, terminal open reaceme inflorescences, persistant calyx, bright yellow corolla, superior ovary and the fruits are pods. In microscopical study, the anticlinal wall of the epidermal cells in lower surface of the lamina are more wavier than the upper surface, simple trichomes and anisocytic stomata occurred on both surfaces. All parts of the plants have different sizes of simple trichomes. In transverse section of stem collateral and open type vascular bundles were numerous. In root, xylem tissues are arranged in radial row, phloem lies outside and pith absent. The plant samples were dried, powdered and kept in an airtight container for the study of diagnostic characters of powdered drug.

Keyword: ***Crotalaria juncea* L.**, morphological and histological characters

Introduction

In traditional medicine most of the diseases have been treated by administration of plant or plant product. *Crotalaria juncea* L. belongs to Fabaceae (Wealth of India, 1950), it is also called as brown hemp, Indian-hemp, Modras-hemp, Sun-hemp, Sun crotalaria, widely distributed in the tropical and of India, Nepal, Sri Lanka and Southern Africa.

It is commonly known as Sun hemp or India hemp (Kirtikar and Basu, 1975 and Wealth of India, 1950). It has great potential as an annually renewable, multi-purpose fiber crop and green manure.

It is used as medicines, edible, culinary purpose by many tribal communities (Chopara *et al*. 1956).

In the folk and Avurvedic medicines (Sharma, 2001), it is used as blood purifier, absortificient, astringent, demulcent, emetic, purgative and in the treatment of anaemia, impetigo, menorrhagia and psoriasis (Bhatt et.al 2009).

Phamacognosical parameters consist of identification of plant and microscopy. These characters are the basic for standardization of herbals.

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[3] Professor and head, Dr, Department of Botany, Taunggoke University

In these research, morphological and microscopical characters of fresh specimens and dried powdered of *Crotalaria juncea* L. were carried out. The aim and objectives are to verify the plant used in this research, to investigate the microscopical characters ofleaves, stems, roots, fruits and seeds, to document the characteristic of powered samples of leaves, stems, and roots for the standardization of crude drug of this plant.

Materials and Methods

Morphological study

The plant specimens of *Crotalaria juncea* L. were collected from Hpa-an Township, Kayin State, during flowering and fruiting periods from June to October, 2018 (Fig.1.1). The morphological study of the plants, was undertaken with the help of available literatures, such as Hooker 1875; Backer 1965; Dassanayake 1983; Kirtikar and Basu 1933.

Histological study of *Crotalaria juncea* L.

Microscopical characters of lamina, midrib, petiole, stem, root, fruit and seed were examined by free hand sections according to the methods of Metcalfe and Chalk 1950, Esau 1953, and Trease and Evans 2002. The leaves, stems and roots were dried at room temperature for two weeks. Completely dried the samples were pulverized by grinding machine and to get powder and stored in airtight containers.

The following reagents were used to examine the section cutting and powered sample. Chloralhydrate and sodium hypochloride were used as clearing agent. Solution of phloroglucinol B.P followed by concentrated hydrochloric acid for testing lignin. Acetic acid, hydrochloric acid and 60% sulphuric acid for testing calcium oxalate crystals. These characters were determined according to the literature of Central Council for Research in Unani Medicine, 1987; Marini Bettolo *et al,* 1981 and Trease and Evans, 2002.

Results

Morphological Characters of *Crotalaria juncea* L.

Scientific Name - *Crotalaria juncea* L.
family - Fabaceae
Myanmar Name - Paik-San-Shaw
Common Name - Indian-hemp, Sunn hemp

Annual shrub, 100 - 150 cm in height, stem erect, branched, solid, cylindrical and ribbed. Leaves simple, alternate, 11.3 - 15.1 cm long, 2.3 - 4.0 cm in width, oblong-lanceolate, tips acute, on both surfaces are silky pubescent. Petioles 0.5 cm long, 0.1 - 0.3 cm in width, pubescent, stipulate. Inforescences terminal open raceme 20 - 25 cm long. Flower brightly yellow, bracteate, bracteolate. Sepals: 5, hairy, standard, 1.8 - 2.0 cm long, 0.3 cm in width, bilabiate, imbricate, persistant, inferior. Petals 5, unequal, the uppermost and the largest petal is known as standard or vexillum 2.9 - 3.2 cm long, 2.0 - 2.5 cm in width, the two free, lateral petals are known as wings or alae, 1.8-2.0 cm long, 0.8 - 1.0 cm

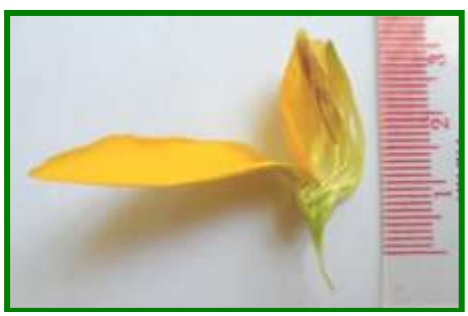
in width, the anterior pair of united petals is termed keel or carina, 1.8 - 2.1 cm long, 0.8 - 1.0 cm in width, imbricate, inferior. Stamens 5+5, basically connate, unequal, male sterile (long) 1.5 - 0.7 cm long, male fertile (short) , 0.5 - 0.8 cm long, male fertile (short) is anther dithecous, basifixed, extrorse, longitudinal dehiscence, inferior. Ovary oblique, 0.5 - 1.0 cm long, monocarpellary, marginal placentation, style long, hairy, stigma simple, superior. Fruits light-green to light-brown 3.6 - 1.2 cm long, 0.8 - 1.1 cm in width, splitting along both dorsal and ventral sutures, pod. Seeds 12 or less, 0.6 cm long, 0.8 cm in width, heart-shaped, from light-green to dark-gray to black in colour. Results were shown in Figure 1a and b.

Habit

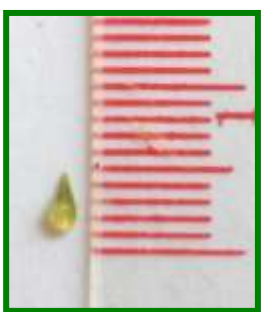
Upper and lower surfaces of leaves

Inflorescences

Flowers



L.S of flowers



Bract

Figure. 1a. Morphological characters of *Crotalaria juncea* L.

Androecium

Stamen

L.S of ovary

T.S of ovary

Fruits

Seeds

Figure 1b. Morphological characters of *Crotalaria juncea* L.

Histological characters of *Crotalaria juncea* L.

Lamina

In surface view, the antictinal wall of epidermal cells in lower surface is wavier than the upper surface. Epidermal cells of both surfaces are thin-walled. The stomata is oval with two reniform shaped guard cells, chloroplast present, anisocytic stomata are found on both surfaces.

In transverse section, the cuticle is present on both surfaces. The upper and lower epidermis are composed of parenchymatous cells which are one layered, rectangular and polygonal in shape. Simple trichomes occurred in both upper and lower epidermis. The mesophyll is differentiated into palisade and spongy cells. Palisade cells found below the upper epidermis, vertically erect composed of only one layered with numerous chloroplasts. Spongy mesophyll cells lies below the palisade cells and consists of 4 - 5 layeres, loosely arranged, irregular in shape, thin-walled and parenchymatous.

Vascular bundles are collateral and open type; these are enclosed by a bundle sheath. Xylem arranged in radial rows 2 - 4 cells in each row, and consists of vessel elements, tracheids, xylem fibres and xylem parenchyma. Phloem consists of sieve tube, companion cells, phloem fibres and phloem parenchyma cells (Fig. 2).

Midrib

In surface view, epidermal cells are irregular and some cells are rectangular. Unicellular trichomes are present.

In transverse section, the cuticle is present on both surfaces. Upper epidermis is one-layered, collenchymatous cells are 3 - 6 layered on the upper surface and 2 - 4 layered in lower surface rounded in shaped. Parenchymatous cells are 8 - 12 layered in adaxial surface and 5 - 8 layered of cells above the abaxial collenchymatous cells.

Vascular bundles are crescent-shaped and collateral type. Xylem cells are hexagonal and arranged in radial rows and thick-walled, composed of vessels, trachieds, xylem fibres and xylem parenchyma cells. Phloem cells are thin-walled and composed of sieve-tube elements and companion cells. The microscopical characters of the midrib are as shown in Fig. 3.

Petiole

In surface view, epidermal cells are thin-walled, irregular and rectangular to polygonal in shape. Unicellular trichomes are present.

In transverse section of petiole showing semi-circular in outline. Epidermal cells are rectangular in shape and tightly arranged. The cells are collenchymatous, 2 - 3 layered and round to circular in shape. Parenchymatous cells 8 - 10 layered above the vascular bundles and 8 - 12 layers below the vascular bundle.

Vascular bundles are arranged in crescent-shaped and collateral type. Xylem cells are hexagonal and arranged in radial rows, with 2 - 6 cells in each row, thick-walled, lignified, xylem cells composed of vessels, trachieds, xylem fibres and xylem parenchyma. Phloem cells are thin-walled and composed of sieve-tube elements and companion cells (Fig. 4).

The stem

The surface view, epidermal cells are thin-walled, rectangular to polygonal in shaped. Unicellular trichomes are present.

In transverse section, the stem is semicircular in outline. Epidermis is outermost layer with closely arranged parenchymatous cells and single layer and composed of barrel-shaped cells. It may produce a few unicellular trichomes. Hypodermis consists of closely arranged chlorenchymatous cells with thin-walled. The cortex consists of thick-walled collenchymatous cells 3 - 5 layer and thin-walled parenchymatous cells are 3 - 8 layers.

Vascular bundles are collateral. Medullary rays are found between the vascular bundles. Pith are present in the central region of the stem with loosely arranged parenchymatous cells (Fig. 5).

Root

In surface view, epidermal cells are thin-walled and irregular in shaped. In transverse section, epidermal cells are 2 - 3 layers, thin-walled rectangular in shape. Cortex layer lies below epidermis and are composed of 2 - 4 layers, thin-walled and rectangular parenchymatous cells. These cells are compactly arranged, without intercellular spaces. Only one layer, thin-walled and pericycle layer is found below cortex.

Vascular bundles are radially arranged. Xylem cells are thick-walled lignified and oval-shaped. They are composed of vessels, tracheids, xylem fibres and xylem parenchyma. Phloem cells are alternating with the xylem, thin-walled and composed of sieve tube, companion cells, phloem fibres and phloem parenchyma. Medullary rays are found between vascular bundles (Fig. 6).

Fruit

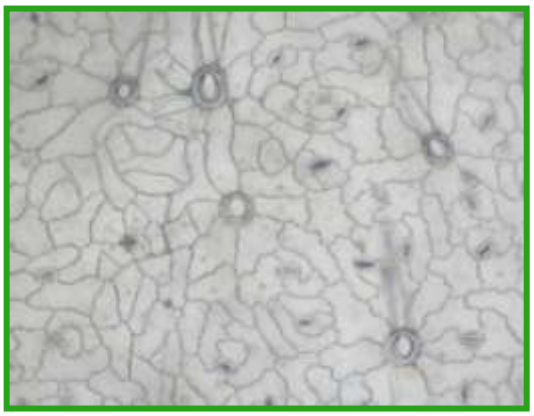
In transverse section, the pericarp is composed of three layers. The outermost layers is made up of a single-layered epidermal cells which are irregular in shape and thin-walled. Simple unicellular trichomes are arising from some epidermal cells. The middle portion is composed of many layers of parenchymatous cells. The innermost portion is made up of 2 - 3 layers of sclerenchymatous (Fig. 7).

Seed

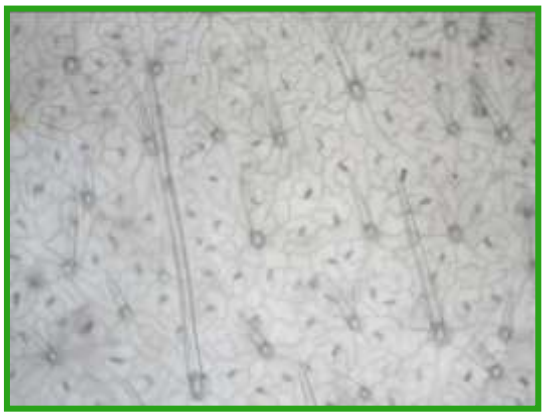
In transverse section of the seed showed the testa, tegmen and cotyledons. The testa is made up of three portions, the upper portion is composed of a single layer of palisade like macrosclereids covered by cuticle, a layer of hour glass cells in middle portion and the lower portion consisted of 2-3 layers of thin parenchymatous cells (Fig. 8).

The tegmen is composed of a single layer of pigmented cells which is also covered by cuticle and with many layers of collapsed parenchymatous cells.

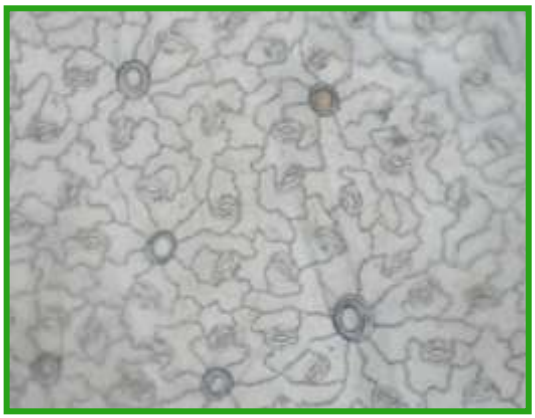
The epidermal cells are thin, 2 - 3 layers of palisade cells and many layers of parenchymatous cells lies between the epidermal cells.



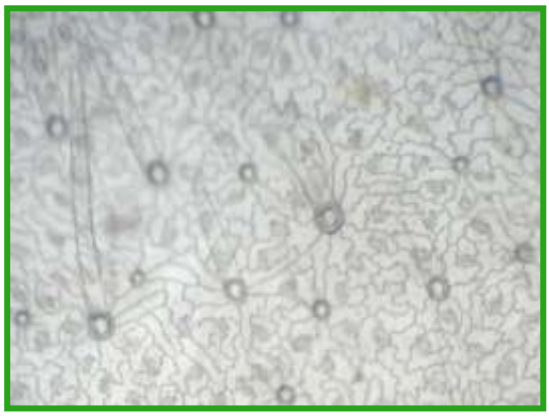
Surface view of upper epidermis with stomata (X400)



Surface view of upper epidermis with simple trichomes (X100)



Surface view of lower epidermis with stomata (X400)

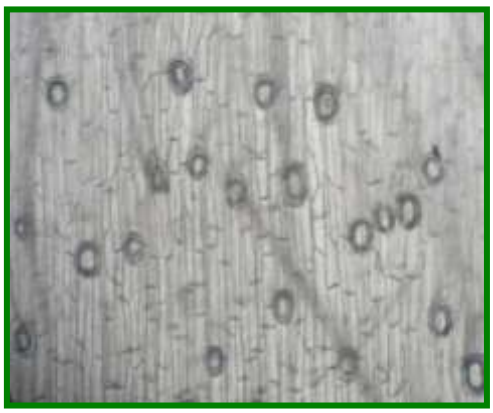


Surface view of lower epidermis with simple trichomes (X100)

T.S of lamina (X400)

T.S of lamina showing vascular bundle (X100)

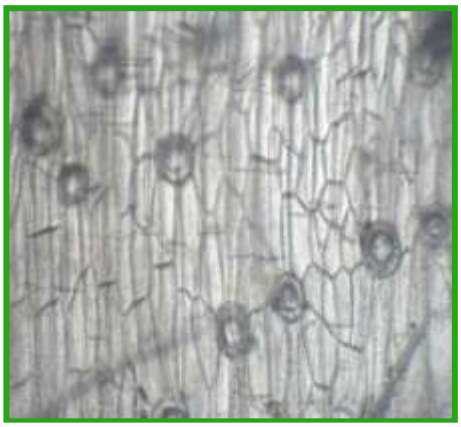
Figure 2. Histological characters of lamina of *Crotalaria juncea* L.



Surface view of midrib (X400)

T.S of midrib (X100)

Figure 3. Histological characters of midrib of *Crotalaria juncea L.*

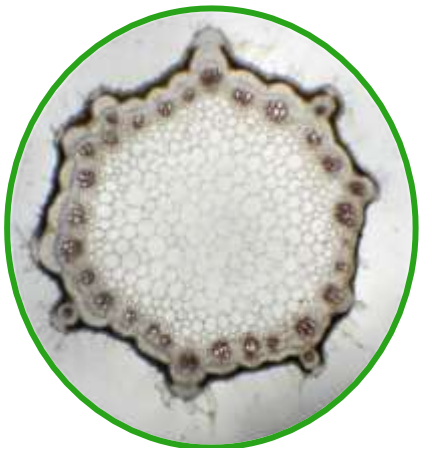


Surface view of petiole (X400)

T.S of petiole (X100)

Figure 4. Histological characters of petiole of *Crotalaria juncea L.*

Surface view of stem(X400)



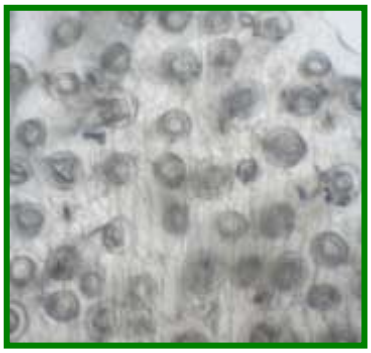
Surface view of epiderma cell of petiole (400x)

Figure 5. Histological characters of stem of *Crotalaria juncea* L.

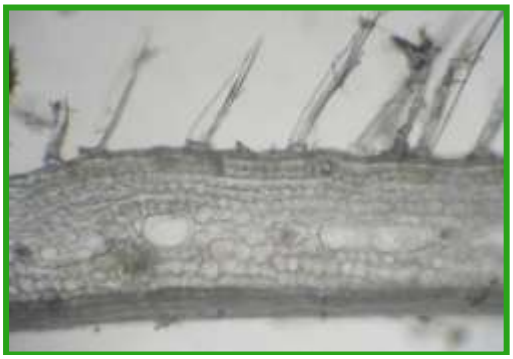
Surface view of root (X400)

T.S of root (X100)

Figure 6. Histological characters of root of *Crotalaria juncea* L.

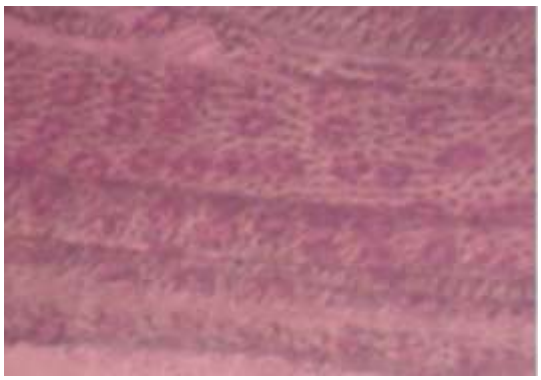


Surface view of fruit wall

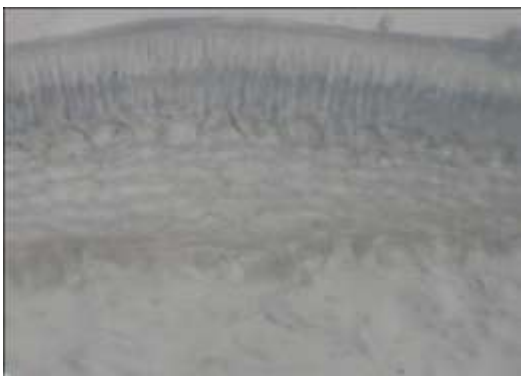


T.S of fruit wall with trichomes

Figure 7. Histological characters of fruit of *Crotalaria juncea* L.



Surface view of fruit wall



Surface view of fruit wall

Figure 8. Histological characters of seed of *Crotalaria juncea* L.

Discussion and Conclusion

In this research, the species of *Crotalaria juncea* L. was selected because it was famous in Myanmar as plants and also as fertilizer. This species grown wild or is cultivated throughout the world.

Morphology and histology characters of this species were investigated. It's taxonomic characters are identified by referring to previous researches Hooker, 1879; Kirtitikar and Basu 1933, Backer, 1965 and Cronquist, 1981.

The species of *Crotalaria juncea* L. was known as in Myanmar as paik-san- shaw. The plant is erect, annual shrub, cyclindrical and ribbed.

The leaves of *Crotalaria juncea* L. are simple, alternate, oblong-lanceolate, the tips sub-acute, the margins entired, clothed on both sides with appressed silky hairs. These characters are in agreement with those of Kirtikar and Basu, 1933.

The inflorescences are terminal opened raceme with brightly yellow flowers, zygomorphic, calyx five, persistent, corolla five, bright yellow. These characters are in agreement with those of Hooker 1879 and Backer, 1965.

The anthers are dithecous, basifixed. The ovaries are monocarpellary, marginal placentation, superior, style long, stigma simple. The fruits are pods,, with hairs. The seeds are heart-shaped, smooth, numerous. These characters are in agreement with those of Hooker, 1879 and Backer, 1965.

In microscopical studies, the epidermal cells in lower surface is wavier than the upper surface, anisocytic stomata and simple trichomes are present on both surfaces.

In transverse section of lamina, the upper and lower epidermal cells one layered, more or less rectangular. Unicellular trichomes are occurred in upper and lower epidermis layer. Palisade mesophyll cells are one layer, spongy mesophyll cells 4 - 5 layers. Vascular bundles occur between palisade and spongy mesophyll cells. In transverse section of the midrib, the vascular bundle is crescent shaped, phloem composed of vessel elements, tracheids, fibres and xylem parenchyma, some cells of epidermis produce trichomes. In microscopical studies, those epidermis of both surfaces of leaves are wavy, anisocytic stomata and simple trichomes are present on both surfaces.

Surface view of petiole, epidermal cells are thin-walled, unicellular trichomes are present. Transverse section of petiole is more or less rounded in outline. Vascular bundles are collateral and opened. Surface view of stem, epidermal cells are thin-walled and rectangular to polygonal in shaped. Unicellular trichomes are present. The stem is found to be circular in outline, the vascular bundles are arranged in a ring, parenchymatous pith are present. Surface view of root, epidermal cells are thin-walled and irregular in shaped. Xylem tissue arranged in radial row, phloem lies outside, pith absent. These characters are in agreement with those of Esau 1953; Metcalfe & Chalk 1950, and Trease & Evans 2002.

In transverse section of fruit, the pericarp is composed of three layers. The outermost layers is made up of a single-layered epidermal cells which are irregular in shape and thin-walled. Simple unicellular trichomes are arising from some epidermal cells. The middle portion is composed of many layers of parenchymatous cells. The innermost portion is made up of 2 - 3 layers of sclerenchymatous. These characters are in agreement with those given by Matcalfe and Chalk 1950 and Pandey 1996. In transerve section of seed, cuticle layer is the outermost layer of seed coat. Malpighian layer consists of closely

packed palisade like cells, that elongate right angle to the surface. Hour glass cells layer is found next to the palisade layer.

In future research programme, *Crotalaria juncea L*. plant should be planted more and propagated by various method so as to benefit to human, society and to promote their socio-economic status for fiber crop and green manure at the same secure additional income. Characteristics of powdered samples leaves, stems, and roots are documented for the standardization of crude drug.

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ဥပစာစကားလုံးများအဖြစ်သုံးစွဲရာမှ အနက်အဓိပ္ပာယ် တိုးပွားလာသောဝေါဟာရများလေ့လာချက်

သီရိတင် *

စာတမ်းအကျဉ်း

ဤစာတမ်းသည် မြန်မာနေ့စဉ်သုံးစကားထဲရှိ ဥပစာစကားလုံးများအဖြစ် သုံးစွဲရာမှ အနက်အဓိပ္ပာယ်တိုးပွားလာသော ဝေါဟာရများကို လေ့လာခြင်းဖြစ်ပါသည်။ထိုသို့ လေ့လာရာတွင် အဘိဓာန်ကျမ်းများ၊ဝေါဟာရအဖွင့်ကျမ်းများစသောစာပေအထောက် အထားများ ကို ကိုးကားထားပါသည်။ ထို့ပြင် စကားပြေစာအုပ်စာတမ်းများ၊ ကဗျာ လင်္ကာများကို အလေ့လာခံအဖြစ်အသုံးပြုပြီး ဥပစာစကားလုံးများ၏ မူလအနက်နှင့် နှိုင်းယှဉ်ကာ အနက်အဓိပ္ပာယ်များတိုးပွားလာပုံကို သုံးသပ်တင်ပြထားပါသည်။

သော့ချက်ဝေါဟာရများ–အနက်အဓိပ္ပာယ်၊အနက်တိုးပွားခြင်း၊အတ္ထဗေဒ၊ဥပစာ

နိဒါန်း

ဤစာတမ်းသည် မြန်မာနေ့စဉ်သုံးစကားထဲရှိဥပစာစကားလုံးများအဖြစ်သုံးစွဲရာမှအနက်အဓိပ္ပာယ် တိုးပွားလာသောဝေါဟာရများ၏ အနက်တိုးပွားလာခြင်းကို လေ့လာသော စာတမ်းဖြစ်ပါသည်။ လေ့လာရာတွင်လည်း “အနက်အဓိပ္ပာယ်တိုးပွားခြင်း၊ ဥပစာစကားလုံးများအဖြစ်တင်စားသုံးစွဲရာမှ အနက်အဓိပ္ပာယ်တိုးပွားလာခြင်း”ဟူ၍ အပိုင်း(၂)ပိုင်းခွဲခြားတင်ပြထားပါသည်။ လူမှုကိစ္စနယ်ပယ် တွင်နေ့စဉ်သုံးဝေါဟာရများကို ဥပစာစကားအဖြစ် တင်စားပြီးပြောဆိုသုံးစွဲရာမှ စကားလုံးတို့၏ ဝေါဟာရအနက်မှာ မူလအနက်မှတိုးပွားလာခဲ့သည်။ထိုသို့ဥပစာစကားအဖြစ်သုံးစွဲရခြင်းမှာလည်း စကားလုံးတစ်လုံး၊အနက်တစ်ခုသုံးပါက စကားလုံးများများပြားလာပေလိမ့်မည်။ထိုအခါမှတ်သား ရခက်ခဲ၍ ရှုပ်ထွေးလာနိုင်ပါသည်။ ထို့ကြောင့် မူလအနက်မှပွားယူကာ သုံးစွဲခြင်းဖြင့် အနက် အဓိပ္ပာယ်တိုးပွားလာပြီး စကားလုံးနယ်ပယ်လည်းကျဉ်း၍ မှတ်သားရလွယ်ကူနိုင်သည်။ သို့ဖြစ်၍ ဥပစာစကားလုံးများ၏ မူလရှိရင်းစွဲအနက်မှပွားယူ၍ တင်စားသုံးစွဲခြင်းဖြင့် အနက်အဓိပ္ပာယ် တိုးပွားလာခြင်းအကြောင်းကို လေ့လာတင်ပြထားပါသည်။

အနက်အဓိပ္ပာယ်တိုးပွားခြင်း

စကားလုံးတစ်လုံးတွင် အနက်အဓိပ္ပာယ်တစ်ခုဟူ၍ ပုံသေသတ်မှတ်၍ မရပေ။ ဝေါဟာရတို့သည် အချိန်ကာလကြာမြင့်သည်နှင့်အမျှ အနက်အဓိပ္ပာယ်တိုးပွားလာတတ်သည်။ မူလအနက်ရှိပြီးသား စကားလုံးကိုပင် အနက်ချဲ့ထွင်၍သုံးစွဲခြင်းဖြင့် စကားလုံးတစ်လုံးတွင် အနက်အဓိပ္ပာယ်သစ်များ တိုးပွားလာရသည်။ ထိုသို့ဖြစ်ပေါ်လာခြင်းကိုပါး(လ)မား၏ အတ္ထဗေဒအမည်ရှိစာအုပ်တွင် “မတူညီသောစကားလုံးများ၌သာ ကွဲပြားသောအဓိပ္ပာယ်များရှိသည်မဟုတ်။ တူညီသော စကားလုံးများတွင်လည်းကွဲပြားသည့်အဓိပ္ပာယ်များရှိသည်။ယင်းမှာအနက်များပြားမှုပင်ဖြစ်သည်။” (Palmer,1976,65) ဟူ၍ဖွင့်ဆိုထားသည်။ အနက်အဓိပ္ပာယ် တိုးပွားခြင်းနှင့်ရုပ်သွင်တူ အနက်ကွဲ တို့ရောထွေးတတ်ကြောင်းကိုလည်း ဂျက်ဖရီလိ(ချ်)က “အတ္ထဗေဒ” အမည်ရှိစာအုပ်တွင် “ရုပ်သွင်တူအနက်ကွဲ၏ ဆန့်ကျင်ဖက်မှာ အနက်များပြားမှုပင်ဖြစ်သည်။ အနက်များပြားမှု ဆိုသည်မှာ စကားလုံးတစ်လုံးကို အနက်တစ်ခုထက်ပို၍ အဓိပ္ပာယ်ဖွင့်ဆိုနိုင်ခြင်းဖြစ်သည်။” (Leech,1974,97)ဟုခွဲခြားပြသည်။ ထိုကြောင့် အနက်အဓိပ္ပာယ်တိုးပွားခြင်းဆိုသည်မှာ“စကားလုံး ရုပ်သွင်ပြောင်းလဲမှုမရှိဘဲ၊ စကားလုံးတစ်လုံးကို မူလအနက်နှင့် ဆက်စပ်သောအနက်အဓိပ္ပာယ်

* ကထိက၊ဒေါက်တာ၊မြန်မာစာဌာန၊တောင်ကုတ်တက္ကသိုလ်

အမျိုးမျိုးသုံးနိုင်ခြင်းကို အနက်ပွားခြင်း"ဟုခေါ်သည်။ အနက်ပွားစကားလုံးများနှင့် ရုပ်သွင်တူ အနက်ကွဲစကားလုံးတို့၏ခြားနားချက်မှာ အနက်ပွားစကားလုံးများသည် မူလအနက်မှဖြာထွက်ကာ အဓိပ္ပာယ်ဆက်စပ်မှုရှိခြင်းဖြစ်ပြီး ရုပ်သွင်တူအနက်ကွဲမှာမူ မူလရင်းမြစ်တူသော်လည်း အနက်အဓိပ္ပာယ်ခြင်းဆက်စပ်မှု မရှိအောင်ကွဲပြားကြောင်းတွေ့ရသည်။

ဥပစာအသုံးများကြောင့် အနက်အဓိပ္ပာယ်တိုးပွားခြင်း

ဘာသာစကားနယ်ပယ်တွင် များပြားလှသော လူမှုကိစ္စများအတွက် စကားလုံးအသစ်များခဲ့ထွင် သုံးစွဲပါကစကားလုံးများ ဖောင်းပွလာနိုင်သည်။ သို့ဖြစ်၍ ရှိရင်းစွဲစကားလုံးကိုပင် ဥပစာစကား အဖြစ်တင်စားသုံးစွဲလာကြသည်။ ထိုသို့တင်စားသုံးစွဲရာမှ အနက်အဓိပ္ပာယ်များ တိုးပွားလာသည် ကိုတွေ့ရှိရပါသည်။

ဥပစာဟူသည်

'ဥပစာ'ဆိုသည်မှာပါဠိသက်ဝေါဟာရဖြစ်သော'ဥပစာရ'မှဆင်းသက်လာပြီး'တင်စား'ဟုအဓိပ္ပာယ်ရ သည်။"တစ်စုံတစ်ခု၏အမည်ကိုအခြားတစ်စုံတစ်ရာ၌တင်၍ပြောဆိုသည်"(မြန်မာအဘိဓာန်၊၁၉၉၁၊ ၄၃၁)ဟု မြန်မာအဘိဓာန်ကဖွင့်ဆိုသည်။ ထို့ပြင် နှစ်ဖက်လှဦးကျော်လွင်ကလည်း ဥပစာအနက် သဘောနှင့်ပတ်သက်၍ "ဝေါဟာရတစ်ခုသည်မိမိ၏ မူလလက်ကိုင် အနက်အဓိပ္ပာယ်ကို ဖော်ပြခြင်းမပြုဘဲ မူလအနက်နှင့်နီးစပ်သည့် အနက်အဓိပ္ပယ်ကို ထွန်းပြခြင်း၊ ထွန်းပြစေခြင်းသည် တင်စားမှုပင်ဖြစ်သည်" (နှစ်ဖက်လှ၊၁၉၆၈၊၂၄၅)ဟူ၍ ဖွင့်ဆိုချက်ကိုလည်းတွေ့ရသည်။ မောင်ခင်မင်(ဓနုဖြူ)က ဥပစာသဘောနှင့်ပတ်သက်၍ "ဥပစာဟူသည်ပိုမို ကျယ်ဝန်းသော အနက်အဓိပ္ပာယ်သစ်ကိုဖြစ်စေပိုမိုတိကျသောအနက်အဓိပ္ပာယ်ကိုဖြစ်စေရရှိစေရန် ရည်ရွယ်ချက်ဖြင့် အရာတစ်ခုနှင့်မချသဘောအရ ဆက်သွယ်နေသောဝေါဟာရကို အခြားတစ်ခုအတွက် ရွှေ့ပြောင်းနိုင်သည့် သဘောကိုအခြေပြုသော ဝေါဟာရမျိုးဖြစ်သည်"(ခင်မင်၊မောင်၊ဓနုဖြူ၊ ၂၀၀၉၊၆၇)ဟူ၍ လည်းကောင်း "ဥပစာတင်စားခြင်းသည်ရှိပြီးသား စကားလုံးကိုပင်အခြား အကြောင်းအရာအတွက် ချဲ့ထွင်အသုံးပြုခြင်း" (ခင်အေး၊ ဒေါက်တာ၊ ၂၀၀၄၊၁၆၃)ဟူ၍ လည်းကောင်းဥပစာနှင့်ပတ်သက်၍ပညာရှင်တို့ကဖွင့်ဆိုထားပါသည်။ မည်သို့ပင်ဆိုစေကာမူ ဥပစာဟူသည် တစ်စုံတစ်ခုကိုရည်ညွှန်းသတ်မှတ်ခေါ်ဝေါ်ရာတွင် ယင်းနှင့်အလားသဏ္ဌာန် တူသော အခြားတစ်စုံတစ်ခုဖြင့် တင်စားခေါ်ဝေါ်ခြင်းပင်ဖြစ်သည်။

ဥပစာအသုံးများကြောင့်အနက်အဓိပ္ပာယ်တိုးပွားလာသောဝေါဟာရများ

ဥပစာတင်စားမှုများဖြင့်ပြောဆိုသုံးနှုန်းသူတို့သည် ဥပစာဟူ၍သတိမမူမိလောက်အောင်နေ့စဉ်သုံး စကားနယ်ပယ်တွင် အသုံးတွင်ကျယ်လျက်ရှိသည်။ ထိုသို့တင်စားသုံးစွဲရာမှ အနက်အဓိပ္ပာယ်များ တိုးပွားလာသောဝေါဟာရများအနက်နေ့စဉ်သုံးမြန်မာစကားထဲမှလူသုံးအများဆုံးဝေါဟာရများကို ထုတ်နုတ်တင်ပြထားပါသည်။

ကြိုးကိုင်

'ကြိုးကိုင်' ဟူသော ဝေါဟာရမှာ ဇာတ်သဘင်လောကမှ ဆင်းသက်လာသော ဝေါဟာရဖြစ်သည်။ ရုပ်သေးစင်တွင်အရုပ်များလှုပ်ရှားအောင်လုပ်ဆောင်ရသူကို'ကြိုးကိုင်'ဟုခေါ်ကြသည်။ ထိုသဘောကို နေ့စဉ်သုံး အပြောစကားတွင် ဥပစာအဖြစ်သုံးစွဲရာ၌–

"သူ့ကိုကြိုးကိုင်တဲ့သူရှိမှတော့သူကြိုးဆွဲရာကတော့မှာပေါ့"
"သီပေါမင်းဟာမိန်းမကြိုးကိုင်တာခံရတဲ့ရုပ်သေးရုပ်ဖြစ်တဲ့အတွက်"

ဟူ၍ တွေ့ရသည်။ 'ကြိုးကိုင်'၏အနက်မှာ 'ကြီးမှူးဆောင်ရွက်သူ၊အကြီးအမှူး'ဟူသော အနက်အဖြစ်တွေ့ရသည်။ ထိုသို့'ရုပ်သေးရုပ်ကြိုးကိုကိုင်ရသူ'ဟူသောအနက်မှ 'အရာရာကို

မိမိစိတ်တိုင်းကျ ဖြစ်အောင် စီမံခန့်ခွဲလုပ်ကိုင်စေသည့်' အနက်ဖြင့်တင်စားသုံးစွဲသောကြောင့် အနက်အဓိပ္ပယ် တိုးပွား လာသည်။

ဆင်ခြေဖုံး

'ဆင်ခြေဖုံး' ဟူသောဝေါဟာရ၏ မူလအနက်မှာ 'ဆင်၏ခြေထောက်ကို ကာကွယ်စောင့်ရှောက်ရသော ရှေးခေတ်မင်းမှုထမ်း'ပင်ဖြစ်သည်။ ရှေးကတိုက်ဆင်များကို တစ်ဖက်ရန်သူများတိုက်ခိုက်လာသော အခါတွင် မထိခိုက်စေရန် ဖုံးရ၊ကာရသောရဲမက်များကို ဆင်ခြေဖုံးဟုခေါ်သည်။ 'နား နှစ်ဖက်၊ အစွယ် နှစ်ချောင်း၊ ရှေ့လက်နှစ်ချောင်း၊ နောက်ခြေနှစ်ချောင်းနှင့် အမြီးကို ကာရသူဟူ၍ ရဲမက်(၉)ယောက် ရှိသည်။ထိုသို့ဆင်ကိုရံထားရသော ရဲမက်များကိုဆင်ခြေဖုံးဟုခေါ်သည်။ ထိုသို့ ဆင်၏ခြေထောက်ကို ဝန်းရံထားသည့်သဘော၊ ကာရံထားသည့်သဘောကဲ့သို့ အခြားလူမှုကိစ္စ နယ်ပယ်တွင်လည်း 'ဆင်ခြေဖုံး'ကို ဥပစာစကားအဖြစ် တင်စားသုံးစွဲကြကြောင်းကိုတွေ့ရသည်။

သာဓကပြရလျှင်–

"မြို့တော်ကိုဝန်းရံထားတဲ့အကွက်စုတွေကိုဆင်ခြေဖုံးတွေလို့ခေါ်တယ်"
"ခါတိုင်းတိုက်ဆင်ကိုဆင်ခြေကာ၊ဆင်ခြေဖုံးလိုဝန်းရံထားသည့်အိမ်ကလေးတွေလည်းမရှိတော့"
"အဘိုးအိမ်ကြီးပေါ်ကငုံ့ကြည့်လျှင်အိမ်ကြီးကိုဝန်းရံလျက်ရှိနေကြသောအိမ်ကလေးတွေတိုက်ဆင်
ကိုရံထားကြသောဆင်ခြေကာ၊ဆင်ခြေဖုံး ရဲမက်တော်ကိုးယောက်လို ငုတ်စိကလေးတွေ"

ဟူ၍ တွေ့ရသည်။ ထိုသို့မြို့ကိုဝန်းရံထားသည့်သဘော၊ ကာရံထားသည့်သဘောသက်ရောက်ပြီး မြို့နှင့်တစ်စပ်တည်းရှိသော အရပ်ဒေသကို 'ဆင်ခြေဖုံး' ဟုတင်စားသုံးစွဲကြသည်။ ဤနည်းဖြင့် 'ဆင်ခြေဖုံး'ဟူသောဝေါဟာရသည် 'တိုက်ဆင်များကို ကာကွယ်ရသောရဲမက်' ဟူသောအနက်မှ 'မြို့ကိုကာရံထားသောအရပ်ဒေသ' ဟူ၍ ဥပစာတင်စားရာမှ အနက်အဓိပ္ပာယ်များ တိုးပွား လာသည် ကိုလေ့လာတွေ့ရှိရပါသည်။

ခုံရင်း

'ခုံရင်း'ဟူသောဝေါဟာရမှာ 'ခုံ'ဟူသောဝေါဟာရမှ ဆင်းသက်လာခြင်းဖြစ်သည်။ 'ခုံ'၏အဓိပ္ပာယ်မှာ'ထွေပစ်ကစားရာတွင်ထွေပစ်သူတို့ ရပ်နေရာစည်းကြောင်း'ဖြစ်သည်။ 'ခုံရင်း'သည် 'ခုံ'နှင့်'ရင်း' ကိုပေါင်းစပ်ထားသော ဝေါဟာရဖြစ်သည်။ 'ရင်း'အဓိပ္ပာယ်မှာ 'မူလအစ' ဟူသော အနက်ဆောင်သည်။ ထို'ခုံရင်း' ဟူသောဝေါဟာရကို ထွေကစားသည့် ဓလေ့နှင့်မဆိုင်သော အခြားလူမှုကိစ္စများတွင် ဥပစာတင်စားကာအသုံးပြုကြသည်။ သာဓကပြရသော်–

"ကာလကို ထောင်းချင်ပြီ၊ ကြောင်းအင်နော်မရှင်း၊ ကောင်းချင်သော် နံဖျင်းလို့ ခုံရင်းသို့လှဲ့မယ်"
"နေထိုင်စားသောက်ရေး အခြေအနေမှာခုံရင်းအတိုင်းပင်ရှိသည်။" ဟူ၍ အသုံးပြုသည်။ အဓိပ္ပာယ်မှာ 'မူလအတိုင်း၊ မူလအခြေအနေအတိုင်း၊ ရှေးမူအတိုင်း၊ ပင်ကိုအခြေအနေ တိုင်း ပြန်ဖြစ်ခြင်း' ဟူသောအနက်ရသည်။ ထို့ပြင်'ခုံရင်း'ကိုနှစ်ထပ်ပြုကာ'ခုံရင်းခုံရင်း' ဟု လည်း အသုံးပြုကြသည်။ သာဓကပြရသော်– "စပါးစျေးတက်ပေးလည်းဒီလိုပါပဲကြီးတော်ခုံရင်းခုံရင်းပါပဲ" ဟူ၍ သုံးစွဲကြသည်။ အနက်အဓိပ္ပာယ်မှာ အတူတူပင်ဖြစ်သည်။ဤနည်းဖြင့်'ခုံ' ဟူသောဝေါဟာရမှ 'ခုံရင်း'၊'ခုံရင်း' မှ 'ခုံရင်းခုံရင်း' ဟူသောအသုံးများတွင်ကျယ်လာသည်။ ထိုသို့ထွေပစ်ကစားသော ဓလေ့မှ ဆင်းသက်လာသော 'ခုံ'ကို လူမှုကိစ္စများတွင် တင်စားသုံးစွဲရာမှ ဝေါဟာရအနက်သည် မူလ အသုံးကိုအခြေခံကာ အနက်အဓိပ္ပာယ်များ တိုးပွားလာသည်ကို တွေ့ရှိရပါသည်။

ပျားပန်းခတ်

'ပျားပန်းခတ်'၏ မူလအသုံးမှာ'ပျားပန်းခပ်'ဖြစ်သည်။ ရှေးက'ပျားပန်းခပ်'ဟု သာ သုံးကြောင်းကို– "ပန်းရက်စုံလျက်၊အံဖြစ်လောက်အောင်၊ ယူဆောင်စုထား၊ ထပ်မနားတည့်၊ ပျားပန်းခပ်ကြ ပိတုန်းတည်း"'"ပျားပန်းခပ်ရွှေပလူကဲ့သို့လိုချင်သူပေါသော်လည်းမဂျမ်းဘုံ၏ နဂိုစိတ်ရင်းကပင် အိမ်ထောင်မပြုလို၍အပျိုကြီးလုပ်သူဖြစ်သည်။" ဟူ၍ တွေ့ရသည်။ 'ပျားပန်းခတ်'၏ မူလအနက်မှာ 'ပန်းဝတ်ရည်ကိုပျားများ အခေါက်ခေါက် အပြန် ပြန်စုပ်ယူသည်' ဟူသောအနက်ရသည်။ ထိုအနက်သဘောဖြင့် ဥပစာတင်စားရာတွင် 'ခေါက်တုံ့ လူးလာရှုတ်ယှက်ခတ်သွားလာခြင်း' ဟူ၍ မြန်မာအဘိဓာန်အကျဉ်းချုပ်တွင် ဖော်ပြ ထားသည်။

ယခုခေတ်တွင် 'ပျားပန်းခတ်'ဟူသောဝေါဟာရကို"လူအများရှုပ်ထွေးနေသည့်" သဘောဖြင့် ဥပစာတင်စားသုံးစွဲသည်။ ထိုသဘောဖြင့် သုံးစွဲပုံကို သာဓကပြရလျှင်–

"အသက်အရွယ်မှာကြီးကြီးလည်းပါ၊ငယ်ငယ်လည်းရှိ၊ယောကျ်ားမိန်းမ မကျန်အားလုံး ပင်ပျားပန်းခတ်ဘိသကဲ့သို့ သောင်ပြင်ကြီးတွင်ဆင်းသူဆင်း၊ တက်သူတက်"

"ဝင်ကြ၊ထွက်ကြ၊လုပ်ကြ၊ကိုင်ကြသူတွေမှာလည်း ပျားပန်းခတ်နေကြ၏"

ဟူ၍တွေ့ရသည်။ပန်းဝတ်ရည်ကို ပျားများခေါက်တုံ့ခေါက်ပြန်စုပ်ယူသကဲ့သို့ လူအများခေါက်တုံခေါက်ပြန်သွားလာနေကြခြင်း ဟူသောအနက်အပြင် ယောက်ယက်ခတ် လှုပ်ရှားနေသည့်သဘောပါသက်ရောက်နေကြောင်း တွေ့ရသည်။ ဤနည်းဖြင့် 'ပျားပန်းခတ်'ဟူသောဝေါဟာရကို တင်စားသုံးစွဲလာကြသောကြောင့် အနက်အဓိပ္ပာယ်များ တိုးပွားလာရသည်။

ပြောင်တလင်းခါ

'ပြောင်တလင်းခါ'ဟူသောဝေါဟာရသည်လယ်ယာလုပ်ငန်းမှလာသောဝေါဟာရဖြစ်သည်။'ပြောင်' ဟူသောဝေါဟာရ၊ 'တလင်း'ဟူသောဝေါဟာရနှင့် 'ခါ'ဟူသောဝေါဟာရတို့ကို ပေါင်းစပ်ထားခြင်းဖြစ်သည်။'ပြောင်တလင်း'ဟူ၍လည်းကောင်း၊'ပြောင်တလင်းခါ'ဟူ၍လည်းကောင်းသုံးစွဲကြသည်။

'ပြောင်'၏အနက်မှာ 'အကြွင်းအကျန်မရှိဖြစ်သော၊တစ်စုံတစ်ရာဘာမျှမရှိဖြစ်သော'ဟူ၍ အနက်ရသည်။'တလင်း'ဟူသောဝေါဟာရမှာ'စပါးနယ်ရာမြေညီကွက်ညီညာရှင်းလင်းသောမြေမျက်နှာပြင်' ဟူ၍ဖြစ်သည်။ ထိုအနက်ဖြင့်–

"ကောက်နယ်တလင်း၊ မြေခင်းရှိလောက်၊ ကြီးမြောက်စွာလှ၊ ကက္ကဋ္ဌကို"

ဟူ၍ တွေ့ရသည်။ 'ပြောင်' နှင့် 'တလင်း' ကိုပေါင်းစပ်ကာ 'ပြောင်တလင်း' ဟူ၍ နာမ်အနက်ဖြင့် ဥပစာတင်စား၍ သုံးကြသည်။ သာဓကပြရသော်–

"ဆင်းရဲကြောင်းစင်းစင်း၊ မွဲပြာကြ ပြောင်တလင်းနှင့်"

"တောင်တန်းများမြင်ရသည်မှာ သစ်ဝါးပင်များများစားစားမတွေ့ရဘဲပြောင်တလင်းဖြစ်နေသည်"

ဟူ၍တွေ့ရသည်။ အနက်မှာ 'ဘာတစ်ခုမှမရှိဘဲ ရှင်းလင်းနေသည့်သဘောဖြစ်သည်။'

လယ်ယာလုပ်သားတို့သည် တလင်းရှိစပါးတို့ကို သိမ်းပြီးနောက် အမှိုက်သရိုက်များနှင့် ရောထွေးနေသောစပါးစေ့များကို ဆန်ကော၊ဆန်ခါတို့ဖြင့် ခါယူရသည်ကိုလည်း 'တလင်းခါ'ဟူ၍ ဆိုသည်။ တစ်နည်းအားဖြင့် အမှုန်အမွှားများ၊ အမှိုက်သရိုက်များကို ကင်းစင်သွားအောင် ပြုလုပ်ခြင်းပင်ဖြစ်သည်။ထိုသဘောကိုအခြေခံကာ'ပြောင်တလင်းခါ'ဟူသောဝေါဟာရကို ဥပစာတင်စားကြသည်။ သာဓကပြရသော်–

"စားစရာများကို ပြောင်တလင်းခါစေသည်။"

"ထမင်းအိုးထဲမှာ ထမင်းတွေ ပြောင်တလင်းခါနေတာပဲ"

ဟူ၍တွေ့ရသည်။အဓိပ္ပာယ်မှာ 'ဘာမျှမကျန်ဘဲ ကုန်ခန်းသည့်သဘော' ဖြစ်သည်။ ဤနည်းဖြင့် 'ပြောင်တလင်း' 'တလင်းခါ' 'ပြောင်တလင်းခါ' စသည်ဖြင့် မူလအနက်ကို နှိုးနွှယ်တင်စားကာ သုံးစွဲခြင်းဖြင့် အနက်တိုးပွားလာသည်ကို တွေ့ရှိရပါသည်။

ဗွေဖောက်

ဗွေဖောက်' ဟူသောဝေါဟာရသည် 'ဗွေ'နှင့် 'ဖောက်'ဟူသော ဝေါဟာရတို့ ပေါင်းစပ်ထားခြင်း ဖြစ်သည်။ 'ဗွေ'၏အနက်မှာ 'မြင်း၊နွား စသည်တို့၏ကိုယ်တွင် ရစ်လည်၍ ပေါက်နေသော အမွေး အစု' ဟူ၍ ဖြစ်သည်။ သာဓကပြရသော်–

" မြင်းများနှင့် ပတ်သက်၍ ဗွေဆိုး ဗွေကောင်း ရွေးချယ်နိုင်ရန်"

"နွား၏အပြစ်အမျိုးမျိုး ဗွေဆိုး ဗွေကောင်း အမျိုးမျိုးတို့ကိုသိ၏"

ဟူ၍ နွား၊မြင်းတို့တွင် ဗွေဆိုး၊ဗွေကောင်းရှိကြောင်းသိရသည်။ ထို'ဗွေ'ဟူသော စကားလုံးကို 'ချွတ်ယွင်းဖောက်ပြန်သည်"ဟု အနက်ရသော'ဖောက်' နှင့်တွဲကာ 'ဗွေဖောက်'ဟူ၍ အခြားသော လူမှုကိစ္စ များတွင်ဥပစာတင်စားကာ အသုံးပြုကြသည်။ သာဓကပြရသော်–

"မိခင်ကြီးကဗွေဖောက်နေသဖြင့်သေမလောက်မွန်ထူနေပြီးအလွန်အကျွံပူပင်သောက ဖြစ်သွားကလား"

ဟူ၍တွေ့ရသည်။ ထို 'ဗွေဖောက်' ဟူသောဝေါဟာရသည် "မူလစိတ်ထားပြောင်းလည်း ဖောက်ပြန်သည်" ဟူသောအနက်ရသည်။ ထို့ပြင် 'ဗွေ' ဟူသော စကားလုံးကို 'ယူ' ဟူသော စကားလုံးနှင့်တွဲကာ 'ဗွေယူ' ဟူ၍လည်းသုံးကြောင်းကို သာဓကပြရသော်–

"အထင်လွဲလျှင် ဗွေမယူပါနှင့် ထိပ်တင်"

"ကျွန်မပြောမှားဆိုမှား ရှိလျှင်လည်း ဗွေမယူပါနှင့်သည်းခံ၍ နားထောင်ပါ။" ဟူ၍ တွေ့ရသည်။ 'ဗွေယူ' ၏အနက်မှာ 'သည်းမခံဘဲအပြစ်ယူသည်'ဟူသော အနက်ဖြစ်သည်။ နွား၊ မြင်းတို့တွင်ရှိသော ဗွေဆိုးကို အပြစ်ဟုမှတ်ယူသကဲ့သို့ လူတို့၌လည်း အပြစ်တစ်ခုခုကိုပြု လုပ်မိပါကပြုလုပ်ခံရသူကို အပြစ်မယူရန် တောင်းပန်သောအခါတွင် သုံးစွဲလေ့ရှိကြောင်းလေ့လာ တွေ့ရှိရသည်။ ဤနည်းဖြင့် နွား၊ မြင်းတို့တွင် တွေ့ရလေ့ ရှိသော 'ဗွေ' ၏အနက်ကို လူမှုကိစ္စ များတွင် ဥပစာတင်စားသုံးစွဲရာမှ အနက် အဓိပ္ပာယ်တိုးပွားလာသည်ကို လေ့လာတွေ့ရှိရ ပါသည်။

ယောက်ယက်ခတ်

'ယောက်ယက်ခတ်' ဟူသော နေ့စဉ်သုံးစကားသည်လည်း အများသုံးနယ်ပယ်တွင် ဥပစာအဖြစ် တင်စား သုံးစွဲနေသော ဝေါဟာရတစ်ခုဖြစ်သည်။ ရှေးက'ယောက်ယက်ခတ်' ကို 'ရောက်ရက်ခတ်' ဟူ၍ရေးသည်။ 'ယောက်ယက်ခတ်' ဟူသောဝေါဟာရနှင့် 'ရောက်ရက်ခတ်' ဟူသော ဝေါဟာရ တို့သည်အနက်အတူတူ ပင်ဖြစ်သည်။ 'ရ'မှ 'ယ'သို့ ဌာန်တူခြင်း ပြောင်းလဲလာခြင်းပင်ဖြစ်သည်။ 'ရောက်ရက်'၏ မူလသဘောမှာ' မငြိမ်မသက်လှုပ်ရှားနေသည့်သဘော'ပင် ဖြစ်သည်။ 'ယောက်ယတ်ခတ်'ဟူသောဝေါဟာရမှာ ရက်ကန်းလုပ်ငန်းဆိုင်ရာမှ ဆင်းသက်လာသော ဝေါဟာရ ဖြစ်သည်။ 'ယောက်'ကို 'ရက်ဖောက်လုံးတွင် ချည်ကိုရစ်ဖြင့် လှည့်၍ ရစ်ပတ်သွင်းသည်ကို ယောက်(သို့) ရောက် ဟုခေါ်ကြသည်။' ထိုသဘောဖြင့်–

"ထားသည့် ရက်ဖောက် မရောက်မရက်၊ တံခါးရွက်ဝယ်"

"ဖခင်ထံ ရက်ဖောက်ကိုရောက်၍ (လုံး၍) ဆောင်ယူရအံ့လောဟုကြံစည်လေ၏"

ဟူသောအသုံးများ၌တွေ့ရသည်။ ရက်ဖောက်ရာတွင်ချည်ကိုယောက်(ရစ်ပတ်)သည့်အခါ ငြိမ်သက်မှုမရှိပုံနှင့် ရက်ခတ်ရာတွင် ယောက်လုံး၏ခေါက်တုံ့ခေါက်ပြန်ရွေ့လျားနေပုံတို့ကို 'ယောက်ယက်ခတ်'ဟုဆိုခြင်းဖြစ်သည်။ 'ယောက်ယက်ခတ်' တွင်ပါသော 'ယက်ခတ်'သည် 'ရက်ခတ်'မှ ဌာန်တူဌာန်နီးပြောင်း လဲလာပြီး အသုံးတွင်ကျယ်ခြင်း ဖြစ်သည်။ ရက်ကန်းခတ်သည်ကို 'ရက်ခတ်' ဟူ၍ သုံးစွဲကြောင်း ကို –

"ယောထည် ရက်ခတ်သည့်အတတ်သည် ယောနယ်ကျေးလက်ဒေသ ရွေးမြန်မာတို့က စည်းကမ်းကာလနားယဉ်သွားနှင့်အချိတ်၊ အနွယ်၊ အပွင့်အပြောက်တို့ကို ရွေးရိုးရာမူဟန်မပျက်စေဘဲ ယောနယ်မြေ၌ ထိန်းသိမ်းရက်လုပ်ခဲ့ကြသော ယောလုံချည် ရက်ခတ်သည့် အတတ်ပညာ ဖြစ်ပါသည်။"

ဟူ၍တွေ့ရသည်။ ထို့ကြောင့် 'ယောက်ယက်ခတ်' ဟူသောဝေါဟာရမှာ ရက်ကန်းလုပ်ငန်းဆိုင်ရာမှဆင်းသက်သော နေ့စဉ်သုံးစကားလုံးဖြစ်ကြောင်းတွေ့နိုင်ပါသည်။ 'ယောက်ယက်ခတ်' ဟူသောဝေါဟာရကိုရက်ကန်းလုပ်ငန်းမှတစ်ဆင့်လူမှုကိစ္စတို့တွင်တင်စားကာအသုံးပြုကြသည်။တစ်နေရာမှတစ်နေရာသို့ ခေါက်တုံ့ခေါက်ပြန် သွားလာနေသည်ကိုလည်းကောင်း၊ မငြိမ်မသက် လှုပ်လှုပ်ရှားရှားဖြစ်နေသည်ကိုလည်းကောင်း၊ 'ယောက်ယက်ခတ်'ဟူ၍ တင်စားသုံးစွဲကြောင်းကို သာဓကပြရသော်–

"စိတ်တွင်းက မငြိမ်မသက် ယောက်ယက်ခတ် ဖြစ်၍နေသည်။"

ဟူ၍ တွေ့ရသည်။ 'ယောက်ယက်ခတ်' ဟူသောအသုံးကို ရှေးက 'ရောက်ရက်ခတ်'ဟူ၍ သုံးသည်ကိုတွေ့ရသည်။

"အချို့မဟာမိတ်များသည်ခြေမကိုင်မိ၊လက်မကိုင်မိသည့်အထိရောက်ရက်ခတ်နေကြ၏"

ဟူ၍ တွေ့ရသည်။ ထို့ကြောင့် 'ရောက်ရက်ခတ်' ဟူသော ဝေါဟာရအနက်မှာလည်း ငြိမ်မသက်၊ လှုပ်ရှားနေသည့်သဘောဖြစ်ကြောင်းတွေ့ရသည်။ ထိုဝေါဟာရသည်လည်း 'ရောက်ရက်' ဟူသော အသုံးမှ ဆင်းသက် လာကြောင်းကို–

"တွေ့ရာကြံစည်၊ မချိမဆန့်၊ လွင့်ပြန့်ရောက်ရက်၊စိတ်ဝိဘတ်များနှင့်"

"သူငယ်ရောက်ရက် အဆိုခက်"

ဟူ၍တွေ့ရသည်။ ထိုကြောင့် 'ယောက်ယက်ခတ်'ဟူသောဝေါဟာရနှင့် 'ရောက်ရက်ခတ်'ဟူသောဝေါဟာရတို့၏ အနက်သဘောမှာ အတူတူပင်ဖြစ်ကြောင်းတွေ့ရသည်။ ထို 'ယောက်ယက်ခတ်' ဟူသောဝေါဟာရသည် ဥပစာအဖြစ်တင်စားသုံးစွဲရာမှ အနက်တိုးပွားလာသည်ကို လေ့လာတွေ့ရှိရပါသည်။

ရှုစ်စပ်ကျင်ကျင်လည်

'ရှုစ်စပ်ကျင်ကျင်လည်' ဟူသော နေ့စဉ်သုံးစကားသည်လည်း အများသုံးနယ်ပယ်တွင် ဥပစာအဖြစ်တင်စားသုံးစွဲနေသော ဝေါဟာရတစ်ခုဖြစ်သည်။ 'ရှုစ်စပ်'နှင့်'ကျင်ကျင်လည်'ဟူသောဝေါဟာရနှစ်ခု၏အဓိပ္ပာယ်ကို ပေါင်းစပ်ထားခြင်းဖြစ်သည်။ 'ရှုစ်စပ်'ဟူသော ဝေါဟာရသည် လယ်ယာလုပ်ငန်းမှ ဆင်းသက်လာသောဝေါဟာရဖြစ်သည်။ 'ရှုစ်စပ်' ဟူသော ဝေါဟာရ၏ အဓိပ္ပာယ်မှာ 'လယ်တစ်ကွက်တွင် စပ်မိအောင် ထွန်ထားသောထွန်ရေးရှုစ်ချက်'တစ်နည်းအားဖြင့် 'လယ်ထွန်ရာတွင်ထွန်ရေးနှံ့စပ်၍ မြေညက်စေရန် ထွန်လေ့ရှိသော ထွန်ရေးရှုစ်ချက်ရှိသည့် လယ်ထွန်နည်း' တစ်နည်းဖြစ်သည်။ အရပ်ရှုစ်မျက်နှာနှံ့စပ်သည့်တိုင်အောင် ထွန်ဖြင့်(၈)ကြိမ်တိုင်တိုင် ထွန်ယက်

ရသည်ကို 'ရှစ်စပ်ကလည်' သည်ဟူ၍ ဆိုကြသည်။ ထိုသို့ လယ်ယာလုပ်ငန်းနှင့် သက်ဆိုင်သော ထွန်ရေးနှံ့စပ်လည်ပတ်ပုံ'ရှစ်စပ်ကလည်'ဟူသောဝေါဟာရကို အခြားလူမှု ကိစ္စများ၌ 'အလွန်နှံ့စပ်လည်ပတ်သည်' ဟူသော အနက်ဖြင့် ဥပစာတင်စားကာ အသုံး ပြုကြသည်။

"ရှစ်စပ်ကလည်နေသော လူ့ပန်ကာများပင်"

"သတင်းစာတွင်ဝင်၍ အလုပ်လုပ်သူသည် ရှစ်စပ်ကလည်မှ တန်ကာကျသည်။"

ဟူ၍တွေ့ရသည်။ 'ဂျင်ဂျင်လည်' ဟူသောအသုံးသည် 'ဂျင်ကလည်(ဂျင်ခြေလည်) 'ဟူ၍ သုံးရာမှ ပြောင်းလဲလာသော ဝေါဟာရဖြစ်သည်။ 'ဂျင်' ဟူသော ဝေါဟာရ၏ အဓိပ္ပာယ်မှာ 'ကြိုးနှင့်ရစ်၍ ပေါက်ကစားရသော သံဆူးအခြေပါသည့်သစ်သားလုံးငယ်' ဖြစ်သည်။ ဂျင်၏ လည်ပတ်ပုံကို လူမှုကိစ္စများတွင်ဥပစာတင်စားကာ'ဂျင်ဂျင်လည်'ဟူ၍ လည်းကောင်း၊ 'ဂျင်ခြေလည်'ဟူ ၍ လည်းကောင်း 'ဂျင်ကလည်' ဟူ၍လည်းကောင်းအမျိုးမျိုးအသုံးပြုကြသည်။သာဓကပြရသော်–

"ကိုမှတ်တင်က မိသားစု၏မန်နေဂျင်း၊ ဂျင်ခြေလည်အောင်လှုပ်ရှားသမျှကို အမြတ်များချင်လှ၏။"
"စင်စစ်သည်ကား ဦးထွန်းဇော်မှာ သားအမိသုံးယောက်တို့ အလည်တွင် ဂျင်ကလည်သဖွယ် မွေ့ချင်တိုင်းမွေ့ခြင်းခံရရှာသူတစ်ယောက်ဖြစ်ချေ၏။" ဟူ၍တွေ့ရသည်။ ယင်းဝေါဟာရတို့၏ အနက် အဓိပ္ပာယ်မှာ 'အလုပ်အလွန်များသည်' ဟူသော အနက်အဓိပ္ပာယ်အတူတူပင် ဖြစ်သည်။ 'ဂျင်ဂျင်လည်' ဆိုသည်မှာ 'ကျင်ကျင်လည်' တစ်နည်း 'ကျင်လည်'သည့်သဘောပင်ဖြစ်သည်။ 'လည်လည်ပတ်ပတ်ဖြစ်သည်၊ နှံ့စပ်ကျွမ်းကျင်သည်' အနက်အဓိပ္ပာယ်ပင်ဖြစ်သည်။ ထွန်ရေးရှစ်စပ်လည်ပတ်ပုံနှင့် ဂျင်၏လည်ပတ်ပုံသဘောတို့ကို ဥပစာတင်စားကာ 'အလွန်လည်ပတ်နှံ့စပ်သည့်' သဘောဖြင့် 'ရှစ်စပ်ကဂျင်ဂျင်လည်' ဟူ၍ အသုံးပြုရာ မှအနက်တိုးပွားလာသည်ကို လေ့လာတွေ့ရှိရပါသည်။

အတောမသတ်

'အတောမသတ်'ဟူသောနေ့စဉ်သုံးစကားသည်လည်း အများသုံးနယ်ပယ်တွင်ဥပစာအဖြစ် တင်စားသုံးစွဲနေသော ဝေါဟာရတစ်ခုဖြစ်သည်။ 'အတော'နှင့်'မသတ်'ဟူသော ဝေါဟာရနှစ်ခု ကို ပေါင်းစပ်ထားခြင်းဖြစ်သည်။'အတော'ဟူသော ဝေါဟာရမှာ 'တော'မှ ဆင်းသက်လာသော စကား ဖြစ်သည်။'တော'၏အဓိပ္ပာယ်မှာ'သီချင်းစာသားမပါသောတီးလုံးအပိုဖြည့်၍ဖွဲ့နွဲ့တီးမှုတ်သည်'ဟူ၍ ဖြစ်သည်သာဓကပြရသော်–

'ပုလဲသံမှန်ကို ဖွင့်လျက် စောင်းနှင့်တော၍ တီးမှုတ်ကြသောအခါ'

ဟူ၍ သုံးသည်ကိုတွေ့ရသည်။ ထို'တော' ဟူသောဝေါဟာရကို 'အ'ရှေ့ဆက်ထည့်ကာ 'အတော' ဟူ၍ သုံးကြောင်းကို–

"သီဆိုရာ၌ ပိုမိုကောင်းမွန်၍ အဆင်ပြေအောင် တူရိယာက တီးလုံးတေးသွားဖြင့် အမွှန်းတင်၍ ပေးလိုက်ခြင်းကို အတောဟု ခေါ်သည်။"

"ဆိလျော်သင့်မြတ်သောတူရိယာသံတို့ဖြင့်အမွှန်းတင်လိုက်သောတေးသွားသံကို အတောဟုခေါ်သည်။"

ဟူ၍ တွေ့ရှိရသည်။ 'အတော၏အဓိပ္ပာယ်မှာ 'သီချင်းသီဆိုတီးမှုရာတွင် ဖြည့်စွက်တီးမှုတ် ရသော တူရိယာတေးသွား' ဟူ၍ဖြစ်သည်။ သီချင်းတစ်ပုဒ်ကိုသီကျူးရာတွင် သီဆိုသူနှင့် တီးခတ်သူတို့ စည်းဝါးကိုက်မှသာလျှင် နားဝင်ချိုနိုင်မည်ဖြစ်သည်။ ထို့ကြောင့်သီဆိုသူနှင့် တီးခတ်သူတို့စည်းဝါး ကိုက်ညီမှုရှိစေရန် 'အတော'ကိုထည့်သွင်းပေးရသည်။ သီချင်းတစ်ပုဒ် သီဆိုရာတွင် တစ်ပိုဒ်ဆုံးပြီး တိုင်း အနားယူနိုင်ရန် အတောတေးသွားကိုတီးခတ်ပေးရသည်။

ယင်းအတောတေးသွား ရှည်နေ၍ အဆုံးမသတ်နိုင်ဖြစ်နေသည်ကို 'အတောမသတ်နိုင်' ဟူ၍ ဆိုလေ့ရှိသည်။ ထိုသဘောကိုမှီ၍ 'အတော မသတ်နိုင်' ဟူသောအသုံးကို ဥပစာ တင်စားရာတွင်–

"ကိုယ်ဘာသာကိုယ် ကြိတ်၍တွေးရင်း အတောမသတ်နိုင်အောင်ရယ်နေမိ၏"

"လူရွှင်တော်ရဲ့ပြက်လုံးကြောင့် ပရိသတ်တွေအတောမသတ်အောင်ရယ်နေရတယ်"

ဟူ၍တွေ့ရသည်။ထို့ကြောင့် 'အတောမသတ်' ဟူသည် 'ပြီးဆုံးရပ်စဲခြင်းမရှိ' ဟူ၍ အနက်ရသည်။ ထိုသို့ 'တော' ဟူသောဝေါဟာရမှ 'အတော' ဟူ၍လည်းကောင်း၊ 'အတော'မှ 'အတောမသတ်'ဟူ၍ လည်းကောင်း ပြောဆိုသုံးစွဲရာမှ ရှိရင်းစွဲစကားလုံးကိုပင် အခြားအခြားသောလူမှုကိစ္စများတွင် ပြောင်းလဲအသုံးပြုလာခြင်းကြောင့် စကားလုံးဖောင်းပွမှုကို ထိန်းချုပ်နိုင်သကဲ့သို့ အနက်အဓိပ္ပာယ် လည်း ကျယ်ဝန်းလာရသည်။

အတိုင်အဖောက်ညီ

'အတိုင်အဖောက်ညီ' ဟူသောဝေါဟာရမှာ ရက်ကန်းလုပ်ငန်းဆိုင်ရာမှ ဆင်းသက်လာသော ဝေါဟာရဖြစ်သည်။ 'အတိုင်' 'အဖောက်'နှင့်'ညီ' ဟူသောဝေါဟာရတို့ကို ပေါင်းစပ်၍ အသုံးပြုထားခြင်း ဖြစ်သည်။ ရက်ကန်းရက်လုပ်ရာတွင် အလျားလိုက်သွယ်တန်းထားသော ချည်ကို 'တိုင်ချည်တစ်နည်းအတိုင်ချည်' ဟူ၍ခေါ်ပြီး လွန်းအတွင်းရှိရစ်ဖောက်တွင် ရစ်ထားပြီး ၄င်းအတိုင်း ကန့်လန့်ရက်သောချည်ကို 'ဖောက်ချည် တစ်နည်း အဖောက်ချည်' ဟူ၍ ခေါ်ကြောင်းကို–

"အဖောက်ချည်သည် အတိုင်ချည်နှင့် ယင်းအတိုင်ချည်များအတွင်း လွန်းဖြင့်ခေါက်တုံ့ခေါက်ပြန်လျှိုသွင်းရသည်။လွန်းအတွင်းရှိ ရစ်ဖောက်တွင် ရစ်ထားသောချည်ကို ဖောက်ချည်ဟုခေါ်သည်။လွန်းမှအဖောက်ချည်စ သည်အတိုင်ပင်ချည်ကြားတွင်လွန်းနှင့် အတူ အသွားအပြန်လှုပ်ရှားပြေးလွှားနေသည်။ရက်ကန်းရက်ရာတွင်အတိုင်ချည်နှင့် အဖောက်ချည် အကြီးအသေးညီမျှမှုရှိသည်ကို အတိုင်အဖောက်ညီသည်"

ဟူ၍တွေ့ရှိရသည်။ ရက်ကန်းခတ်ရာတွင် လွန်းမှအဖောက်ချည်သည် အတိုင်ပင်ချည်ကြား၌ လွန်းနှင့်အတူအသွားအပြန်လှုပ်ရှားပြေးလွှား နေရသည်။ထိုသို့အနေအထားတွင် အတိုင်ချည်နှင့် အဖောက် ချည်တို့သည်အရွယ်ပမာဏအကြီးအသေး၊ ခိုင်ခဲ့မှုစသည်ဖြင့်ညီညွတ်ရသည်။

ညီညွတ်မှုမရှိပါက အထည်ပြေပြစ်ချောမွေ့မှုမရှိခြင်း၊ ချည်မျှင်များပြတ်တတ်ခြင်းစသည်ဖြင့် အခက်အခဲများကိုတွေ့ရသည်။ ထို့ကြောင့်အတိုင်အဖောက်ညီမှသာလျှင် အထည်ကောင်းမွန်ပြီး ချောမွေ့အဆင်ပြေမည်သာ ဖြစ်သည်။ ထိုသဘောကိုအခြေခံပြီး အခြားလူမှုကိစ္စနယ်ပယ်များတွင် ဥပစာတင်စားကာ အသုံးပြု ကြောင်းကို သာဓကပြရသော်–

"တိုက်အုပ်ဆရာတော်နှင့် တိုက်ကြပ်ဆရာတော်သည် အချီအချအတိုင်အဖောက် အလွန်ညီညွတ်လှပေသည်၊"

"သားအမိ၊သားအဖတွေအတိုင်အဖောက်ညီနေလိုက်တာ"

ဟူ၍တွေ့ရသည်။ အဓိပ္ပာယ်မှာ"အစချီသူနှင့် နောက်လိုက်သူတို့ညီညွတ်ကြသည်"ဟူသောအနက်ရသကဲ့သို့ " နှစ်ဦးနှစ်ဖက်ပူးပေါင်းဆောင်ရွက်ရသောကိစ္စများတွင် အပေးအယူ၊ အယူအဆလိုက်လျောညီညွတ်ပြေပြစ်သည်' ဟူသောနက်အဓိပ္ပာယ်ရသည်။ဤနည်းဖြင့် မူလဝေါဟာရ၏ အနက်ကို အခြေခံကာအနက်အဓိပ္ပာယ်များ တိုးပွားလာသည်ကို လေ့လာတွေ့ရှိရပါသည်။

အမွှမ်းတင်

'အမွှမ်းတင်'ဟူသောဝေါဟာရသည် 'အမွှမ်း'နှင့် 'တင်' ဟူသောဝေါဟာရတို့ကိုပေါင်းစပ်၍ အသုံးပြုထားခြင်းဖြစ်သည်။ 'အမွှမ်း' ဟူသောဝေါဟာရသည် ဗိသုကာသုံးဝေါဟာရဖြစ်သည်။ 'အမွှမ်း' ဟူသောဝေါဟာရသည် 'အမွှမ်း' ဟူသောဝေါဟာရမှ ဆင်းသက်လာခြင်းဖြစ်သည်။ 'မွှမ်း' ၏ အဓိပ္ပာယ်မှာ 'မွှမ်းမံခြယ်လှယ်သည်၊ ပို၍မြတ်နိုးဖွယ်တင့်တယ်အောင်ပြုသည်' ဟူသောအဓိပ္ပာယ်ရသည်။သာဓကပြရသော်–

"ခါးပန်းအမွှမ်း၊ နင်းကြမ်းပြင်တော့၊ရွှေငွေမွှမ်းသည်"

"ရွှေချရင်လွှမ်း၊ရွှေခြည်မွှမ်း၍၊အားရမ်းအင်တက်"

ဟူ၍တွေ့ရသည်။ ထို'မွှမ်း'ဟူသောစကားလုံးကို '-'ထည့်ကာ 'မွှမ်း'ဟူ၍ သုံးစွဲကြပုံကို–

"နှင်တံ ပတ္တမြား၊ မြသားအုပ်ခက်၊ လည်ဖက်ပြိုးပြွမ်း၊မျက်စုံမွှမ်းလျက်"

ဟူ၍တွေ့ရသည်။အဓိပ္ပာယ်မှာ 'မွှမ်း'နှင့် အတူတူပင်ဖြစ်သည်။ ဗိသုကာလုပ်ငန်းတွင် ပို၍လှပအောင်အဆင်တန်ဆာခြယ်ခြင်းကို'အမွှမ်းတင်'ဟူ၍ သုံးစွဲကြသည်။ ထို'အမွှမ်းတင်'ဟူသော အသုံးကို 'ချီးကျူးဂုဏ်တင်သည်' ဟူသောအနက်နှင့် ဥပစာတင်စားကာ အသုံးပြုလာကြသည်။

သာဓကပြရသော် –

"အင်စပက်တော် မောင်တက်တူမှာ ချင်းလူမျိုးပင် ဖြစ်သော်လည်း တိုက်ရည်ခိုက်ရည်
ရှိသူဖြစ်ပြီးလျှင် သဘောထားကြီးသူတစ်ယောက်ဖြစ်ကြောင်းနှင့် ခင်မြမေအား
အမွှမ်းတင်၍ပြောလေ့ရှိ၏။"

ဟူ၍ တွေ့ရသည်။ 'အမွှမ်းတင်' ဟူသောအသုံးသည် 'လှပအောင် အဆင်တန်ဆာခြယ်ခြင်း' ဟူသော ဗိသုကာအသုံးမှ လူမှုကိစ္စနယ်ပယ်တွင် 'ချီးကျူးဂုဏ်တင်သည့်' ဟူ၍ အနက်နှီးနွှယ်ကာ အသုံးပြုခြင်းဖြင့် ဝေါဟာရအနက်တိုးပွားလာသည်ကို လေ့လာတွေ့ရှိရပါသည်။

ခြုံငုံသုံးသပ်ချက်

မြန်မာလူမျိုးတို့ပြောဆိုသုံးစွဲနေသောနေ့စဉ်သုံးမြန်မာဘာသာစကားတွင် တင်စား၍သုံးစွဲနေသော ဥပစာစကားလုံးများရှိသည်။ထိုဥပစာစကားလုံးများကိုမူလအနက်အဓိပ္ပာယ်မှတင်စားပြီး အဓိပ္ပာယ်ပွားယူကာ သုံးစွဲခဲ့ကြသည်။ ထိုသို့အနက်ပွားခြင်းဖြင့် မြန်မာဘာသာစကားတိုးပွားခြင်း၊ အကျိုးကျေးဇူးကိုရရှိခဲ့ပါသည်။မြန်မာလူမျိုးတို့သည် မိမိတို့ဘာသာစကားတိုးတက်ရန်အတွက် စကားလုံးပွားကာအသုံးပြုသကဲ့သို့၊ အနက်ပွားကာလည်းအသုံးပြုကြသည်။ အနက်တစ်ခုထက်ပိုသည့် စကားလုံးဖြစ်စေရန်ဥပစာတင်စားမှုသည်လည်းအရေးပါသည်။ စကားလုံးများကျယ်ပြန့်လာသော်လည်းအသစ်မတီထွင်တော့ဘဲ၊ရှိပြီးသားစကားလုံးများတွင် တင်စားအသုံးပြုရာမှအနက်အဓိပ္ပာယ်ပွားများလာပြီးမြန်မာစကားအသုံးအနှုန်းအဓိပ္ပာယ်တိုးပွားလာကြောင်းကိုလေ့လာတွေ့ရှိရပါသည်။

နိဂုံး

လူတို့၏နေ့စဉ်သုံးဘာသာစကားသည် ရှင်သန်လျက်ရှိသော ဘာသာစကားဖြစ်သည်။ ထို့ကြောင့် နေ့စဉ်သုံးဘာသာစကားများတွင် ကွယ်ပျောက်သွားသောအနက်များ၊ ပြောင်းလဲသွားသောအနက်များရှိသကဲ့သို့ပွားများလာသောအနက်များလည်းရှိသည်။ထိုအနက်များအနက်ယခုတင်ပြထားသော စာတမ်းသည်ပွားများလာသောအနက်ကို တင်ပြထားခြင်းဖြစ်သည်။ အနက်ပွားရာတွင်မူလအနက်နှင့်လုံးဝမတူသောအနက်များမဟုတ်ဘဲ မူလအနက်မှတစ်ဆင့်ခံကာတိုးပွားလာသောအနက်များကို လေ့လာခြင်းဖြစ်သည်။ သို့ဖြစ်ပါ၍မြန်မာစကားတိုးတက်မှုအတွက် အနက်ပွားမှုသည် အထောက်အကူဖြစ်သည်ဟု ထင်မြင်မိပါသည်။

ကျေးဇူးတင်လွှာ

ဤစာတမ်း ဖြစ်မြောက်ရေးအတွက် ကူညီပေးပါသော တောင်ကုတ်တက္ကသိုလ် ဒုတိယပါမောက္ခချုပ်၊ ဒေါက်တာသန်းထွဋ်လွင်၊ မြန်မာစာဌာန၊ပါမောက္ခ(ဌာနမှူး)ဒေါက်တာသန်းထိုက်နှင့် တောင်ကုတ်တက္ကသိုလ် သုတေသနဂျာနယ် ဖြစ်မြောက်ရေးအဖွဲ့တို့ကို ကျေးဇူးတင်ရှိပါသည်။

ကျမ်းကိုးစာရင်း

ခင်မင်၊ မောင်(ခနုဖြူ)။(၁၉၈၅)။ ***စကားပြေသဘောတရား စကားပြေအတတ်ပညာ***။ ရန်ကုန်၊ မြန်မာစာဌာန။

ခင်မင်၊ မောင်(ခနုဖြူ)။(၁၉၉၇)။ ***စကားသမုဒ္ဒရာ စာသမုဒ္ဒရာ***။ ရန်ကုန်၊ မြမြဝင်း ပုံနှိပ်တိုက်။

ခင်မင်၊ မောင်(ခနုဖြူ)။(၂၀၀၁)။ ***တစ်သံနှစ်သံသုံးလေးသံ***။ ရန်ကုန်၊ ကံသာ ပုံနှိပ်တိုက်။

ခင်မင်၊ မောင်(ခနုဖြူ)။(၂၀၀၉)။ ***ဘာသာအမြင်စာပေအမြင်***။ ရန်ကုန်၊ ပုဂံစာအုပ်တိုက်။

ခင်အေး၊ဒေါက်တာ။(၂၀၁၄)။ ***အတ္ထဇေဒနီဒါန်း*** ။ ရန်ကုန်၊ ပညာတန်ဆောင် ပုံနှိပ်တိုက်။

ငွေဒေါင်းဖြူ။(၁၉၆၅)။ ***နေ့စဉ်သုံးမြန်မာဝေါဟာရ အဘိဓာန်***။ ရန်ကုန်၊ ဒေးလီးဂေဇက် ပုံနှိပ်တိုက်။

စိန်ဝင်း၊ရေနံ့သာ။(၁၉၉၆)။ ***မြန်မာ့ရိုးရာရက်ကန်းပညာ***။ ရန်ကုန်၊ စာပေဗိမာန်။

တင်လှ၊ဦး။(၁၉၆၆)။ ***ဘာသာနှင့်စာပေ***။ ရန်ကုန်၊ ကုမာရစာပေ။

နှစ်ဖက်လှ။(၁၉၆၈)။ ***ကဗျာလင်္ကာနှင့်နည်းပစာအကျယ်ဖွင့်ကျမ်း***။ ရန်ကုန်၊ စာပေလောက။

ပါရဂူ။(၁၉၇၅)။ ***သီပေါဓ၏မဟေသီ***။ ရန်ကုန်၊ မဟာနန္ဒာစာပေ။

မြန်မာစာအဖွဲ့။(၁၉၉၀)။ ***မြန်မာအဘိဓာန်***။ ရန်ကုန်၊ မြန်မာစာအဖွဲ့ဦးစီးဌာန။

မြန်မာစာအဖွဲ့။(၁၉၉၉)။ ***ခရီးဆောင်မြန်မာအဘိဓာန်***။ ရန်ကုန်၊ မြန်မာစာအဖွဲ့ဦးစီးဌာန။

လှသမိန်။(၁၉၆၇)။ ***မြန်မာစာအမြုတေ***။ ရန်ကုန်၊ သူဇာပုံနှိပ်တိုက်။

အောင်မြင့်ဦး၊ဒေါက်တာ။(၂၀၁၀) ။***ဘာသာစကားသုတေသန***။ ရန်ကုန်၊ ဓူဝံစာအုပ်တိုက်။

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Geographical Assessment of Solid Waste Disposal Problems in Taunggoke, Rakhine State

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Abstract

The study tends to identify the solid waste disposal problems in Taunggoke, Rakhine State. Taunggoke is situated in the western coastal region of Myanmar and it is part of Taunggoke Township. Taunggoke is developing in economic, increasing in population and extension in urban area. The amount of waste is increasing and so, the effective handle of this waste has become important issue. Most of the people in the study area have poor knowledge or poor awareness perception on about solid waste disposal. Besides, insufficient waste collection and disposal system, people in the area practically dump the garbage in the nearby water bodies. Since Taunggoke Creek flows through the town, the creek suffers much of water pollution due to garbage dumping. Thus this study aimed to solve immediate challenge for the decision makers and planners how to improve the solid waste management system. In this study, primary data from field observation and questionnaire are mainly used and secondary data from concerned department were analyzed by using GIS techniques with Arc Map software. The results of this analysis show that the distribution of temporary dustbins sites are insufficient, waste collection service is limited and use and immediate disposal of solid waste of town dwellers are found especially plastic grocery bags.

Introduction

Solid waste is inevitable by products of man's daily activities. These are waste materials discharged and unnecessary from everyday life. These discarded materials affect the environment. Solid waste disposal is very important to keep the environment clean and beautiful. These are also direct relationship between public health and the environment. During the early period, solid wastes were conveniently and unobtrusively disposed of, as the density of population was low with large open land space. High population density, extensive landused for residential, commercial and changes of behavior use led to adverse impact on the environment.

Waste management problems have already become severe in many places including Taunggoke. This problem is compounded by the rapidly increasing amount of waste of complex nature and composition, which result from the growth in urban population and changes in their consumption patterns. The sources of waste are related to landuse of Taunggoke. The most important categories can be classified to include residential, commercial, institutional and others. The volume of waste from residential is greater than other sources. Without an effective and efficient solid waste management program, the waste generated from various human activities can result in health hazard and negative impacts on the environment. Management of municipal solid waste is becoming one of the priority urban issues and how much impact on environment should be studied.

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Aim and Objectives

- to solve immediate challenge for the decision makers and planners how to improve the solid waste management system.
- to share knowledge the attitudes and perception of people towards a systematic solid waste disposal.
- to create people awareness and to encourage participation in environmental promotion activities.

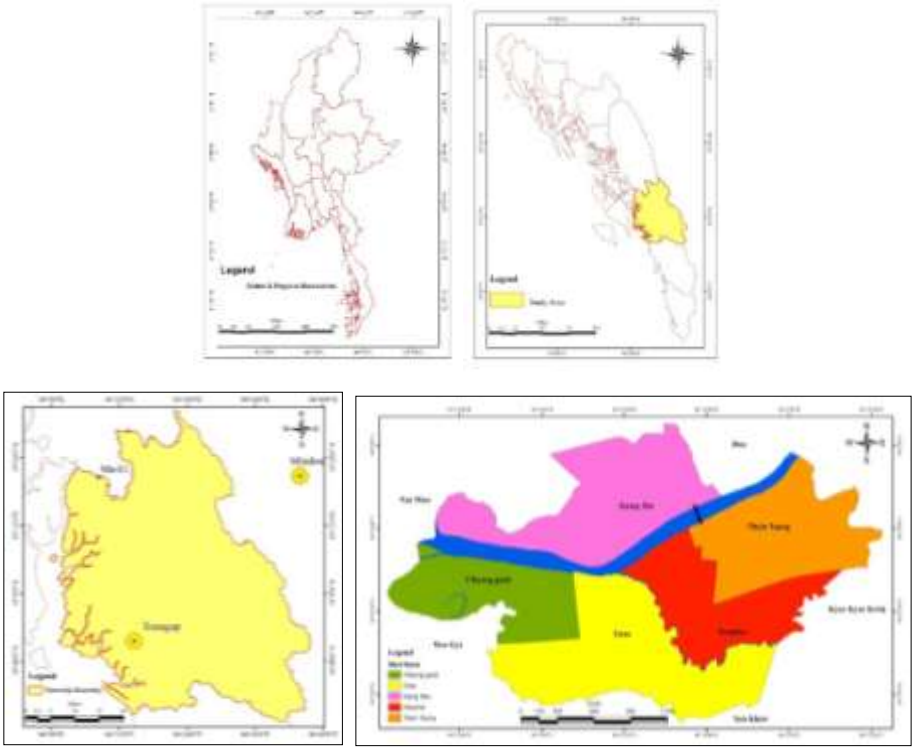
Methodology

In the course of this study, made literature reviews, observed environmental point of views, discussed and interviewed with Municipal officers and household level and delivered the questionnaire papers to the residents while examining the state of the solid waste disposal problem in Taunggoke. Geographical Statistics analysis was also analyzed.

Physical Conditions

Taunggoke is situated between the Rakhine Yoma and the Bay of Bengal and in the southern part of the Rakhine State. It lies between the northern latitudes of 18º 38′ and 19º 20′, and the eastern longitudes of 93º 59′ and 94º 18′. Taunggoke covers an area of about 4.52 square miles and composed of 5 wards which represent 0.08% of the Taunggoke Township.

The physical configuration of this township is mainly affected by the Rakhine Yoma and the sea. So, It is abundant the numerous mountain ranges and sparse. The Taunggoke Chaung, one of the major streams originates over the Rakhine Yoma and flows westward into the Bay of Bengal.



Map 1. Location Map of Taunggoke

Sources: UTM Map:1894_01, 1894_02, 1894_05, 1894_06, 1894_09, 1894_10, 1994_03, 1994_04, 1994_07, 1994_08, 1994_12,

Population Conditions

Population is a key factor for determining any form of urban solid waste problems study in Taunggoke Town. There were 28650 persons in 2014 and the population gradually increased to 31988 persons in 2019.

In 2019, the households of the whole town were 6799 and the numbers of houses were 6393. The rapid growth of population, extension of urban area and development of economic in Taunggoke are increasing the amount of solid waste and the effective handle of this waste has become important issue.

Solid Waste Sources and Generation in Taunggoke

Solid Waste is one of the important challenges to the environment. Municipalities; generally; are responsible for the waste management. Solid Waste is usually generated from variable sources where different human activities are encountered. In the study area, residential wastes including kitchen, household, yard and estate wastes are the main sources of solid waste in Taunggoke. The other important sources are commercial waste including market, hospital and clinical waste and others. Wastes from any sources have to collected daily and temporary kept the buildings or disposed at the nearest dumpsite. And now, these are 3 temporary dustbin sites in Taunggoke. Some are disposed into streamlets and mostly are discharged into the Taunggoke Chaung via open drains or existing natural streams without proper treatment.

According to the data of Township Development Committee, it is estimated that the biggest volume of solid waste is generated from residential waste (50%), the second in rank is market waste (20%), and hospital waste (5%) is the third in rank and other sources waste are (25%) respectively. Based on the study, the estimated amount of waste is about 5 tons per day.

Present Situation of Solid Waste Management in Taunggoke

Taunggoke Township Development Committee is responsible for the collection of solid waste generated in the Taunggoke municipality area.

Collection

One of the major tasks of Taunggoke Township Development Committee is to collect and dispose solid waste from the residential areas. The frequency of solid waste collection in residential areas is twice per week. These are two main daily activities, early morning and evening waste collection and waste collection through bell ringing system. Wastes are collected with three waste collection vehicles. This is the collection of solid waste by a truck with four workers for handling.

Another important task of Township Development Committee is the collection of solid waste from markets and cleaning the surrounding of Municipal market (Sipintaryar market). In Taunggoke, there are one market and four bazaars; Municipal market (Sipintaryar market), Seiyonkwetthit morning bazaar, Kaingshe morning bazaar and evening Nyazay bazaar. In Municipal market (Sipintaryar market), shop owners and vendors store their wastes in the baskets or plastic bags beside their stalls. As market closes, they collect their wastes and keep it ready to transfer to dumpsites of the market place. There are two workers for waste cleaning management in the market. Waste collection vehicle collects solid waste from this daily in 3:00 pm. Generating of solid waste from Seiyonkwethit morning Bazaar and evening Nyazay Bazaar regularly collect by waste collective vehicles, except Kaingshe morning Bazaar and Theintaung morning Bazaar. Therefore, the solid waste of Kaingshe morning Bazaar is easily disposed of

beside the Taunggoke Chaung. But in Theintaung morning Bazaar, vendors store their waste in plastic bags and keep it to dispose to final dumpsite by using rented vehicles in one time per week.

Hospital waste or biomedical waste or infections waste is permitted to be collecting two times per week. Nearly all of the wastes generated from other sources have to apply to Taunggoke Development Committee and ask for the permission. However, the cost depends upon amount and kind of waste and distance to final disposal site.

Storage

Residents participating in the existing solid waste management system store their solid wastes in basket or bin or plastic bag or sack of different size and shape and keep the inside their house, mostly in the kitchen . The waste collection vehicles collect the waste at regular intervals for final disposal. But where bell ringing system is not available; town dwellers carry wastes to nearby roadsides or public places or streams and drains, especially into Taunggoke Chaung.

Transportation

Township Development Committee set up the time schedule and three vehicles for collection and transportation. The waste is directly loaded onto these vehicles manually and spades or baskets.

Final Disposal Site

The safe and reliable long-term disposal of solid waste is an important component of integrated waste management. Decision makers and planners are facing problems to get proper site for final disposal. The present condition of final disposal site in Taunggoke is located near the Gyokyarkwin village at Natpingyi, but this is only temporary site. After the rainy season, Decision makers and planners are carrying out to move the existing site to near Phonnyo Mountain.

Recycling

The waste collector shops not only somewhat reduce the solid waste and help clean and beautify the city, but also play an important role in waste recycling industry. There are 8 large scale waste collector shops and over 10 small scale waste collector shops in Taunggoke according to field observation. These shops buy all kinds of waste from any sources. Most household routinely separate recyclable waste such as bottle, paper, plastic, iron scrap and etc. for sale to itinerant buyers, or sell them directly to waste collector shops. The garbage is sorted out and taken by gatherer were also sold at these shops. Ultimately, waste collector shops resell directly to the appropriate processing factories for reuse as raw materials to Yangon.

Current Waste Disposal Problems in Taunggoke

Within the wards where absolute lacking with dustbin sites and waste collection route, almost all waste are easily disposed by throwing them down from the riverside without considering any environmental impact for many years. Since Taunggoke Chaung suffers much of the water pollution due to easy way of waste disposing. There are mainly due to insufficiency of waste dustbins, improper maintenance and distribution of dustbins, insufficient waste collection vehicles and labourforces and public awareness of waste disposal practice.

Insufficient of Waste Dustbins

There are 5 temporary dustbins sites in last year. But effective solid waste management systems of Township development Committee are limited. Therefore, some

of these dumpsites are incompatible with the surroundings. Wind blows litters and spreading wastes outside the sites and on the surrounding roads and adjacent surface water. People are protested to close sites because of nuisance. Therefore, the city authority is thinking to control the negative impacts of the temporary dumpsites. As these conditions, there are 2 dustbins sites and 1 dumpsite within the study area. Nevertheless, according to questionnaires, most people where no bell ringing system areas, are willing to bring their household wastes to nearby disposal sites that mostly exist at road-corners.

Insufficient of Vehicles and Labourforces

In Township Development Committee, there are 3 waste collection vehicles and 12 workers. The total amount of waste generated are 5 tons per day and the frequency of waste disposal per vehicle per day is two times. Although all wards in Taunggoke are planned to give bell ringing system by Township Development Committee, the service system cannot perform sufficiently and efficiently. Nevertheless, some streets and paths are narrow to access by vehicles for waste collection and difficult to give bell ringing system. Limited roads and streets can enjoy bell ringing system in Taunggoke by waste collection vehicles. If the waste collection vehicles access to the whole roads and streets in the study area, vehicle and labourforces inadequacy will increase. The total numbers involved in waste disposed are not enough for the whole town. Even though, the workers at the disposal site handle the wastes without any protective working equipment. The workers are easily exposed to waste related health problems. So, no one is more willing to work in municipal solid waste collection and disposal processes.

Waste Disposal Practice in Residential Area

The area where is no service by dustbins sites and bell ringing system, town dwellers to dispose their household waste is difficult. So, most of the people use to dispose their household waste indiscriminately instead of proper dustbins or sites into the drains especially Taunggoke Chaung and streamlets. These wastes are mostly composed of biodegradable and non-biodegradable substances. Biodegradable substances are those which decompose naturally in the environment such as air, water, soil, etc. and non-biodegradable substances are those wastes which do not decompose easily naturally in the environment, cause pollution and also harmful to the living being. Indiscriminate non-biodegradable substances especially plastic bags disposal practice has result in Taunggoke Chaung degradation with water pollution.

Plate 1. Indiscriminately Dispose into the Drain
Sources:Field Survey in 2020

Plate 2. Indiscriminate Dumpsites at the Streamside
Sources:Field Survey in 2020

Present Waste Collecting Routes

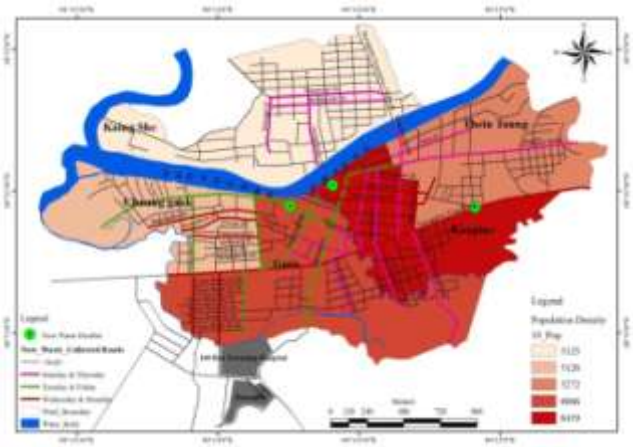
In Taunggoke, there are mainly four roads such as Ann-Taunggoke, Taunggoke-Pyay, Taunggoke-Thandwe and U Ottama and any number of streets. Above those roads and only few streets operate bell ringing system every alternate day by waste collecting vehicles. Waste collecting vehicles do not have sufficient to extend the service to feeder streets of these main collection routes.

Map 2. Location of dustbins sites and waste collecting routes before 2019
Sources: Google Earth, 2019 and Township Development Committee

Map 3. Location of dustbins sites and waste collecting routes after 2019
Sources: Google Earth, 2019 and Township Development Committee

Overlay Analysis on Insufficiency of Waste Collecting Routes

According to, map overlaying analysis method was made with the data of population density, waste collection routes, streams and dustbin sites.



Map 4. Overlay analysis of the population density, dustbin sites, streams and waste collecting routes
Sources: Google Earth, 2019, Township Development Committee and Immigration Department of Taunggoke Township

Some of the population density area such as Guta, Kanpaine and Chaunggauk wards between U-Ottama Road and Taunggoke-Pyi Road that can find to collect the most of the waste collecting routes. The remaining population density areas are not preferable to dispose their waste with the condition of present waste collecting routes. Most of the streets of Theintaung and Kaingshe wards are absolute lacking by both services (service collection route and service where the people want to dustbin). The areas where there no service by calculating with both method, town dwellers are often do not dispose the garbage into the waste dustbins and wastes are usually roadside and use to dispose in the

drains indiscriminately. As a result, flooding and inundation occurred by blocking of drain in the rainy season. This should take action to improve the waste disposal management in Taunggoke Town.

Findings and Discussion

Respondents of public cooperation, education level, awareness on waste disposal and estimated plastic bags consumption and disposal are one of the most influencing indicators on solid waste disposal problems in Taunggoke.

During the process of primary data collection, some of the respondents were not ready to cooperate and also did not fill in questionnaires. So, RSM (Random Sampling Method) questionnaire gave on about 500 households and 100 questionnaires each ward respectively but given back answer were about 365 household.

Public Cooperation on Solid Waste Disposal Questionnaire in Each Ward

During the study undertaking, the majority of respondents were Kaing She (24.9%), Gutar (24.4%), Theintaung (21.6%), Kanpaing (18.1%) and Chaungkauk (11%) respectively. This result shows that resident in Kaingshe where waste disposal services of Township Development Committee are not enough available. Therefore, most of the respondents were ready to cooperate on this Questionnaire and they want to solve the present inefficient waste disposal management.

Table (1) Number of Suggestion Respondents of the Wards

No	Respondents	Number of Households	%
1	Kaing She	91	24.9
2	Chaung gauk	40	11.0
3	Thein Taung	79	21.6
4	Guta	89	24.4
5	Kanpine	66	18.1
Total		365	100.0

Sources: Field Survey in 2020

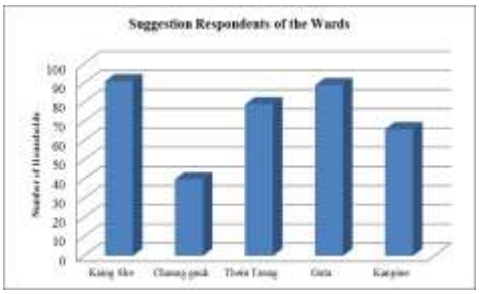


Figure (1) Suggestion Respondents of the Wards

Sources: Based on Table. 1

Respondents on Education Level

Further analysis of the data showed that education level is one of the most influencing indicates on attitudes and perceptions of people to solid waste disposal management in Taunggoke. The level of education the number of respondents: who gave back their suggestion questionnaire. Generally, it can be suggested that people who have higher level of education have the more knowledge and interest for more environmental promotion activities.

Table (2) Education Level of Respondents

No.	Level of Education	Nounmber of Respondents	Nounmber of Respondents who gave back their suggestion	Percent of Respondents who gave back their suggestion
1	Primary	65	26	40.0
2	Middle	107	52	48.6
3	High	122	57	46.7
5	Graduate	71	51	71.8
Total		365	186	207.2

Sources: Field Survey in 2020

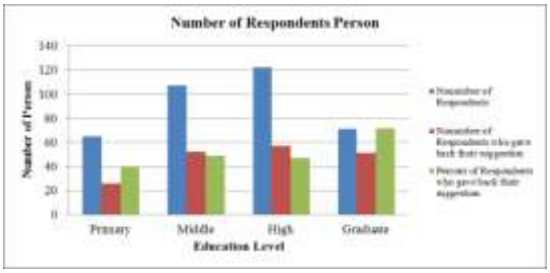


Figure (2) Education Level of Respondents Person

Sources: Based on Table. 2

Respondents Awareness on Waste Disposal

From this result, 40% of the respondents are disposing their solid waste into the drains. This means, there is about nearly one-half of the whole residential solid waste disposed into the Taunggoke Chaung and streamlets 33% of the respondents is disposed to Municipal Waste Collection Vehicles and the remaining 27% disposed to Municipal dustbins.

Table(3) Respondents Awareness on Waste Disposal

No.	Site	Frequency	%
1	Into the Drain	147	40.3
2	Municipal Waste Collection Vehicle	121	33.2
3	To Municipal Dustbin	97	26.6
	Total	365	100.0

Sources: Field Survey in 2020

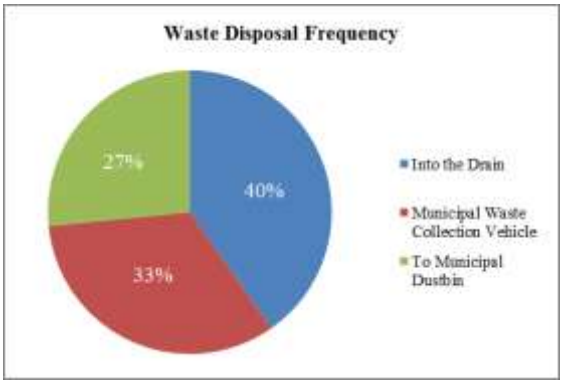


Figure (3) Waste Disposal Frequency
Sources:Based on Table. 3

Respondents on estimated Plastic Bag Consumption and Disposal

Among the households under question 41% use about 5 bags,39% between 5 and 10 bags and 20% about over 10 bags, while 63% dispose about 5 bags,29% between 5 and 10 bags and 8% about over 10 bags per day. These results show that these have a little potential for upgrading the existing environment situation.

Table (4)Respondents on estimates Plastic Bag Consumption and Disposal

No	Plastic Bag use/day	Comsumption Frequency	%	Disposal Frequency	%
1	about 5	151	41.4	230	63.0
2	between 5-10	140	38.4	106	29.0
3	over 10	74	20.3	29	7.9
	Total	365	100.0	365	100

Sources: Field Survey in 2020

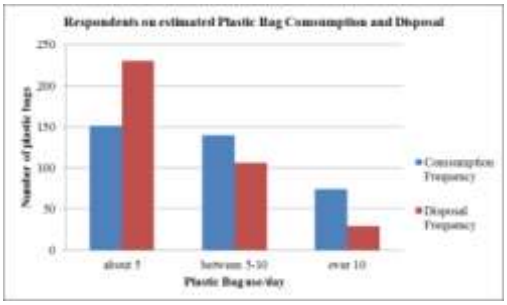


Figure (4)Respondents on estimates plastic bag consumption and disposal
Sources: Based on Table. 4

Decision makers and planners not only are responsible, but also town dwellers participate to solve effectively the solid waste management. Therefore, decision makers and planners concerned should prescribe specific legislation, regulation and policies affectively. Town dwellers incentive is based on the responsibilities of individuals as part of the community for the improvement, and is creative by public awareness and school education programs. Effective education programs become an essential part of the Township Development Committee in relation to waste management 7R is must be known and should be practiced it in every communities.

Conclusions

In this study area as the urban expansion and the Population is increasing year by year. So, town dwellers are facing more severe solid waste disposal problems. This is also due to the added factors such as awareness and perception of people and their imbedded habits are the main ones. Township Development Committee has inadequate of resources (e.g., manpower and budget, etc.) to provide the bell ringing system for every street. The current solid waste crisis should be maintained. Although this study emphasize on waste disposal problems in Taunggoke, there still many perspectives to be explored. Continuous study should be made with the aim to become more appropriate and efficient solid waste management plan for Taunggoke.

Acknowlegements

Firstly, we would like to express our thanks to Dr Than Htut Lwin, Pro Rector, Taunggoke University for his advice and encouragement. We also grateful to Dr Thida Aye, Professor and Head, Department of Geography, Taunggoke University for her encouragement and guidance of writing this research. We are deeply grateful to officers of Township Development Committee for his valuable data in completion of this research. Thanks to the respondents who spent their time participating during the interviews and given their answer in the questionnaire paper.

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Provincial Administrative Officials in Konbaung Period (1752-1852) In Lower Myanmar

Aye Khine [Ä]

Abstract

The objectives of this paper are to know about the appointment and succession of provincial officials systematically and to understand the functions of the provincial officials in Myanmar administration. In order to effectively administer the remote towns and villages, the king appointed a hierarchical number of administrative officials.

It contains that the king appointed two types of officials. One class of officials were appointed only after intensive training and education and another class of officials were hereditary in nature. Myowun, Rewun, Sitke, Nakhan, Myo Ok and Myo bo etc were appointed after intensive training. Myothugyi, Ywathugyi and Myaydaing etc were usually hereditary officials. Their main duties consisted of collection the revenue, recruiting soldiers for the King's army, maintaining peace and security and establish the rule of law throughout the kingdom of Myanmar.

They were exempted from paying taxes and were allowed to receive ten percent commission on all revenue collected by them. There might be corruption and abuse of power committed by the provincial officials. However, by the appointment of Nakhan, the officials could not rule their subjects unfairly or unjustly check and balance is very important to control the abuse of power and authority for good government and clean governance. In the appointment order, the qualities of officials were defined, to be a man of understanding Dhama Wut, Yaza Wut and Law Ka Wut. They received the various insignias of rank giving by the king.

Key words; peace and security, corruption and abuse, Dhama Wut, Yaza Wut, Law ka Wut, hierarchical number.

Introduction

It contains that the King appointed two types of official. One class of officials were appointed only after intensive training and education and another class of officials were hereditary in nature. *Myowun* (Town Officer), *Rewun* (Port Officer), *Akhun Wun* (Revenue Officer), *Akauk Wun* (Custom Officer), *Sitke* (Regimental Officer), *Nakhan* (Liaison Officer), *Myo Ok* (Town Ruler) and *Myobo* (Town Chief) etc were appointed after intensive training. *Myothugyi*, *Ywathugyi* and *Myaydaing* etc were usually hereditary officers. Among the officials, the *Myowun* was a mediator between the Royal Hluttaw and the towns, cities and villages of Myanmar. The *Myothugyis* were the back bone of the political and social system throughout the district. Their main duties consisted of collecting the revenue, recruiting soldiers for the King's army, maintaining peace and security and establishing the rule of law throughout the Kingdom of Myanmar. None of the officials received any salary. But they were exempted from paying taxes and were allowed to receive ten percent Commission on all revenue collected by them. They received the various insignias of rank giving by the King. When an official and family died, they were entitled to special funeral rites.

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Appointment and Succession of Provincial Officials

In the administration of Konbaung Period, the highest authority was rested in the Myanmar Monarch.[1] He undertook administrative function through the central and provincial administrative systems. He controlled those two administrative machineries with five administrative departments such as *Hluttaw, Byetaik, Sheyone, Anaukyone and Tayayone*.[2] He assigned duties and vested authority in the administrative staff according to their ranks and position. The King himself at capital handled all administrative and political affairs.[3]

In the provincial administrative system, the King appointed two types or classes of officials. One class of officials were appointed only after intensive training and education and another class of official were hereditary in nature.[4] *Myowun, Rewun, Akhun Wun, Akauk Wun, Sitke, Nakhan, Myo Ok* and *Myobo* etc were appointed after intensive training. *Myothugyi, Ywathugyi. Myaytaing, Shwe Khun Hmus, Ngwe Khun Hmus* etc were hereditary officials.[5] The King also appointed *Myosas* (Holders of Town in fief) and *Ywasas* (Holders of village in fief).[6] Official position was the only sign of the rank and all officials were appointed or dismissed at the king's will. Succession to the office of hereditary was generally governed by primogeniture. They used to administer generation by generation.

The role of myosa

The myosas were not hereditary.[7] They were chosen from the princes of the royal-blood or from among his most loyal ministers, military officers or Senior Leaders. Women as well as men were appointed as Myosas and Ywasas. The appointment of Myosa was passed by one-line order (တစ်ကြောင်း စာချွန်တော်) with the King's insignia. The King gave them towns, cities and village to govern.[8] However, they did not administer the towns and villages that they had been given to govern.[9] They merely enjoyed the taxes collected from these towns and villages.[10] Although they did not directly govern their towns, cities and rural areas, they still had some kind of authority. Most of them who were appointed by the King did not usually reside at their towns and rural areas. They appointed their agents to collect taxes from these places. Sometimes, these Myosas and Ywasas visited their towns and villages. Although Myosas were not given the absolute power they had to help in the general administration. For example, they had to call up recruits and hand over them to the leaders sent from Hluttaw. They were responsible for choosing and appointing new

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1 Dr. Than Tun, ခေတ်ဟောင်းမြန်မာရာဇဝင်၊ *(Ancient Myanmar History)*, Rangoon, Maha Dagon Sarpay Publishing, 1964, P. 139

2 Dr.Toe Hla, အလောင်းမင်းတရားကြီး၏ ကုန်းဘောင်ရွှေပြည်၊ (Alaungmintaya's Golden Konbaung Capital), Yangon, Moe Kyi Sarpay, Aung Oa Kala Press, May. 1993, p 43

3 U Mg Mg Tin, ရွှေနန်းသုံးဝေါဟာရအဘိဓာန် (Dictionary of Royal Usages), Buddhist Missionary Press. 1975, pp. 12-14

4 Ba Oo, မြန်မာအုပ်ချုပ်ရေးပညာ (Myanmar Administrative Techique), Mandalay, Bahosi Newspaper Press, 1940, p. 107 (Hereafter cited as Ba Oo, Technique)

5 U Tin, မြန်မာမင်းများအုပ်ချုပ်ပုံစာတမ်းနှင့်ဘိုးတော်ဘုရား၏ ရာဇသတ်ခေါ်သော အမိန့်တော်တမ်းကြီး၊ အပိုင်း(၄)၊ (Treatise on Administration of Myanmar Kings and Royal Edicts of King Badon, Part IV), Ministry of Culture, 1979, p. 103 (Hereafter cited as Tin, Treatise IV)

6 Fran N, Trager, Yi Yi and Willian J Koenig, Burmese Sit-tans of 1764-1826, The University of Arizona Press, 1979, p.48 (Hereafter cited as Trager, Yi Yi, Koenig, Burmese Sit-tans)

7 U Khin Mg Kyi and Daw Tin Tin, "မြန်မာရှေးဟောင်းအုပ်ချုပ်ရေးအသွင်များ"၊ ("The Forms of Administration System of Ancient Myanmar Administration"), Journal of literary and Social Science, the Union of Myanmar, Vol. II, No. II, 1969, p.258 (Hereafter cited as Khin Mg Kyi & Tin Tin, "Ancient")

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9 Targar, Yi Yi & Koenig, Burmese Sit-tans. p.48

10 Dr. Yi Yi, "ကုန်းဘောင်ခေတ်ဦး မြို့နယ်အုပ်ချုပ်ရေး"၊ ("Provincial Administration in Early Konbaung Period)", Jounal of Literary and Social Science, Vol.I, No.2, may 1968, p.382 (Hereafter cited as Yi Yi, "Provincial Administraion")

officers such as Customs Officer, Town Officer, Revenue Officer, Regimental Officer, Liaison Officer and Town Constable to petition the King. Myosars also were responsible for collection, food and rations for the Myanmar soldiers.[1] The King did not permit them to directly appoint subordinate officials except Myo Oks (Town Ruler) and Myo Kaings (Town Controller) to collect taxes and also transferred them one town to the next. So that the people of the town would not become too attached to him and make trouble for the King.[2]

Myosas received no fixed salaries but were allowed to appropriate part or all of the revenue due from certain tracts or villages. If there was a Myosa, a half went to him; if there was no Myosa a half went to the Ayadaw or state. When a Myosa or a Ywasa was appointed, if he was not required to live at the capital, he went out to his domain and governed there, sometimes the villagers had to build a house for him or paid to household tax to him and he in his turn, sometimes gave the Thugyi a complete set of clothing and once in a way, paper and needles to the villagers.[3]

Figure (1) Myo Sa

Sources: Nyo Mya ကုန်းဘောင်ရှာပုံတော် (Searching for Konbaung), Yangon, Yapyi Press, 2003.

In those days, Rajahtani Zekhun (tax on the market in the royal capital) was presented to queens or princes or princesses. The Myosars and Ywasars who were privileged to enjoy Away-zay-khun (tax on the markets in provincial towns) used to vest authority in their inferiors to collect tax from the markets. In addition to Zay-akhun, taxes on lakes, weirs and creeks were also collected by them.[4] If the territory of Myosas, Ywasas, princes, queens and ministers included Ayardawmyè (land belonging to royalty), they could enjoy the tax on this land as the king did. The tax must not be heavier than that fixed by the king. It is found that royal decrees were issued for the tax-collectors not to levy heavier tax on their tax-payers than usual.[5] Apart from the tax, provincial administrators were entitled to

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1 Dr. Than Tun, The Royal Order of Burma, AD 1598-1885, Part VII, A.D 1811-1819, Kyoto, the center for Southeast Asia Studies, Kyoto University, 1988, p. 149.

2 Dr. Than Tun, The Royal Order of Burma, AD 1598-1885, Part VI, A.D 1807-1810, Kyoto, the center for Southeast Asia Studies, Kyoto University, 1987, p. 307 (Hereafter cited as Than Tun, ROB, VI.)

3 Ma Mya Sein, Administration of Burma, Rangoon, Zabumeitswe Pitaka Press, 1938, p.33 (Hereafter cited as Mya Sein, Administration)

4 Ma Kyan, *ကုန်းဘောင်ခေတ်အခွန်တော်ရေးရာ*၊ (*The Revenue Affairs of Konbaung*), Yangon, Mon Yway Press, 2009, p. 24 (Hereafter cited as Ma Kyan, *Revenue Affairs*)

5 U Tin, မြန်မာမင်းများအုပ်ချုပ်ပုံစာတမ်းနှင့် ဘိုးတော်ဘုရား၏ ရာဇသတ်ခေါ်သော အမိန့်တော်တမ်းကြီး၊ အပိုင်း(၃)၊ (Treatise on Administration of Myanmar Kings and Royal Edicts of King Badon, Part III), Ministry of Culture, 1976, p. 51.

using vehicles and insignias according to their positions and ranks. Appropriate insignias were bestowed on the relatives of the King and ministers and myosas who were appointed Myosa by the King issuing royal decrees.[1]

The appointment of Myowun

The king appointed the Myowun from among the military commanders of a fifty-man troop who was also his faithful comrade or blood bound brotherhood (*thwethauk*).[2] In the early period of the Myanmar kings, the Myowun was called the Myo-kut (မြို့ကွပ်) and he was the most important man in his province. In the appointment order, the qualities of Myowun were defined: to be a man of learning and was supposed to be conversant with all spiritual and temporal affairs, to be responsible for the prosperity of the religion (Dhama Wut), well being of the king (Yaza Wut) and the welfare of the state (Lawka Wut).[3]

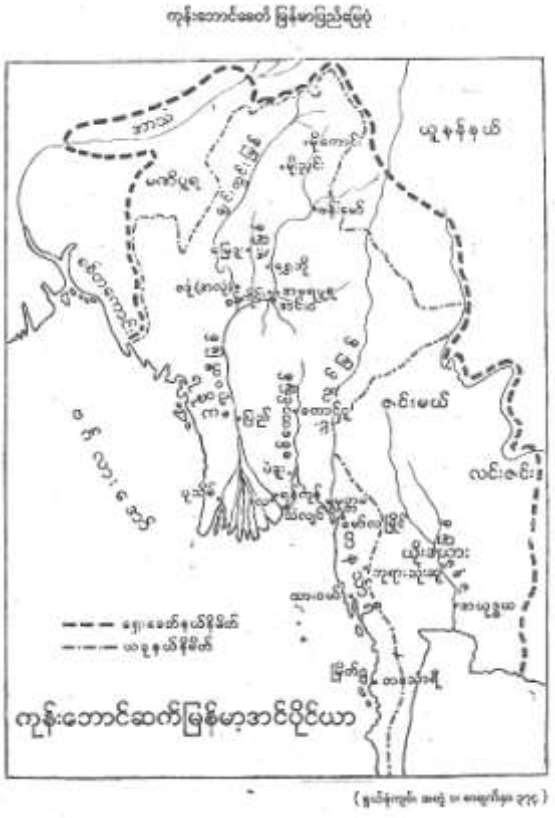

Figure (2) The Myanmar Empire in 1824

Sources: Nyo Mya, ကုန်းဘောင်ရှာပုံတော်

Figure(3) The Myanmar Empire in 1826

Sources: ဦးမောင်မောင်တင်၊ ကုန်းဘောင်ဆက် မဟာရာဇဝင်တော်ကြီး (တတိယတွဲ)

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1 မှူးတော်မတ်တော်တို့.သနားတော်မြတ်ခံရသည့် အဆောင်အရွက်ပြန်တမ်းအမိန့်.တော် (Royal Order on Insignias Conferred on Minister, Manuscript No. 609, National Library (Hereafter cited as Insignias)

2 U Mg Mg Tin, ကုန်းဘောင်ခေတ်မဟာရာဇဝင်တော်ကြီး၊ (The Great Chronicle of Konbaung) Vol. I, Rangoon, Iedi Mandaing Press, 1967, p.355

3 U Tin, မြန်မာမင်းများအုပ်ချုပ်ပုံစာတမ်းနှင့် ဘိုးတော်ဘုရား၏ ရာဇသတ်ခေါ်သော အမိန့်.တော်တမ်းကြီး၊ (Treatise on Administration of Myanmar Kings and Royal Edicts of King Badon) Part I, cultural Department of the Union of Burma, Revolutionary Council Government, archaeological Department, 1931 (first print), 1963 (Reprint), p.180 (Hereafter cited as Tin, Treatise. I)

In the Lower Myanmar of Konbaung Era, according to the Sit-tans, the Regions and Provinces of Hanthawaddy, Muttama, Pathein, Pyay and Taungoo were administered by Myowuns appointed by the King.[1]

On 2 January 1784, King Badon attacked and occupied Rakhine so it became part of the Myanmar King. The administration of Rakhine under the Myanmar King was divided into administrative regions. They were Myouk-U (Danyawady), Råmbye (Rammawady), and Thandwe (Dwarawady) administrative regions under the name of three "waddy" administration. Manaung Island under Rambye administrative region was one of the regions that opposed the rule of Myanmar King. The island was distant from Rambye and was difficult to access Rambye Myowun supplicated to the Myanmar King that Manaung (Maygawady) island should be separated from the Rambye administration. So, a separate administration was established for Maygawady island in May 1786. So the four waddy administration emerged in Rakhine beginning from 1786. Rakhine was administered by the Myanmar King from 1784 to 1824.[2] However, with the conclusion of the first Anglo-Myanmar War in 1824, the province of Rakhine was annexed by the United Kingdom.[3]

The Myanmar king did not allow the Myowun to be in one place for along time but transferred him from one town to the next. This was because the Myanmar king did not wish the people to become so attached to their Governor that they might start on uprising against the central Administration.

Figure (4) Myo Wun and his Party

Sources: Nyo Mya, ကုန်းဘောင်ရှာပုံတော် (Searching for Konbaung),

Yangon, Yapyi Press, 2003.

1 Trager, Yi & Koenig, Burmese Sit-tans, p.34

2 Report on the progress of Arakan under the British Rule from 1826 to 1869, Rangoon, the Government Press, 1874, p.27.

3 W.B Tydd, Burma Gazetter (Sandoway District Vol. (A), Government Printing and Stationery, Burma, 1902, p.11 (Hereafter cited as Tydd, Gazetteer of Sandoway District.)

The Duty of the Officials

The duty of Myowun

The main duties of the *Myowun* consisted of keeping the peace and administrative justice to his people. For security and keeping the peace, the *Myowun* had to keep weapons, medicines, and fire-wood from being destroyed by fire or from becoming soaked in rain.[1] The *Myowun* must also decide legal cases brought by the officers and soldiers under his charge.[2] He must swiftly send the royal revenue to the càpital and if war broke out, he must quickly send fresh recruits, weapons and rations to the battle zones. The *Myowun* had to decide in both criminal and civil cases. The *Myo wun* was given a lot of freedom to govern his town and surrounding villages and he was able to retain his position longer by being faithful to the king. When an ordinary Myanmar citizen committed a crime, the *Myowun* could give him the death penalty. When a person rebels against the King or hinder the administration in any way three times, the *Myowun* can sentence him to death. When the King's officers or faithful servants commit crimes, the *Myowun* must send a report to the *Hluttaw* and wait for its decision.[3] The *Myowun* was a mediator between the Royal *Hluttaw* and the towns, cities and villages of Myanmar. Besides coming out his daily duties, the *Myowun* must obey the king's Royal Orders and Directives. When the Royal Order arrives ordering him to make lists of well-born citizens and economic reviews or *sit-tans*, he must at once command his subordinates to complete these lists and return them immediately to the capital. The Myowun had to carry out not only administrative duties but also defence duties. When there is an emergency, the Myowun had to collect fresh recruit from his jurisdiction for the King's Army.[4] But the King tried to limit the power of Myowun by passing orders. The Myowun must be endowed with the following attributes;

1. He must know both old residents and new comers of the town.
2. He must study the conditions of town and village incognito or as - the *Myowun*.
3. To understand the manner and behaviour of his town men.
4. To be just and impartial in deciding legal cases.
5. Never be lazy and indolent.[5]

When a murder, rape or robbery occurred within his jurisdiction, the Myowun must swiftly bring the culprit to justice. Without any partiality, the Myowun had to cancel small crimes and make the big crimes smaller.[6] Ten percent was also collected on the value of all civil suits decided by the Wun, as well as in criminal cases where fines were inflicted. [7]

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1 Tin, *Treatise*, IV, p. 148
2 Dr. Than Tun, *The Royal Orders of Burma*, AD 1598-1885, Part IV, A.D 1782-1787, Kyoto, the center for Southeast Asia Studies, Kyoto University, 1986, p. 242
3 Sir James George Scott, *Gazetteer of Upper Burma and the Shan States*, Vol. II, Part I, Rangoon, Superintendent Government Printing, 1900, pp. 509-10 (Hereafter cited as Scott, *Gazetteer of Upper Myanmar*)
4 Than Tun, *ROB*, VI, p. 254
5 Tin, *Treatise*, I, p. 179
6 Tin, *Treatise*, IV, p. 149
7 Scott, *Gazetteer of Upper Burma*, p. 512

Figure (5) Myo Wun and his duty in office or Myo Yon

Sources: Nyo Mya, ကုန်းဘောင်ရှာပုံတော် (Searching for Konbaung), Yangon, Yapyi Press, 2003.

The role of other officials

To assist the Myowun in the affair of administration and defense, the king had appointed a police and military officer (Sitke) or regimental officer who supervised at times the administration of religious affairs, a tax collector and granary supervisor (or) revenue officer (Akunwun), (Yewun) in charge of war boats (or) Port officer and shipping inspector and customs officer (Akaukwun) etc.[1]

Figure (6) Sitke

Sources: Nyo Mya, ကုန်းဘောင်ရှာပုံတော် (Searching for Konbaung), Yangon, Yapyi Press, 2003.

[1] John F. Cady, *A History of Modern Burma*, New York, Cornell University Press, 1958, p. 24 (Hereafter cited as Cady, *Modern Burma*)

In big cities, two *Sitkes* were stationed, and if the town was of middle size, one *Sitke* kept law and order. But in very small towns, there were no *Sitkes*. The main duties of these *Sitkes* stationed in towns and cities were to keep the peace and maintain law and order. Therefore, their duties corresponded to that of policemen in modern Myanmar.[1] When an emergency situation arose, the *Sitke* must make a special enquiry and submit his report to Myoyon (Hall of Justice). Sometimes when the *Myowun* was called to the capital, the *sitke* must administrate the area in his absence.[2] If there were legal cases to be decided, the sitke must make the big litigation cases to minimize the seriousness of an offence through arbitration. He must prevent thieves and robbers from committing heinous crimes. Then he had to send rebellious persons to capital after arresting them. He must also supervise the merchants and traders in connection with using weights and measures.[3]

Figure (7) Port in Rangoon (Yangon) in 1824

Sources: G.E, Harvey, History of Burma from the earliest times to 10 march 1824 the beginning of the English Conquest, New York, 1925.

Yewuns were appointed only in towns and cities that had good seaports and harbours like Yangon.[4] In the absence of the *Myowun,* the *Yewun* acted as Governor of Yangon City. The *Yewun* carried out his duties with the assistance of the pilot who was also stationed in Yangon.[5] In times of emergency, the garrisons guarding the towns must be quickly moved to the front-line areas either by boat and rivercraft or by horse or ox-drawn carts. Whenever a foreign ship with foreign passenger arrive at the sea port, the *Yewun* must travel to the mouth of the River, welcome the visitors and search their ships so that no contraband was found hidden on them.[6] The *Yewun* together with his entourage which consisted of *sitke, Nakhan, Akauk-wun, Akun-wun, clerks, Taik-soe*, *Taik-sayay* and the Assessor must board the foreign ship and examine all the goods. They must distinguish

1 B.R Pearn, " A Burma Diary of 1810", *Journal of Burma Research Society*, Vol. XXVII, 1939, p. 56
2 Dr. Than Tun, *The Royal Orders of Burma*, AD. 1598-1885, Part V, AD. 1788-1806, Kyoto University, 1986, p. 102 (Hereafter cited as Than Tun, *ROB*, V)
3 Tin, *Treatise*, IV, p. 151
4 Mya Sein, Administration, pp. 38-39
5 *ဟံသာဝတီမြို့ စစ်တမ်း 1164 M.E (Hanthawaddy Tonship Sittan 1802 A.D*), Manuscript No. 740 National Library
6 Wana Kyaw Htin U Tha Tin (Saya Magha), *ပုသိမ်ရာဇဝင်* (*A History of Pathein)*, Yangon Zwe Press, 20.7.67, pp.68-69

the presents for the King from other imported goods, must put the Royal seals on them and send the presents immediately to the capital.[1]

Under the authority of the *Myowun*, there was one *Akauk-wun* or customs officer. The port cities of Pathein and Myeik each had one *Akaukwun* who collected the public revenue. During the Konbaung Era, the King usually appointed foreigners as *Akauk-wuns* in all the Port cities and towns because ordinarily the foreigner dealt directly with oversea traders and were thought to have better knowledge of trading condition and shipping than Myanmar officials. The foreigners called the *Akauk-wun*, the *Shahbunder* meant Lord of the Haven.[2] The *Akauk-wun* having no jurisdiction outside the port.[3] The Akauk Wun's duties were also to collect taxes on merchandise such as "*Seik,* Te,** Pwe***, Kin**** and Kudo ******[4] Custom clerks were also appointed and they had to obey their officers.[5]

There was also a Revenue Officer (Akhun Wun) who served under the Myowun. He was the collector of land revenue and also in charge of the granaries. He was assisted by a granary keeper and several touring officers called pabia who had to visit the district annually and collect the revenue. Since the reign of Alaungmintaya up to the reign of King Badon (1752-1819), the Kings of early Konbaung had levied taxes in accordance with customary laws. The rates to be levied as taxes were directed by the Hluttaw. To collect the revenue systematically, *Akunwun* (Revenue officer) and staff were appointed.[6] They were mainly concerned with collection of gold tax, silver tax, paddy fields tax, cultivated land tax, farmland tax, garden tax and fishery in ponds, lakes and creek tax etc. As concerns revenue collection, it was divided into three kinds like "Khun ma"* "Khun thay"** and "Khun Shin"*** such as taxes on toll gates, import and export. Most of the revenue had to be paid in kind.[7]

Currency System

In Myanmar, before the reign of King Mindon, standard coinage had not been used except Rakhine. Revenue and commercial transactions were conducted in what might be termed as raw lump currency. Silver bullion in the form of buttons and ingots was the most common standard of exchange, it was negotiated in term of the weight and purity of the metal. There were many standards of silver alloyed with copper but the most common standard and the one in which crown revenue had to be paid was *ywet-ni*[8] or flowered silver, an eighty-five percent alloy. Copper was also a medium of exchange, while 'lead

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1 Tin, *Treatise*, IV, p. 152
2 Cady, *Modern Burma*, p. 25
3 B.R Pearn, A History of Rangoon, American Baptist Mission Press, Rangoon, 1939, p. 56
* Seik - harbour, port
** Te – Seasonal Trade Fair and/ or Permanent Market
*** Pwe – Tade Depot or Brokerage
**** Kin – Toll Station of Guard House3
***** Gando - Ferry
4 Ma Kyan, *Revenue Affairs*, p. 12

5 U Aye Kyaw, "ဗဒုံမင်းလက်ထက်ရန်ကုန်ဆိပ်ကမ်း၊" "Port of Rangoon in the reign of King Badon", *University Educational Journal* Vol. IV, Part II, Rangoon, central Universities Press, 1964, p. 59 (Hereafter cited as Aye Kyaw, "Port of Yangon Part II")
6 Mya Sein, *Administration*, p. 39
* Khum Ma = tax collected exclusively for the King of main tax
** Khun they = annually fixed tax
*** Khun shin = Tax which were not fixed
7 Aye Kyaw, *Port of Yangon*, Vol. IV, II, p. 59
8 Ywet-ni=Standard Silver as a medium of exchange
Dr. Than Tun, The *Royal Orders of Burma*, A.D. 1598-1885, Part X, Epiloge, Glossary and index, Kyoto, the center of Southeast Asian Studies, Kyoto University, 1990, p. 126

was often used for purchases in the markets. Gold was used only for jewelry, ornamental utensils and the gilding of religious and royal edifices. In Rammawaddi and Muttama Sittans, coins and metsei (မတ်ဆေး) are found that they used them as medium of exchange.[1]

The Role of Nakhan

The Central Administration had appointed two Nakhan Daws (Liaison Officers) who served loyally to the King in every region. The chief duty of these two Nakhan Daws were to try and collect the correct news and information and send secret reports to the Hluttaw and the King. This was how the Provincial Administration was controlled by the King so that so Myowun and other administrative officers in the provinces could not abuse their powers and authority.

Remuneration for the Provincial Officials

Provincial officials were entrusted with duties to perform as well as entitled to privileges title and insignias to enjoy. The king appointed suitable provincial officials to manage administrative affairs. They did not enjoy a fixed salary.[2] Instead they were given farmland and other facilities.[3] So, the taxes were collected from those who worked cultivation and trade. They were also exempted from paying taxes and allowed to receive ten percent commission on all revenue collected by them.[4]

In the Royal orders it is stated that the king directed the provincial officers to levy tax from the citizen in accordance with the customs and in conformity with the Royal order 1/10 of the income of common folks.[5] Those who were responsible to levy tax were not allowed to collect more than the due tax. If they collected more tax, they had to repay ten times the amount of money that they had exacted without authority from the people.[6] The tax payers were not also allowed to pay the taxes lesser than the due taxes. They were liable to pay one tenth of their products. In case if the tax-payers had desire to pay in term of money, it was calculated by the price of the localities. In case if the cultivated crops were not successful or if the cultivator cultivated for house hold use, tax was not imposed on their products. [7]

The role of Myothugyi

Succession to the office of Myothugyi was generally governed by primogeniture. They used to administer generation by generation. In some sittans were found hereditary rulers of women replaced by men and viceversa.[8] Hereditary office could not be sold even of both parties were willing.[9] If there were any rival claims, sometimes neighbouring Thugis were required to make statement. In these cases of supplications, Shwetaikwun or Treasury Officer checked the application with the inquest of 1783 A.D and 1802 A.D. After getting the recommendation of the Hluttaw, the petition had to submit to the King

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1 Trager, Yi & Koenig, *Burmese Sittan*, p. 50
2 Tydd, *Gazetteer of Sandoway District*, p. 55
3 Tin, *Treatise IV*, p. 280
4 Tydd, *Gazetteer of Sandoway District*, p. 55
5 *ကျောက်မော်မြို့ စစ်တမ်း 1164 M.E (Kyauk-Maw Township sittan 1802 A.D)*, Manuscript No. 741, National Library (Hereafter cited as Kyauk Maw *Township Sittan (1802 AD)*)
6 Than Tun, *ROB*, V, p. 94
7 Than Tun, *ROB*, V, p. 461
8 (a) J.S Furnivall, "Some Historical Documents", *Journal of the Burma Research Society*, Vol. VIII, Part II (1918), 1977, p.33
(b) *ဒင်းမဲမြို့ စစ်တမ်း 1164 M.E, Dinme Township Sittan, (1802 A.D)*, Manuscript No. 741, National Library
9 Mya Sein, *Administration*, p. 53

for his approval.[1] After the Royal Seal and Letters of Appointment, his office as Thugyi was secure.[2] "The Hluttaw issued sometimes the order of one line (Ta Kyaung Sachun) and at times the order of two lines (Hnit Kyaung Sachun), depending on the circumstances. The Sachun is about forty-two inches[3] long and pointed at both end. On the left hand side of the writing, the seal was impressed. Only one line was written across the leaf giving the date, name and place. Great care was taken to select a palm-leaf free from any tear or mark and the order was written very carefully and accurately. On the reverse of the Sa-chun, the Myothugyi was instructed to govern and help the Athis (commoner).[4]

Townships were often divided into smaller units known as the village or hamlet. Myaytaing, Taw-ke, Ywa-ok (Rural Guardian) or Ywa-gaung (Rural Head) and Se-ein gaung were appointed to help the Myothugyi and Yawthugyi in administrative affairs. It is doubtless true that the government of Ywathugyi or the headman of village depended a great deal on the acquiescence of the people. Without the support and confidence of the people, a Ywathugyi could not possibly perform his duties efficiently. When building new villages and hamlets, Ywa-ok Ywa goungs were chosen to govern there. If there was more than one eligible person and the candidates were reluctant to compete with each other, a method of drawing lot was resorted to.[5]

The Myothugyi and the Ywathugyi had to have the following virtues: -

(i) They must have a good character so that the villagers and town-men respected, loved and feared them.

(ii) They must be able to withstand the intensity of cold and heat, i.e they must have a healthy body and mind.

(iii) They must have great valour and be able to lay their lives aside if necessary, for their town man and village folk.[6]

The Myothugyis were the back bone of the political and social system throughout the district. The Myothugyi acted as a mediator between the Kings and the people of Myanmar.[7] He was basically the protecting police officer, the local judge-arbiter of disputes, the apportioner and collector of taxes and the recruiter of local quota-contingents for the armed forces in time of war.[8] The income of the position of Myothugyi was substantial. The office was by custom entitled to a commission on the revenue collections which in some cases exceeded the amount of the revenue itself. In this sphere of the Myothugyis work, there were opportunities of embezzling state money.[9] In the areas where gold, silver and iron were extracted, Shwe Khun Hmu (officer of Gold Revenue),

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1 Trager, Yi & Koenig, *Burmese Sit-tans*, p. 40
2 Yi Yi, "Provincial Administration", p. 347
3 "တစ်ကြောင်းစာချုံလက်ခံ၊" "Ta Kyaung Sachun Lat Khan", Manuscript No. 909, Archive, Historical Research Department, Ministry of Culture, Rangoon
4 Mya Sein, *Administration*, p. 59
5 U Tin, *မြန်မာမင်းအုပ်ချုပ်ပုံစာတမ်းနှင့်ဘိုးတော်ဘုရား၏ ရာဇသတ်ခေါ်သောအဓိန့်တော် တမ်းကြီး၊ အပိုင်း (၂)၊* (*Treatise on Administration of Myanmar Kings and Royal Edicts of King Badon*), Part II, Rangoon, Government Printing and Stationery, 1932, p. 158
6 Ba Oo, *Technique*, p. 102
7 Mya Sein, *Administration*, p. 64
8 Cady, *Modern Burma*, p. 29
9 Mya Sein, *Administration*, p. 67

Ngwe Khun Hmu (Officer of silver Province) and Than Khun Hmu (Officer of Iron Revenue) were appointed.

It is found that the funeral customs of the provincial officials are different from those of their relatives. Regarding this, very few evidences have been discovered so far. Even the custom of the funeral ceremony of Myothugyis may have varied from town to town.[1]

Conclusion

The King had the autocratic power. He was at the apex by exercising the state power. The King himself at capital handled all administrative and political affairs. In order to effectively administer the remote towns and villages, the King appointed a hierarchical official. Their main duties consisted of collecting the revenue, recruiting soldiers for the King's army, maintaing peace and security and establishing the rule of law throughout the Kingdom of Myanmar. There might be corruption and abuse of power committed by the provincial officials. However, by the appointment of Nakahn, the officials could not rule their subjects unfairly or unjustly. The remuneration of provincial officials lay more in the exercise of powers and the prestige of their positions than in direct money advantage. Check and balance is very important to control the abuse of power and authority for good government and clean governance. Superior person requires to follow the six rules of virtue; alertness, industry, mercy, patience, sound judgement and vision. And, they also should be free from favour, fear, anger and delusion. In the appointment order, the qualities of officials were defined; to be a man of understanding Dhama Wut, Yaza Wut and Lawka Wut.

It is learnt that appointment of administrative officials was made systematically during the region of ancient Myanmar kings. Although provincial administration was based on the rural administrative system, it was not neglected at all by the Hluttaw but directly administered by it. Therefore, it can be concluded that choice and appointment of provincial administration was very systematic during Konbaung Period.

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[1] Dr. Yi Yi, "ကုန်းဘောင်စစ်တမ်းများ"၊ ("The Sit-tans of Konbaung Period"), *Journal of Burma Research Society*, Volume, XLIX, I, June, 1966, p. 122

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ဒင်းမဲမြို့စစ်တမ်း 1164 M.E (Dinme Township Sit-tans 1802 A.D), Manuscript No. 741, National Library

မှူးတော်မတ်တော်တို့ သနားတော်မြတ်ခံရသည့် အဆောင်အရွက်ပြန်တမ်းအမိန့်တော ် (*Royal Order on Insignias Conferred on Minister*, Manuscript No. 609, National Library

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A Study of the Concept of Non-Violence (Ahimsa) in Gandhi's Thought

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Abstract

This paper attempts to focus the important role of philosophical awareness to the concept of Non-violence (Ahimsa). Gandhi's philosophy bears the influence of (Satya) Truth, Ahimsa (Non-violence), Tapas (Self-suffering) and self-purification. Non-violence (Ahimsa) forms the foundation of Gandhian Philosophy. Non-violence (Ahimsa) not only develop man's moral dignity and personality, but it also makes possible an ideal state or society. Non-violence is an ethical principle applicable to all living and plays an important role to build up peaceful society. Thus for the construction of well-developed as well as well-ordered human society Ahimsa is crucial. The aim of this paper is to undertake a critical study of the concept of non-violence as a significant ethical concept in Gandhi's philosophy.

Key Words:Non-violence, Ethics, Self-suffering, Self-purification, Truth

Introduction

Mahatma Gandhi, the pioneer of non-violence was born on 2nd October 1869. His prominent role in India's freedom struggle fetched him the title of 'Bapu' (Father of the Nation). The birthday of this Indian preeminent spiritual and political leader is celebrated as "International Day of Non-Violence" throughout the world. Gandhi's philosophy bears the influence of a number of sources and ahimsa forms the basic foundation of Gandhian Thought. According to Gandhi, ahimsa is the greatest force available to humankind, "It is mightier than the mightiest weapon of destruction devised by the ingenuity of a man"[1] (M. K. Ggandhi, Harijan,p-180). Though the concept of non-violence was not originated by Gandhi, he was the first person to apply it for a political purpose. Gandhi's greatest contribution, therefore, is the use of non-violence into a successful technique for direct mass action. The concept of non-violence was not a new one. Before the teachings of Gandhi, the notion of ahimsa finds an important place in Holy Scriptures, teachings of Gautama Buddha and works of various philosophers. However, it was Gandhi who converted it into a social and political technique and super humanitarian method of resolution to all type of crisis and problems. Gandhi firmly believed that non-violence stands out as something inevitable for the reformation of politics. Gandhi was a real visionary who through the use of non-violence gave new direction to Indian freedom struggle. He objected to violence as he considered that it created more problems than it solved and the after math of it was sheer heatedness and bitterness amongst peoples. His nonviolent resistance was a dynamic and spiritually active force, which aimed to destroy the sin and not the sinner. Gandhi was committed to follow this principle and therefore, he made every possible effort to achieve this goal with the help of non-violent action. Gandhi was not only a political and social reformer but also a political thinker and a faithful humanist as well. Gandhi in his teachings communicated to the people concept ranging from freedom, independence or Swaraj, self-reliance, self-sufficiency to protection of distinctive social values. It is very correctly said about Gandhi that: Moral values like truth, non-violence, renunciation of the pleasures of life etc., political ideas such as freedom,

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democracy, peace etc., social objectives such as abolition of castes distinctions, emancipation of women, unity of all religious groups and communities. Gandhi through his concept of truth tried to enlighten the people of his country. His spinning wheel becomes a symbol of self-reliance and rejection of foreign goods implies autonomy and striving for self-identity and human dignity. Amongst all these notable examples of his contributions, the idea and practice of Satyagraha is the most important to his political thought and ethical motivation. In this study, a brief section of Gandhi's life has been touched upon, his opinions on some concept have been mention, and the values he promoted for peace and his opinions on these values have been included.

Meaning and Definition of Satyagraha: Gandhian Perspective

The term 'Satyagraha' is a combination of two Sanskrit words, 'Satya' meaning 'Truth' and 'Agraha' meaning 'determined pursuit' or 'holding on to truth'. The word therefore, literally means, 'insistence on truth'. Gandhi defines Satyagraha as 'a relentless search for truth and a determination to reach truth'[2](R.P. Misra,The Way to Peace,p-141). It is based on the principle of love and believes in 'love for all' and 'suffer for all'. It excludes the use of any form of violence since it is based on the philosophy that man does not know the absolute truth and therefore, cannot punish anyone. Mahadev Desai wrote in Harijan: Satyagraha is dynamic, passive resistance is static. Passive resistance acts negatively and suffers reluctantly and in fructuously; satyagraha acts positively and suffers with cheerfulness because from love and makes the sufferings fruitful. Satyagraha or non-violent action means soul-force or truth-force that is it is based and is a way to achieve truth. Gandhi explained about what he means by using soul-force for Satyagraha:

"When I refuse to do a thing that is repugnant to my conscience, I use soul-force. For instance, the government of the day has passed a law which is applicable to me. I do not like it. If by violence I force the government to replace the law, I am employing what may be termed body-force. If I do not obey the law and accept the penalty for its breach, I use soul force. It involves sacrifice of the self"[3](A.Appadorai, Through the Age,p-200-201). There are four things of great importance in Satyagraha. These are Satya (Truth), Ahimsa (Non-Violence) and Tapas (Self-suffering) and Self-purification. Lets us briefly examine them one by one.

The Concept of Truth

The identification of non-violence as the ideal of conduct with Truth that Gandhism is undoubtedly on ethic metaphysical system. Gandhi embodies the spiritual culture and practical ethics he has applied the central truth to concrete life. He has pointed out that evil must be hated because it is due to the malevolent tendency and ignorance of the evildoer. Hence, we must behave differently towards the evildoer and the benefactor because of their differences of conduct. But at the same time, we should never hate the evildoer because the doer in every individual is not the body, or the mind, or the intellect, but the spirit.We should look at friend and foe alike without hating their person, but we should not behave neutrally toward both so far as our judgment of good and evil is concerned. We should not imitate evil. Not only this, we should hear neither anybody is evil, nor see it, nor speak about it. But we ought to love all human beings, whether they are good or bad, kind of cruel, broad-minded or selfish, because the spirit, central in them. Gandhi believed that even the meanest person was capable of being reformed because 'man is the image of God'.

Gandhi never explained his notion of liberation or Moksa, because his aim, like that of the Buddha, was not metaphysical exposition, but practical eradication of suffering, the well-being of humanity. But it goes without saying that he believed in the infinite existence of the soul after physical death, and that his ethics was on the one hand, based on the concept of the immortality of soul, and on the other, it aimed at the merger of the finite individual self with the universal infinite Truth or God.

The aim of the path of non-violence seems to be other worldly. But we know that Gandhi was pragmatic. As such he did say that the practical aim of non-violence was self-purification. Enunciating the five characteristics of non-violence are (a) Non-violence implies as complete a self-purification as is humanly possible. (b) Man, for man, the strength of non-violence is in exact proportion to the ability, not the will of the non-violent person to inflict violence. (c) Non-violence is without exception superior to violence, i.e., the power at the disposal of a non-violent person is always greater than he would have if he was violent. (d) There is no such thing as defeat in non-violence. The end of violence is surest defeat. (e) The ultimate end of non-violence is surest victory-if such a term may be used of non-violence. In reality when there is no sense of defeat, there is no sense of victory.

The Concept of Ahimsa

Ahimsa; The literal meaning of " Ahimsa", the term Gandhi used for his second great principle, is 'harmlessness' or 'non-injury', but this translation carries misleading negative suggestions and does not do justice to its richness of meaning. As interpreted by Gandhi, ahimsa is somewhat akin to Schweitzer's principle of 'reverence for life', which is not to be understood simple as a refusal to destroy life unnecessarily but as concern for the wellbeing of all living things, especially one's fellow men. Therefore, Gandhi though the accepts the interpretation of ahimsa namely that it is not merely a negative state of harmless but it is a positive state of love, of doing good even to the evil-doer.

Non-violence, the principle most commonly associated with Gandhi, beings out the negative aspect of ahimsa but fails to suggest its more positive side. This positive side includes the concern and active support that belong to the agapeistic as contrasted with the erotic conception of love and also that sense of the underlying unity of all living things which is such a common feature of the religious thought and felling.

The latter sentence can be variously understood. But I take it to refer, among other things, to the pervasive sense of unity which is generated in religious mind by the recognition of God-the-Creator as immanent in the universe he has created. Satyagraha, according to Gandhi, excludes all forms of violence since use of coercion, on one hand suppresses the development of the individuals and fails to show respect to adversary and on the other hand, obscures the vision of truth. His concept of Satyagraha is based on the notion that the adversary is also a human being having faculty of reasoning and goodness.

Gandhi strongly opposed violence or suppression since it went against the integrity of an individual[4] (B.N.Ray,Gandhigiri,p-67). Every individual has an equal right to be respected by others as Kant also holds, and bears a moral duty to show the same respect to other people’s integrity and freedom. Gandhi said that violence can never be justified no matter for what noble cause it is used. This is because for Gandhi means and ends are inseparable. To achieve justice, one cannot force his views on others and curb their freedom. The use of violence for Gandhi not only degrades the opponent but also makes its user a lesser human being. He considered that a violent person is always at war ‘with the world and believes that the world is at war with him and he has to live in perpetual

fear'[5](Ibid, p-67,141,142). Therefore, the consequence of violence is always utter helplessness, isolation and it functions to create a gulf between the aggressor and the society.

For Gandhi to practice ahimsa or non-violence one needs a proper training of strong will, patience and moral courage and all these in turn lead to transformation of mind. For this transformation an inner conscience is needed which gives an excess to truth. Each one of us have a relative truth and non-violence acts as a tool that arbitrates between these truth claims. To live a life of non-violence Gandhi asserted, one needs a training to fully arouse his inner conscience and devotion and finally one achieves knowledge of truth about the moral and physical world. Gandhi's ahimsa therefore, provides a political agent the sense to take right kind of political action. Non-violence in this sense becomes a sort of guide in practical prudence in search of relative truth of the political world. It gives one the power to take decisions about relative truth in socio-political life than to just contemplate about good life and other mere theoretical perspectives.

Gandhi believed that ahimsa has evolved with the evolution of human civilization. The early man lived in caves and were basically cannibals having no definite place to live. With time an agricultural society was established and man started to settled down. An evolution took place and man became from a member of a family to member of community, following laws and rules to live together in a social environment. With slow process of civilization accompanied the transformation of himsa to ahimsa or violence to non-violence. For Gandhi, this slow evolution of ahimsa with civilization of man is a fact, which he expresses, "Had it been otherwise, the human species should have been extinct by now, even as many of the lower species have disappeared"[6](Surjeet Kaur. Jolly,p-278).

The Concept of Self-Suffering

Satyagraha further constitutes of self-suffering. Gandhi considered self-suffering to be superior to the sacrifice of others. For him, such sense of self-sacrifice aims at a right cause and by using it causes suffering only to the person who uses it and not to others. Gandhi explains what self-suffering really meant. He said:

Non-Violence in its dynamics condition means conscious suffering. It does not mean meek submission to the will of the evil-doer, but it means putting of one's whole soul against the will of the tyrant. In this way, Gandhi knew the power of suffering and what Satyagraha incorporates. He made his followers, who truly believed in non- violent action, fully aware that suffering is an indispensable part of Satyagraha. He strongly believed that suffering is an inseparable aspect of non-violent action. Along with fearlessness and courage, non-violent actionists need to be prepared to face the sufferings that follow. Gandhi aptly wrote, "Without suffering it is impossible to attain freedom"[7] (M.K.Gandhi,Satyagraha,p-67).

This does not imply that suffering is an inevitable aspect of only nonviolent action but rather violent actions too lead to a lot of sufferings. Various forms of political violence, like civil wars, guerilla wars, world wars, or other terrorist movements of past and present involve higher risk of sufferings and causalities as we have observed. Therefore, it is wrong for the supporters of 'violent action' to disregard 'non-violent action' on the grounds of the sufferings involved.

The Concept of Self-purification

Self-purification, which is the essential characteristics of non-violence conduct, ultimately leads the individual to attain a state of equipoise and equilibrium, at which he rises above the contradictions of defeat and victory. The spiritual development of the personality is therefore the pragmatic purpose of the path of non-violence. Non-violence is not the creed of the coward or the weakling, but that of the brave and the courageous. It makes a person fearless and absolutely indifference to physical death. Unless he masters that much courage, he cannot follow the path of non-violence, and unless he is non-violent and truthful to the core, he cannot attain spiritual strength. Gandhi did accept the ideal of Sthitaprajna of the Bhagavadgita as the ideal. He actually practiced it and come to the conclusion that self-restraint ultimately leads to self-purification.

Gandhi gave the message of eternal value to the world that truth and non-violence were the supreme ideals for mankind. He asked men to inculcate the twin virtues of truth and non-violence for their individual perfection and for the happiness of the human race as a whole. Truth he considered as the supreme value and non-violence as the supreme method. Following the ancient Indian ideas of "dharma" Gandhi knew that there has been repeated insistence on speaking truth and following the path of truth since only truth comes out victorious in the end. For Gandhi, truth acquired a comprehensive meaning in a wider sense. One should be truthful in though, actions and motives. In his personal and public life Gandhi conduct experiments in truth to find out his own determination to be truthful. His whole life proved to be a continuous process of experimentation with truth. He came to believe that truth was the most important name of God, or even God Himself. His faith in God was not dogmatic and theistic but fully rational and humanistic. He asked people to follow the path of truth in case they wanted to profess their faith in God. Gandhi did not believe in God imprisoned in temples, mosques or churches. We found Gandhi thought my uniform experience has convinced me that there is no other God than truth. The transcendental nature of truth makes it eternal Reality. He considered no other justification of human existence except the devotion to truth.

With Gandhi laid equal emphasis on the principle of non-violence. Non-violence is the supreme religious duty taught by the Mhabharata and by the Buddha and Mahavira. But Gandhi felt that non-violence in our ancient scriptures implied more or less a negative principle. Men were advised to avoid inflicting pain on others as it amounted to sin. Gandhi made a very great contribution in giving positive interpretation of it. He said a more important thing for a follower of non-violence was to love others. Non-violence and love are identical in meaning.

Gandhi distinguished non-violence from cowardice because the former was the weapon of the strongest. Violence is evil and a man of character and strength would not return evil or evil. Evil must be returned with good. Even in the most difficult situation of his life, Gandhi struck to the principle of non-violence, the philosophy of love for hate, justice for injustice, non-violence for violence. Gandhi was a practical man and there was a lot of flexibility in his application of non-violence. He recommended the killing of an ailing calf, undergoing great agony, which could not be cured. To the question of what should dong with a man dog, Gandhi's reply was it must be killed. Thus, non-violence was a perfectly rational and practical method of the Marxists for establishing classes society Gandhi declared that good end could not justify bad means. This became a doctrine and a creed for all people throughout the world struggling for justice and freedom.

Gandhi was very rational and practical thinker. He wanted religion to help in solving all problems related to man as an individual and as a member of society. His social philosophy is equally important because he wanted to bring about total social transformation without creating ill will, violence and injustice to any section of the society. Caste and class division only impeded social progress; hence, the socialist ideal of classless society must be accepted. All men are children of one human family like branches of a tree, therefore, discriminations on the basis of birth or status is immoral.

Gandhi worked out a religious philosophy in which belief in one God and respect for all religious faiths were cardinal principles. With this philosophy he wanted to solve the Hindu-Muslim conflict causing great harm to the India society. In spite of Gandhi's sincerity, idealism and great courage in waging a struggle for social peace and harmony, his methodology, could not convince the majority of the Muslims of his unorthodox Hindu character. Some thinkers have been gore to the extent of calling him the great architect of Hindu revivalism in modern India and considered his philosophy and method unsuited to resolve the Hindu-Muslim conflict in India society which is not purely a religious problem as Gandhi viewed it. It needed causal understanding to find out deep-rotted historical factors involved in it. Failure of Gandhian philosophy is very clearly visible in this connection.

Conclusion

Gandhi asserted most emphatically that adherence to non-violence was not restricted to the personal sphere of an individual. The goal of non-violence conduct is self-purification on the one hand, and social well-being on the other. Since Gandhi's religion of humanity, based on the conviction that every man has the spark of truth, non-violence or love in him, and since the best way to overcome evil is not to kill the evildoer but to change his heart by refusing to retaliate, it is evident, that this religion has a social bearing.

The bearing of this religion on social life is, or has to be seen in one's daily social contact. To be true to such religion one has to lose oneself in continuous and continuing service of all life. Realization of truth is impossible without a complete merging of oneself in, and identification with, this limitless ocean of life. Hence, there is no earth beyond or apart from it. Social service here must be taken to include every department of life. In this scheme there is nothing high. For all is one, though we seem to be many.

Self-realization always implies self-sacrifice, because it means the realization of the higher or the universal self by sacrificing or neglecting the lower or the individual self. Individuals or nations, who would practice non-violence, must be prepared to sacrifice all expect honour.

To sum up Mahatma Gandhi has tried to rationalize the ancient Indian philosophy of Vedas, the Upanisads, the Bhagavadgita, the classical school of Buddhism and Vedanta, etc. Gandhi is the eager seeker of truth and strong upholder of the path of non-violence. According to Gandhi, non-violence implies a classless society and world without economic, political or social disparities. His aim in life was God-realization. Thus, he accepts that the application of non-violence to the individual was God-realization of setting nearer the truth or god. The goal of non-violent conduct is self-purification on the one hand, and social well-being on the other. Practical problems at the national and international can be solved by adhering to the principles of truth, non-violence, justice and peaceful co-existence. Gandhi showed the way towards peace, national and international.

The upshot of the discussion is that Mahatma Gandhi is the symbol of non-violence. He is truly the man who changed the course of history and paved way for India's victory through his indestructible weapon of non-violence and taught the world human society that only non-violent action can pave the way for peaceful co-existence, goodwill love and sympathy and can work global peace. This ahimsa preached by Gandhi holds a great relevance in today's society where the world is in the grip of crisis whether in Iraq, Afghanistan, Sri Lanka, Palestine or India and only non-violence advocated by Gandhi can helps us to solve critical problems of our times and can come out to remove the dirty spots of terrorism, exploitation, racial discrimination, injustice and hatred from the face of humanity.

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The Problem of the Seven Co-natals of the Bodhisatta in Buddhist Literature

Khin Soe Min [Ä]

Abstract

This paper attempts to focus on the problem of the seven Co-natals of the Bodhisatta in the Buddhist Literatures. The many accounts of the seven Co-natlals of the Bodhisatta that are described in the Lalitavistara, Mahāvatthu and Buddhavaṁsa are differ from one another. This paper presents to express the discrepancies of co-natal of the Bodhisatta between Thearavāda Buddhist texts and Mahāyana one. The seven co-natals are constant throughout these lists, though they may be slightly differently arranged or described: Rāhulamātā, Ānanda, Channa, Kanthaka, nidhikumbhā, Mahābodhirukkha, Kāḷudāyī. There has been little qualitative analysis of the seven co-natals of Bodhisatta. The main purpose of this study is to develop a comprehending of the seven co-natals of the Bodhisatta in a number of scattering Buddhist literature.

Keywords: *Seven Co-natals, Bodhisatta, Thearavāda, Mahāyana,*

Introduction

The *Buddhavamsa* describes the life of *Gotama* Buddha and of the twenty-four previous Buddhas who had prophesied his attainment of Buddhahood. It is the fourteenth book of the *Khuddaka Nikāya*. Chapter 27 of the *Buddhavamsa* is an account of *Gotama* Buddha. Seven co-natals of the *Bodhisatta* is observed in the *Buddhavaṁsa Aṭṭhakathā* written by *Buddhadatta* as the name of *Madhuratthavilasini.*

There are a number of versions in descriptions of seven co-natals of the *Bodhisatta*: Srilanka Version, Myanmar Version, Indian and Thailand version. They are disagreed with one another according to the versions. The ultimate aim of this study is to describe and interpret seven co-natals of Bodhisatta articulation of the key factor of *Buddhavamsa,* the essentials of which remain normative for many Buddhists in studying of different *Buddhavamsa* versions. Scholars and students will find the seven co-natals of Bodhisatta an indispensable resource for the understanding of orthodox Buddhism at this important historical juncture, as well as the present day.

The meaning of *Boddhisatta*

In Buddhism, a *Bodhisatta* (Collins English Dictionary, p-27. In this dictionary, it can be found that *Bodhisatta* is described as *Bodhisatva. Bodhisatta* is Pali Language and *Bodhisatva*, Sanskrit one.) is any person who is on the path towards Buddhahood.

In *Mahayana* Buddhism, a bodhisattva refers to anyone who has generated *Bodhicitta*, a spontaneous wish and compassionate mind to attain Buddhahood for the benefit of all sentient beings. (The *Bodhisattva* Vow: 2nd. ed., 1995)

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The Seven Co-natals of the *Bodhisatta*

At that precise moment of the birth of the *Bodhisatta*, the following seven were born simultaneously:

(1) Princess *Yasodharā*, also named *Baddakaccānā*, mother of Prince *Rāhula*;

(2) Prince *Ānanda*;

(3) Minister *Channa*; (The Bodhisattva Vow: 2nd. ed., 1995, See, Appendix – 5.)

(4) Minister *Kāḷudāyī*;

(5) Royal stallion *Kaṇḍaka*;

(6) *Mahā Bodhi* or *Assattha Bodhi* Tree; and

(7) Four urns of gold.

Since they were born or coming into being at the same time as the *Bodhisatta*, they were known as the seven co-natals of the *Bodhisatta*. Of these seven:

(1) Princess *Yasodharā Bhaddakaccānā* was born of the *Suppabuddha*,King of *Devadaha* City, and Queen *Amittā*;

(2) Prince *Ānanda* was the son of the *Sakyan Amittodana*, younger brother of King *Suddhodana*;

(3) The *Mahā Bodhi* Tree grew at the centre of the site of victory where the Buddha attained Enlightenment in *Uruvelā* forest of the Middle Country;

(4) The four large urns of gold appeared within the precincts of the palace of *Kapilavatthu* City. Of these four;

(a) one was named *Saṅkha*, the diameter of its brim being one *gāvuta*;

(b) another was named *Ela*, the diameter of its brim being two *gāvutas*;

(c) the third was named *Uppala*, the diameter of its brim three *gāvutas*;

(d) the last one named *puṇḍarika*, the diameter of its brim being four *gavutā*; equivalent to one *yojana*

In the exposition of the story of *Kāḷudāyī* in the *Aṅguttara* Commentary (AA, 76) and also in the exposition of the story of *Rāhula* in the *Vinaya Sārattha Dīpanī Ṭīkā,*(SDṬ, 98) *Ānanda*'s name has been left out from the list. It includes: (1) *Bodhi* Tree, (2) *Yasodharā*, (3) The four urns of gold, (4) Royal elephant named *Ārohanīya*, (5) *Kaṇḍaka* the steed, (6) Minister *Channa*, (7) Minister *Kāḷudāyī*, in that order.

Prince *Yasodharā* or *Rāhulamātā*

Rāhulamātā was the name, generally given in the texts, of Rāhula's mother (Vin.i.82) and Siddhattha's wife. She is also called Bhaddakaccā, (Bu.xxvi.15; Mhv.ii.24) and, in latertexts, Yasodharā (BuA.,p.245), Bimbādevī (Jā.ii.392f.) and, probably, Bimbāsundarī (Jā.vi.478 [12]). The Commentarial (AA.i.204.) explanation, that she was called Bhaddakaccānā because her body was the colour of burnished gold, is probably correct.Rāhulamātā was born on the same day as the Bodhisatta (Jā.i.54). She married him (Gotama) at the age of sixteen, the following account is taken chiefly from Jātaka (Jā.i.58ff), and was placed at the head of forty thousand women, given to Gotama by the

Sākiyans, after he had proved his manly prowess to their satisfaction. Later, when the Buddha allowed women to join the Order, Rāhulamātā became a nun under Mahā Pajāpatī Gotamī (AA.i.198).

Buddhaghosa identifies (AA.i.204f) *Rāhulamātā* with *Bhaddakaccānā* who, in the *Anguttara Nikāya* (A.i.25), is mentioned as chief among nuns in the possession of supernormal powers (*mahābhiññappattānam*). She was one of the four disciples of the Buddha who possessed such attainment, the others being *Sāriputta, Moggallāna* and *Bakkula*. She expressed her desire for this achievement in the time of *Padumuttara* Buddha.

She joined the Order under *Pajāpatī Gotamī* in the company of *Janapadakalyānī* (*Nandā*), and in the Order she was known as *Bhaddakaccānā Therī*. Later, she developed insight and became an *arahant*. She could, with one effort, recall one *asankheyya* and one hundred thousand *kappas* (AA.i.205).

Prince Ānanda

Ānanda was one of the principal disciples of the Buddha. He was a first cousin of the Buddha and was deeply attached to him.

He came to earth from *Tusita* and was born on the same day as the *Bodhisatta*, his father being *Amitodana* the *Sākiyan*, brother of *Suddhodana*. *Mahānāma* and *Anuruddha* were therefore his brothers (or probably step-brothers). According to the Mahāvastu (Mtu.iii.176), *Ānanda* was the son of *Sukkodana* and the brother of *Devadatta* and *Upadhāna*. His mother was *Mṛgī.*

Not all the *Suttas* addressed to *Ānanda* are, however, the result of his questions. Sometimes he would repeat to the Buddha conversations he had had with others and talks he had overheard, and the Buddha would expound in detail the topics occurring therein.

Ānanda came to be known as *Dhammabhaṇḍāgārika*, owing to his skill in remembering the word of the Buddha; it is said that he could remember everything spoken by the Buddha, from one to sixty thousand words in the right order; and without missing one single syllable (ThagA.ii.134).

The Pāli Canon makes no mention of *Ānanda*'s death (Fa Hsien Giles trans. 44). The story also occurs in *Dhammapada* Commentary (DhA.ii.99ff), with several variations in detail, however, relates what was probably an old tradition. When *Ānanda* was on his way from *Magadha* to *Vesāli*, there to die, *Ajātasattu* heard that he was coming, and, with his retinue, followed him up to the *Rohini* River. The chiefs of *Vesali* also heard the news and went out to meet him, and both parties reached the river banks. *Ānanda*, not wishing to incur the displeasure of either party, entered into the state of *Tejokasina* in the middle of the river and his body went up in flames. His remains were divided into two portions, one for each party, and they built *Cetiyas* for their enshrinement. (Rockhill,op. cit., 165f. 1972)

Minister *Channa*

Channa was *Gotama*'s charioteer and companion, born on the same day as *Gotama*, a number of texts (J.i.54) said that he was the son of a servant woman of *Suddhodana*. He was one of the seven co-natal. When *Gotama* left household life, *Channa* rode with him on the horse *Kaṇḍaka* as far as the river *Anomā*. There *Gotama* gave him his ornaments and made him take *Kaṇḍaka* back to his father's palace (Dvy.391). When,

however, *Kaṇḍaka* died of a broken heart, *Channa*'s grief was great, for he had suffered a double loss. It is said that he begged for leave to join *Gotama* as a recluse, but this leave was refused (J.i.64f). He therefore returned to *Kapilavatthu*, but when the Buddha visited his *Sākiyan* kinsfolk, *Channa* joined the Order. Because of his great affection for the Buddha, however, egotistical pride in "our Buddha, our Doctrine" arose in him and he could not conquer this fondness nor fulfil his duties as a *Bhikkhu* (ThagA.i.155).

When *Ananda* visited *Channa* at the *Ghositārāma* and pronounced on him the penalty, even his proud and independent spirit was tamed; he became humble, his eyes were opened, and dwelling apart, earnest and zealous, he became one of the *arahants*, upon which the penalty automatically lapsed in *Vinaya Piṭaka* (Vin.ii.292).

Minister Kāḷudāyī Thera

Kāḷudāyī Thera was son of one of Suddhodana's ministers at Kapilavatthu; he was born on the same day as the Buddha and grew up as his playfellow. After Gotama left the world, Suddhodana made Kāḷudāyī one of his most trusted counsellors. When the king heard of his son's Enlightenment he sent several of his ministers with large retinues to bring the Buddha to Kapilavatthu, but they all became arahants as soon as they heard the Buddha's preaching and then forgot their mission. In the end the king sent Kāḷudāyī, on the understanding that he should first be allowed to join the Order (Mtu.iii.233, he was accompanied by Channa in this mission). He went to the Buddha and, having listened to him, himself became an arahant. When the rains fell, covering the earth with the glory of leaves and flowers, Kāḷudāyī felt that it was time for the Buddha to visit his kinsmen, and gave him their invitation, singing the season's beauties in a series of verses. The Buddha took sixty days in covering the sixty leagues from Rājagaha to Kapilavatthu, and each day Kāḷudāyī went by air to the king's palace to tell him of the progress made in the journey and to bring back to the Buddha from the palace a bowl full of excellent food. By the time the Buddha reached his home his kinsmen were already full of faith in him. Because Kāḷudāyī accomplished this feat, he was declared pre-eminent among those who gladdened the clans (A.i.25; Thag.527-36).

It is said that he was called Udāyī because he was born on a day on which the citizens were full of joy (udaggacittadivase jātattā); and called Kāḷa because of his slightly dark colour (AA.i.167).

The Dhammapada Commentary refers to an assembly at which Kāḷudāyī was present, his body of golden hue, sitting near Pasenadī, at sunset, with the moon rising in the eastern sky. Ānandā looks at them and declares how the Buddha suffuses them all with his glory. Kāḷudāyī is identified with Sakka in the Bhisa *Jātaka* (Jā., iv.314).

Royal Stallion Kaṇḍaka

Kaṇḍaka, Bodhisatta's riding steed, was born on the same day as the *Bodhisatta* (Jā., i.54). In heaven he had a magnificent palace of *veluriya* gems, which *Moggallāna* visited on one of his tours in *Tāvatimsa* (DhA.i.70).

The horse on which *Gotama* left his father's palace, accompanied by his attendant *Channa*. It is said that when *Kaṇḍaka* was saddled for the journey, he realized the importance of the hour and neighed loudly for joy, but the gods muffled the sound of his neighing as also that of his footsteps as he galloped through the streets; ordinarily the sound of his neighing and galloping could be heard throughout *Kapilavatthu*. He was eighteen cubits long from neck to tail and proportionately broad, quite white in colour, like a clean conch-shell.

In this journey of *Gotama, Channa* held on to *Kaṇḍaka's* tail. The horse had the strength, had it been necessary, to clear the ramparts of the city, eighteen hands high, at one bound, with the prince and *Channa* on his back. Just outside *Kapilavatthu* the prince stopped the horse, in order to take a last look at the city. A *cetiya* was later erected on this spot and called *Kaṇḍakanivatta-cetiya*. The horse travelled thirty leagues between midnight and the following morning, as far as the river *Anomā*. It is said that *Kanthaka* could travel round the whole *cakka-vāla* in one night. With one leap the horse cleared the river, which was eight fathoms wide. On arriving on the opposite bank, the *Bodhisatta* gave orders that *Kanthaka* should be taken back to *Kapilavatthu,* but *Kanthaka* kept looking back at his master, and when the *Bodhisatta* disappeared from view the horse died of a broken heart, and was reborn in *Tāvatiṁsa* under the name of *Kanthaka-devaputta* (Jā., i.62-5).

Mahā Bodhi or Assattha Bodhi Tree

Bodhi-tree is a play an important part of Buddha's biography. There was the generic name given to the tree under which a Buddha attains Enlightenment (D.A.ii.416). The tree is different in the case of each Buddha.

The site of the *Bodhi* tree is the same for all *Buddhas* (BuA.247), and it forms the navel of the earth (Jā., iv.233; puthuvinābhi). No other place can support the weight of the Buddha's attainment (J.iv.229).

In the case of *Gotama* Buddha, his *Bodhi* tree sprang up on the day he was born (DA.ii.425). After his Enlightenment, he spent a whole week in front of it, standing with unblinking eyes, gazing at it with gratitude. A shrine was later erected on the spot where he so stood, and was called the *Animisalocana cetiya*. The spot was used as a shrine even in the lifetime of the Buddha, the only shrine that could be so used. While the Buddha was yet alive, in order that people might make their offerings in the name of the Buddha when he was away on pilgrimage, he sanctioned the planting of a seed from the *Bodhi* tree in *Gayā* in front of the gateway of *Jetavana*. This tree, because it was planted under the direction of *Ānanda*, came to be known as the *Ānanda Bodhi* (Jā., iv.228ff).

Conclusion

As for a long time the number seven has been regarded as a symbol of completion or perfection (Jā vi 489), so seven are those held to have been of simultaneous birth, co-natal with the *Bodhisatta*, born on the same day as he was, *satta sahajatāni* (Jā vi 512); and so as they were also born on the same day as one another each had six co-natals, apart from the *Bodhisatta*, to form a set of seven. Though this set may not be intrinsically

of much importance as a set, and in this respect differs from its individual members, yet, as possible quasi-history, even authentic history in some cases and as a tradition surviving in some of the commentaries, a little investigation here may not be out of place.

The co-natals are listed three times in *Buddhavaṁsa Aṭṭhakathā* (BvAC 131) and at least seven times in five other commentaries and also in *Jinakāmālī* (Jā i, 54; DA ii, 425). Besides this, one commentary speaks of one member only the set, another commentary of another member, and still a third of a different member as being co-natal with the *Bodhisatta* (Da, i, 284(the four urns); SA,ii , 317 (Channa); VvA, 314 (Kanthaka).

The list of the co-natals at *Jātaka* (Jā, i, 54) though spoken of as seven, contains only six names in Fausböll edition. These are *Rāhulamātā devī, Channo amacco, Kāḷudāyī amacco, Kanthako assarāja, Mahābodhi rukkho, cattāro nidhikumbhiyo*. Here *Ānandā*'s name is absent as is that of his substitute, the *hatthirājā*, the state-elephant of *Buddhavaṁsa Aṭṭhakathā* in Ceylon (BvAC, 276). But it is open to the question whether it is not Fausböll who is responsible for the omission.

Ānanda is also omitted at *Buddhavaṁsa Aṭṭhakathā* in Ceylon (BvAC, 298), but here again *Buddhavaṁsa Aṭṭhakathā* in Myanmar fills the blank, as it does that at *Buddhavaṁsa Aṭṭhakathā* in Ceylon (BvAC, 276), by giving his name, though it notes no other reading. One would therefore like to know whether what *Buddhavaṁsa Aṭṭhakathā* in Myanmar is giving here is a genuine reading or put in by later editors to make *Buddhavaṁsa Aṭṭhakathā* more consistent with itself. Attention has been called above to the omission of *Ānanda*'s name at *Apadāna Aṭṭhakathā* (ApA, 58) in the SHB edition.

There seems no indication of *Kāḷudāyī*'s age when he died. After becoming an *arahant* and having successfully urged *Gotama*, very recently awakened, to return to *Kapilavatthu* at his father's insistent requests, he was declared pre-eminent among the disciples to gladden the clans (A, i, 25), but then becomes rather a shadowy figure of whom little more is recorded.

Little is known about the Buddha's early life. No biography was written during his life time. Only isolated events from his life before he attained enlightenment were preserved. Some of the following are probably mythical in nature.

Myanmar Theravada Buddhists agree the seven co-natals of Bodhisatta to the traditional view which complied with Buddhist Myanmar literature named for Mahābuddhavamsa written by Min Kun Sayardaw. This paper presents the respective views of the seven co-natals of Bodhisatta which scattered in the Buddhist canons and non-canonical literatures.

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Evaluation of Some Parameters of Formulated Sunscreen Lotions

Ei Ei Thwin [Ä]

Abstract

Sunscreen products contain active ingredients that absorb, reflect or scatter the sunlight, depending on their nature. It can be evaluated the effectiveness of a sunscreen by determination of the sun protection factor (SPF). It was reported that zinc oxide (ZnO) gave protection against UV B (290-320 nm) rays. The aim of this study was to determine some parameters such as appearances, colour, texture, consistency, pH, spreadability, thermal stability and the SPF values of the formulated sunscreen lotions containing zinc oxide, olive oil and coconut oil. UV-Vis spectrophotometer was used to measure the UV absorption of the formulated sunscreen lotions and the Mansaur equation was applied to obtain the SPF value. The method used in this work is simple, fast, not expensive and easy-to-use. These formulated sunscreen lotions were found to possess SPF of 17.32, 21.48 and 21.71 that can protect against suntans and sunburns. They are range in 15 to 30 so they are suitable for daily application against photo-damage.

Keywords: formulated sunscreen lotion, sun protection factor, UV radiation, UV-Vis spectrophotometer, zinc oxide

Introduction

Skin is the outermost and the largest part of the body and it is most sensitive to photodamage because it directly exposed to solar radiation and other environmental factors. The harmful effects of solar radiation are usually caused by the ultraviolet (UV) region of the electromagnetic spectrum. It may cause several harmful effects to the eyes, skin and immune system (More, *et al*., 2013). UV radiation can be classified into UVA (400-320 nm), UVB (320-290 nm), and UVC (290-100 nm). The ozone layer in the atmosphere (12-42 km thick) absorbs UV rays with wavelengths below 290 nm, and 90 % of UV rays with wavelengths 315-290 nm. The intensity of radiation is directly associated with the angle at which UV rays reach the Earth's surface and with altitude. The intensity is the highest at noon. Around 60% of total daily radiation from the sun is reached in the period from 10:00 AM to 4:00 PM. The amount of UV radiation increases by 15% per every 1000 meters of altitude (6% for UVB rays). Thick clouds decrease UV radiation by 10%-80%; the reflection from snowy or icy surfaces increases it by 75% and from sandy or rocky surfaces by 10%-15% (WHO, 1994). The photo protection against UV radiation can be determined *in-vivo* and *in-vitro*. The *in-vivo* determined by photo testing in human volunteers has been used from several years. It is complicated, time consuming as well as costly technique. Due to this, scientists have developed an *in-vitro* technique to measure the efficiency of sunscreen. The *in-vitro* test is quick, inexpensive screening methodology (Rasheed, *et al*., 2012).

Sunscreen agents used on preparations applied topically on the skin can be divided into organic and inorganic agents. Organic or chemical filters: usually these filters consist of molecules containing carbon rings with multiple double bonds and with oxygens bonded to carbons along the backbone of the molecule. Organic filters absorb the UV light, causing the double bonded ring system to attain a higher energy. The molecule quickly returns to its molecule can then again absorb UV light. Organic sun protection

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compounds penetrate the skin very easily and have a reasonable chance of being harmful or causing allergic reactions.

Inorganic or physical filters: these filters are comprised of ionic solids existing as micro- or nano-particles. The smallest units are crystal extended structures. ZnO and TiO_2 powder are very popular because they are efficient, insoluble and are not absorbed by the skin. Inorganic sunscreens are considered the most non-toxic and safe sunscreens to use, and also provide the broadest spectrum protection (Shine, 2016).

Zinc oxide (ZnO)

Zinc oxide is a common inorganic compound with a large number of uses. It is insoluble in water but soluble in dilute acids and bases. Its melting point is extremely high 1975 °C, where it also decomposes. Zinc oxide is used in wide range of cosmetics and personal care products including makeup, nail products, baby lotions, bath soaps and foot powders. It is also used in skin protectants, such as diaper rash ointments and sunscreen products. It is a mineral that sits on top of the skin, scattering, reflecting, and absorbing UVA and UVB rays. It is a white, powdery mineral with a long history of use as sun protection. (FDA, 2019)

ZnO-based on sunscreens

A sunscreen that contains ZnO works two different ways:

- Absorption: ZnO particles can absorb UV radiation, both UVA and UVB, and re-emit the absorbed energy as heat.

Scattering: The ZnO particles mixed in the sunscreen also scatter some UV and visible light away from the skin (Shine, 2016).

Figure 1 shows the rate of SPF effect on UVB protection and SPF selection guide for skin types are shown in Figure 2.

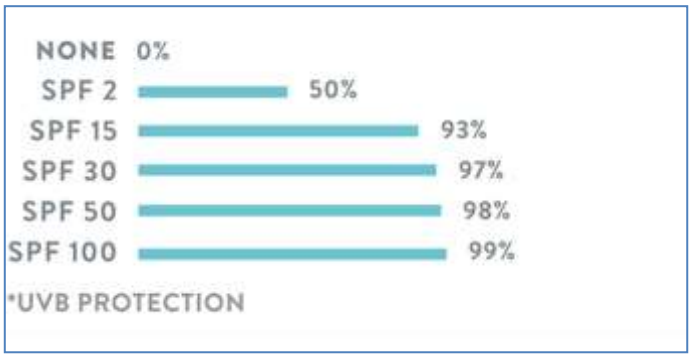

Figure 1. Rate of SPF effect on UVB protection*

Figure 2. SPF selection guide for skin types*

Materials and Methods

Collection and preparation of the ingredients

The ingredients in formulated sunscreen lotion were purchased from Monywa Market, Monywa Township, Sagaing Region. It was prepared in Laboratory of Chemistry Department, Taunggoke University.

Materials

UV-visible spectrophotometer (UV 1800ENG 240V, SOFT), pH meter (HI 207), magnetic stirrer, balance (TP-1102), oven (ON-02G), hot plate, water bath, tripod stand, two glass plates

Preparation of formulated sunscreen lotions

Accurate quantity of bee wax and zinc oxide were weighed as described in Table 1. Accurate quantities of olive oil, coconut oil and glycerin were measured and poured into a 100 mL beaker. Weighed of bee wax was added to the mixture and warmed the beaker in water bath. The mixture was heated to a temperature of 80°C to 85°C. When the ingredients in the beaker were melted, heating was stopped and cooled at room temperature. After that, zinc oxide was slowly poured into the mixture solution a little at a time and stirred constantly. Stirring was continued until a smooth and uniform paste. Then weighed quantity of vitamin E was added and stirred well until all the ingredients mixed uniformly. Finally, one drop of perfume was added as flavoring agent. The formulated sunscreen lotion was obtained. Figure 3 and Figure 4 show the ingredients in formulated sunscreen lotions.

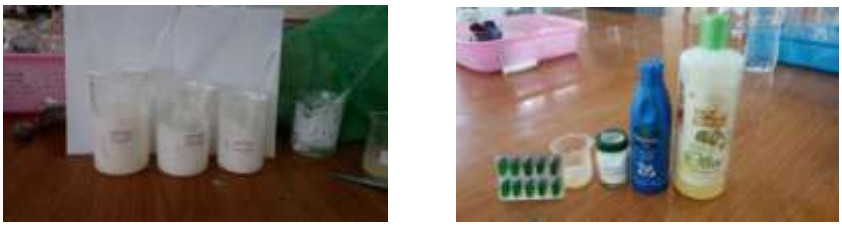

Figure 3. Formulated sunscreen lotions and their ingredients

Figure 4. Melting bee wax and weighted zinc oxide

Table 1. Composition in Formulated Sunscreen Lotions

Sr No.	Ingredients	F-1	F-2	F-3
1	Olive oil (emollient)	5 mL	4 mL	3 mL
2	Coconut oil (emollient)	3 mL	4 mL	5 mL
3	Bee wax (stiffening agent)	1 g	2 g	3 g
4	Zinc oxide (covering materials)	3 g	4 g	5 g
5	Glycerin (humectants)	1 mL	1 mL	1 mL
6	Vitamin E (preservative)	0.5 mL	0.5 mL	0.5 mL
7	Perfume (odour)	1 dp	1 dp	1 dp

Evaluation of Physicochemical Parameters of Formulated Sunscreen Lotions

The physicochemical parameters such as appearances, colour, texture, consistency, pH (Gaspar and Maia Campos, 2003), thermal stability and spreadability (Henry, 1997; Sagarin, 1957) of formulated sunscreen lotions were evaluated.

pH determination

All the formulated sunscreen lotions were oil in water semisolid emulsions. As pH of the lotions not to be directly measured, 10% dilutions were made with distilled water and the resulting pH of mixture was determined with a pH meter. Each 1g of lotion was dispersed in 9 ml of distilled water to determine the pH. Figure 5 shows measuring the pH value by a pH meter. The results are shown in Table 3.

Figure 5. Measuring pH values by pH meter (HI 207)

Stability Studies

Thermal stability

The lotions were transferred into glass bottles with the help of spatula and tapped it to settle to the bottom. Filled up to one third capacity of bottle, plug was inserted and tightened the cap. The filled bottles were kept in the oven at 45 °C for 48 hr. Figure 6 shows the filled bottles and the oven (ON-02G).

Figure 6. The bottles filled with formulated sunscreen lotions and the oven used for Thermal stability

Spreadability

The parallel plate method is most widely used method for determining the spreadability of semisolid preparations. A modified laboratory apparatus was used to evaluate spreadability. The setup consists of two glass slides of dimensions (10 x 10 cm) placed on a tripod stand on which excess of lotion (3g) was applied in between two glass slides. The upper slide was movable and the lower slide was firmly fixed to the stand. 100 g weight was placed on them for 5 minutes to compress the cream to uniform thickness and the excess lotion was scrapped off from the edges. Then 50 g weight was added to the slides and the upper slide was pulled till a distance of 7.5 cm. The time in seconds required to separate two glass slides by 7.5 cm was taken as a measure of spreadability. A shorter interval indicates better spreadability. The spreadability was calculated by using the formula (Henry, 1997; Sagarin, 1957).

$$S = m.l/t$$

Where, S= spreadability, m= Weight tied to upper glass slide, l= Length of glass slide, t= Time taken to separate them. In present experiment, M= 50g and l= 7.5 cm. Figure 7 shows preparation photos of spreadability of formulated sunscreen lotions. The data showing the spreadability of different formulated sunscreen lotions are in the Table 3.

Figure 7. Photographs of test for spreadability

Determination of Sun Protection Factor (SPF) of Formulated Sunscreen Lotions

Preparation of solutions

Sun protection factor (SPF) was determined by using UV-Visible spectrophotometer. 0.10 % solution (w/v) each of the three formulated sunscreen lotions in n-hexane was prepared by dissolving 0.05g of the sunscreen lotion in 50.0 ml of n-hexane. The prepared aliquots of each formulation were scanned between 290 and 320 nm, with 5 nm interval. SPF was calculated by using the equation derived by Mansaur (Mansaur 1986; Santo et al., 1999). EE (λ) x I (λ) values determined by Sayre (Sayre et al. 2003) was used in below equation.

$$SPF_{spectrophotometric} = CF \sum_{290}^{320} EE(\lambda) \times I(\lambda) \times A(\lambda)$$

Where, correction factor, CF=10, EE(λ)= erythemogenic effect of radiation of wavelength λ, I(λ)= intensity of solar light of wavelength λ, A(λ)= spectrophotometric absorbance values at wavelength λ.

Figure 8. Photographs of preparation steps for SPF

The values of EE (λ) x I (λ) are constants. They were determined by Sayre *et al*., (2003), and are showed in Table 2.

Table 2. Normalized Product Function Used in the Calculation of SPF

Wavelength (λ nm)	**EE x I (normalized)**
290	0.0150
295	0.0817
300	0.2874
305	0.3278
310	0.1864
315	0.0839
320	0.0180
Total	1

Results and Discussion

The results of physicochemical analysis of formulated sunscreen lotions are shown in Table 3.

Appearances of formulated sunscreen lotion of F-1, F-2 and F-3 were gel-like, cream and paste. Because of bee wax amount, the appearances of these lotions were different. F-1 was gel-like as bee wax contained the fewest amounts while F-2 and F-3 were more containing bee wax weight. The highest amount of bee wax in F-3 provided paste in appearances.

The findings revealed that the three formulated sunscreen lotions were white in colour. No change in colour was observed at room temperature in storage condition up to five months of observation.

Smooth and good in texture and consistency were advantage for regularity in skin. They were able to maintain the skin's moisturizer as these formulations were oil-based products. Bee wax is used as an excipient in formulations with the purpose of increasing consistency of the preparations.

Table 3. Physicochemical Parameters of Formulated Sunscreen Lotions

Parameters	F-1	F-2	F-3	Acceptable Value
Appearances	Gel-like	Cream	Paste	-
Colour	White	White	White	-
Texture	Smooth	Smooth	Smooth	-
Consistency	Good	Good	Good	-
pH	6.41	7.25	7.30	5-8
Thermal stability	No separation of phases	No separation of phases	No separation of phases	-

The pH value is important for determining the stability of cosmetics. Any change in pH of the product indicates a possible interaction of chemical reactions. The pH of human skin normally ranges from 4.5 to 6.0. Acceptable pH range of moisturizers should be 5-8 range. This formulated sunscreen lotions had pH values of 6.41, 7.25 and 7.30, which were acceptable and non-skin irritating pH values.

Thermal stability of formulated sunscreen lotions which were oil-based products were studied at 45 °C temperature for 48 hours in oven. When three formulated sunscreen lotions were placed in oven at 45 °C temperature, there were no phase separation and any change in colour and nature. This showed that formulated sunscreen lotions were thermally stable.

The spreadability of formulated sunscreen lotions were determined by parallel plate method. This indicates good spreading of lotions when they are applied to the skin. The spreadability showed that formulated sunscreen lotion F-1 has better spreadability compared with F-2 and F-3. The greater the spreadability, the better the lotion's spreading. The results are summarized in Table 4 and Figure 9.

Table 4. Spreadability of Formulated Sunscreen Lotions

Formulated Sunscreen Lotions	Time (s)	Spreadability (g.cm/s)
F-1	6	62.50
F-2	14	26.79
F-3	27	13.88

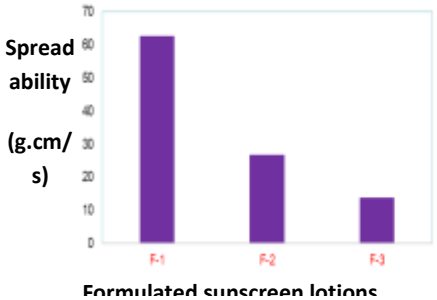

Figure 9. Spreadability of formulated sunscreen lotions

The absorbance values at various wavelengths from 290 to 320 nm of three formulated sunscreen lotions are given in Table 5.

Table 5. Absorbance Values of the Formulated Sunscreen Lotions

Wavelength (nm)	Absorbance Values		
	F-1	F-2	F-3
290	2.776	3.302	3.250
295	2.327	2.730	2.733
300	1.804	2.256	2.277
305	1.645	2.041	2.083
310	1.556	1.958	1.977
315	1.501	1.905	1.907
320	1.466	1.861	1.840

The SPF values of formulation F-1, F-2 and F-3 were calculated and presented in Table 6 and Figure 10. The results showed that F-2 and F-3 had SPF of 21.48 and 21.71 which may be attributed to the presence of more coconut oil and zinc oxide. This may be the fact that due to high content in saturated fatty acids in coconut oil which is an excellent fat for the synthesis of most of the cosmetic and zinc oxide which can absorb and scatter UV B rays. The F-1 showed medium SPF (with SPF ranging 15-20 are considered to be medium protection sunscreens) which was generally sufficient for protection against sun burn for a period of about 3 hours. As the formulated sunscreen lotions were found to possess SPF in the range of 15 to 30, they can be used for very fair skin, fair skin, light skin and medium skin rely on the length of prevention time to protect suntans and sunburns.

Table 6. SPF of the Formulated Sunscreen Lotions

Sr No.	Formulated Sunscreen Lotions	SPF
1	F-1	17.32
2	F-2	21.48
3	F-3	21.71

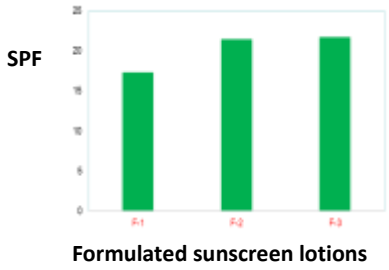

Figure 10. SPF of formulated sunscreen lotions

Conclusion

This study attempted to develop handmade sunscreen lotion using simple materials and examined their efficacy for preventing sunburn. The analysis of some parameters of formulated sunscreen lotions suggested that an efficient and safe sunscreen product was proposed. They are compatible with other cosmetic ingredients. According to the results, F-2 and F-3 have higher SPF than F-1. F-3 has the highest SPF. Their SPF range of 15 to 30 can help to prevent from sun-induced damage such as dark spots, wrinkles and skin cancer. This study reveals that using UV Spectrophotometer is the rapid, acceptable and inexpensive method for the evaluation of sun protection factor (SPF) of sunscreen lotions. It can be concluded that the formulated sunscreen lotions may be hopefully applied in the treatment of suntans and sunburns causing effects of UV rays and able to maintain moisture in the skin for a long time.

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Some Applications to Integral Equations on Hilbert Spaces

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Abstract

In this paper, some applications of theory of Hilbert spaces to integral equations are described. Firstly, some important points of existence and uniqueness theorems for operator equations are introduced. And then, different kinds of examples of Fredholm integral equations are presented in order to prove the existence result.

Keywords: Fixed point, Fredholm integral equations, Volterra integral equations.

1. Some Definitions and Examples

1.1 Definitions. A mapping $T: E \to E$, where E is a subset of a normed space, is called a ***contraction mapping*** if there exists positive number $0 < \alpha < 1$ such that $\|Tx - Ty\| \leq \alpha\|x - y\|$ for all x, y in E. If $Tx = x$, x is called ***fixed point*** of the mapping T.

1.2 Definition. Let E be a complex vector space. A mapping

$\langle .,. \rangle: E \times E \to \mathbb{C}$ is *called* ***an inner product*** if for any $x, y, z \in E$ and $\lambda, \mu \in \mathbb{C}$, the following conditions are satisfied:

(1) $\langle \lambda x + \mu y, z \rangle = \lambda \langle x, z \rangle + \mu \langle y, z \rangle$,

(2) $\langle x, y \rangle = \overline{\langle y, x \rangle}$,

(3) $\langle x, y \rangle \geq 0$ and $\langle x, x \rangle = 0$ if and only if $x = 0$.

A vector space with an inner product is called an ***inner product space***.

1.3 Definition. A complete inner product space is called a ***Hilbert space***.

Every inner product space is a normed space with the norm

$\|x\| = \sqrt{\langle x, x \rangle}$. Hence Hilbert spaces are Banach spaces.

1.4 Examples. Examples of Hilbert spaces are

(a) The space $l^2(\mathbb{C})$ defined by $l^2(\mathbb{C}) = \{x = (x_i) : \sum_{i=1}^{\infty} |x_i|^2 < \infty\}$ with $\langle x, y \rangle = \sum_{i=1}^{\infty} x_i \overline{y}_i$.

(b) The Lebesgue space $L^2([a, b]) = \left\{ f : [a, b] \longrightarrow \mathbb{C} : \int_a^b |f(x)|^2 \, dx < \infty \right\}$. The inner product on $L^2([a, b])$ is defined by $\langle f, g \rangle = \int_a^b f(x)\overline{g(x)} \, dx$ and the norm is

$$\|f\| = \left(\int_a^b |f(x)|^2 \, dx \right)^{\frac{1}{2}}.$$

2. Basic Existence Theorems

In this section, we recall basic result which will need in this paper.

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2.1 Theorem. Let S be a closed subset of a Banach space and T be a contraction mapping. Then

(a) the equation $Tx = x$ has one and only one solution in S, and

(b) the unique solution x can be obtained as the limit of the sequence (x_n) of elements of S defined by $x_n = Tx_{n-1}$, $n = 1,2,3, \ldots$ where x_0 is an arbitrary element of S such that $x = \lim_{n\to\infty} T^n x_0$.

This theorem not only represents an existence and uniqueness result but also gives an algorithm for finding the solution by an iterate procedure.

The following theorem is a generalization of Theorem 2.1. It is an essential in the proof of existence and uniqueness of solutions of integral equations.

2.2 Theorem. Let E be a Banach space and $T: E \to E$. If T^m is a contraction for some $m \in N$, then T has a unique fixed point $x_0 \in E$ and $x_0 = \lim_{n\to\infty} T^n x$ for any $x \in E$.

2.3 Theorem. If A is a bounded linear operator on a Banach space E and φ is an arbitrary element of E, then the operator defined by

$$Tf = \alpha Af + \varphi, \quad \alpha \in \mathbb{C},$$

has a unique fixed point for any sufficiently small $|\alpha|$. More precisely, if k is positive constant such that

$$\|Af\| \le k\|f\|$$

for all $f \in E$, then $Tf = f$ has a unique solution whenever $|\alpha|k < 1$.

Proof. Since A is bounded, there exists a constant k such that

$$\|Af_1 - Af_2\| \le k\|f_1 - f_2\| \qquad \text{for all } f_1, f_2 \in E.$$

Thus $$\|Tf_1 - Tf_2\| = |\alpha|\|Af_1 - Af_2\| \le |\alpha|k\|f_1 - f_2\|.$$

Hence T is a contraction if $|\alpha| < \frac{1}{k}$. By Theorem 2.1, T has a unique fixed point. ■

When the iterated process is applied in the case described in previous theorem, we obtain the following corollary.

2.4 Corollary. Let A be a bounded linear operator on a Banach space. Then

$$f = \varphi + \alpha Af$$

has a unique solution

$$f = \sum_{n=0}^{\infty} \alpha^n A^n \varphi$$

if $|\alpha|\|A\| < 1$.

2.5 Theorem. Let the initial value problem for the ordinary differential equation

$$\frac{dy}{dx} = f(x,y), \quad y(x_0) = y_0 \tag{1}$$

where f is a continuous function on

$$D = \{(x,y): a \le x \le b, c \le y \le d\}$$

containing the point (x_0, y_0) in its interior. If f satisfies the Lipschitz condition

$$|f(x,y_1)-f(x,y_2)| \le \mu|y_1-y_2|$$

for some $\mu > 0$ and all $(x,y_1),(x,y_2) \in D$, then there exists a unique solution $y = \varphi$ defined in some neighborhood of x_0.

Proof. Every solution of the integral equation

$$y(x) = y_0 + \int_{x_0}^{x} f\big(t,y(t)\big)dt \tag{2}$$

satisfies (1), and conversely.

Define the operator T on $C([a,b])$, the set of all continuous functions on $[a,b]$, by

$$(T\varphi)(x) = y_0 + \int_{x_0}^{x} f\big(t,\varphi(t)\big)dt. \tag{3}$$

Let $M = \sup\{\,|f(x,y)| : (x,y) \in D\}$ and select $\varepsilon > 0$ such that $\mu\varepsilon < 1$ and $[x_0 - \varepsilon, x0+\varepsilon \subset a,b$.

If $S = \{\varphi \in C([x_0-\varepsilon, x_0+\varepsilon]): |\varphi(x) - y_0| \le M\varepsilon\}$, then S is a closed subset of Banach space $C([x_0-\varepsilon, x_0+\epsilon])$ with

$$\|\varphi\| = \sup|\varphi(x)|, \quad \text{for all } x \in [x_0-\varepsilon, x_0+\epsilon].$$

Moreover, if $\varphi \in S$ and $x \in [x_0-\varepsilon, x_0+\varepsilon]$, then

$$|(T\varphi)(x) - y_0| = \left|\int_{x_0}^{x} f\big(t,\varphi(t)\big)dt\right| \le M\varepsilon.$$

Thus T maps S onto itself.

For any $\varphi_1, \varphi_2 \in S$, we have

$\|T\varphi_1 - T\varphi_2\| = \sup\left|\int_{x_0}^{x}\Big(f\big(t,\varphi_1(t)\big) - f\big(t,\varphi_2(t)\big)\Big)\,dt\right| \le \mu\varepsilon\,\|\varphi_1 - \varphi_2\|$. Since $\mu\varepsilon < 1$, T is contraction. Hence from Theorem 2.1, there is a unique solution φ of the equation $T\varphi = \varphi$. Thus $y = \varphi$ is a unique solution of (2). ■

2.6 Theorem. Let A be a self-adjoint compact operator on a Hilbert space H. Then the nonhomogeneous operator equation

$$f = Af + \varphi \tag{4}$$

has a unique solution for every $\varphi \in H$ if and only if the homogeneous equation

$$g = Ag \tag{5}$$

has only trivial solution $g = 0$. Moreover, if Equation (4) has a solution, then $\langle\varphi, g\rangle = 0$ for every solution g of (5).

Proof. Since A is self-adjoint compact operator, H has an orthonormal basis (v_n) consisting of eigenvectors of A with eigenvalues (λ_n). Let

$$\varphi = \textstyle\sum_{n=1}^{\infty} c_n v_n \text{ where } \langle\varphi, v_n\rangle.$$

The solution of (4) is the form

$$f = \sum_{n=1}^{\infty} a_n v_n$$

$$\sum_{n=1}^{\infty} a_n v_n = \sum_{n=1}^{\infty} a_n \lambda_n v_n + \sum_{n=1}^{\infty} c_n v_n .$$

$$a_n = \frac{c_n}{1-\lambda_n} \text{ if } \lambda_n \neq 1.$$

If (5) has no nonzero solution, 1 is not eigenvalue of A.

If (4) has a solution, it is of the form

$$f = \sum_{n=1}^{\infty} \frac{c_n}{1-\lambda_n} v_n . \tag{6}$$

This shows that if (4) has a solution, then it is unique.

To prove that (4) has a solution, we have to show that the series (6) is convergent. Since $\lambda_n \to 0$ as $n \to \infty$, there exists $M > 0$ such that $\frac{1}{1-\lambda_n} \leq M$ for all n.

$$\sum_{n=1}^{\infty} \left| \frac{c_n}{1-\lambda_n} \right|^2 \leq M^2 \sum_{n=1}^{\infty} |c_n|^2 < \infty.$$

Thus, the series (6) converges and its sum is a solution of (4).

If (5) has a nontrivial solution g and f is a solution of (4), then $f + cg$ is a solution of (4) for any $c \in \mathbb{C}$. In that case, (4) has infinitely many solution.

Finally, suppose f and g are solutions of (4) and (5) respectively.

$$\langle f, g \rangle = \langle Af, g \rangle + \langle \varphi, g \rangle = \langle f, Ag \rangle + \langle \varphi, g \rangle = \langle f, g \rangle + \langle \varphi, g \rangle.$$

Then $\langle \varphi, g \rangle = 0$. Hence, if (4) has a solution, then φ is orthogonal to every solution of(5). ■

3. Fredholm Integral Equations

In this section, we study the solvability of integral equations.

3.1 Definitions. The equation of the form

$$\varphi(x) = \alpha \int_a^b K(x,y) f(y) dy,$$

where φ is given and f is unknown function, is called a ***Fredholm integral equation of the first kind***.

The function K is called the ***kernel***. If $K(x,y) = K(y,x)$, K is called ***symmetric kernel***.

If the unknown function is outside the integral, i.e.,

$$f(x) = \alpha \int_a^b K(x,y) f(y) dy + \varphi(x)$$

then the equation is called a ***Fredholm integral equation of the second kind***.

The following theorem is an existence and uniqueness of solution of Fredholm nonhomogeneous linear integral equation of the second kind.

3.2 Theorem. The Fredholm integral equation

$$f(x) = \alpha \int_a^b K(x,y)f(y)dy + \varphi(x) \tag{7}$$

has a unique solution $f \in L^2([a,b])$ if the kernel K is continuous in$[a,b] \times [a,b]$, $\varphi \in L^2([a,b])$ and $|\alpha|k < 1$ where

$$k = \sqrt{\int_a^b \int_a^b |K(x,y)|^2 \, dxdy}\,.$$

Proof. Let $(Tf)(x) = \alpha \int_a^b K(x,y)f(y)dy + \varphi(x)$. Since $\varphi \in L^2([a,b])$, $Tf \in L^2([a,b])$ if

$$\int_a^b K(x,y)f(y)dy \in L^2([a,b]). \tag{8}$$

By Cauchy Schwarz's inequality,

$$\left|\int_a^b K(x,y)f(y)dy\right| \leq \int_a^b |K(x,y)f(y)|dy$$

$$\leq \left(\int_a^b |K(x,y)|^2 dy\right)^{\frac{1}{2}} \left(\int_a^b |f(y)|^2 dy\right)^{\frac{1}{2}}$$

$$\leq \left(\int_a^b |K(x,y)|^2 dy\right)\left(\int_a^b |f(y)|^2 dy\right). \tag{9}$$

By integratingboth sides w.r.t x, we get

$$\int_a^b \left|\int_a^b K(x,y)f(y)dy\right|^2 dx \leq \int_a^b \left(\int_a^b |K(x,y)|^2 dy \int_a^b |f(y)|^2 dy\right) dx$$

$$\leq \int_a^b \int_a^b |K(x,y)|^2 dydx \int_a^b |f(y)|^2 dy.$$

Since $\int_a^b \int_a^b |K(x,y)|^2 dydx < \infty$ and $\int_a^b |f(y)|^2 dy < \infty$, (8) is satisfied

Thus T maps $L^2([a,b])$ into itself.

From (9), the operator defined by

$$(Af)(x) = \int_a^b K(x,y)f(y)dy$$

is bounded. Hence by Theorem 2.3, the equation $Tf = f$ has a unique solution if $|\alpha|k < 1$. ■

By applying above theorem, we examine the existence and uniqueness of solution of the following Fredholm linear integral equation.

3.3 Example. Let the integral equation be

$$f(x) = \alpha \int_a^b \left(e^{\frac{(x-y)}{2}}\right) f(y)dy + \varphi(x) \tag{10}$$

where φ is given function. Then $\int_a^b \int_a^b \left(e^{\frac{(x-y)}{2}}\right)^2 dxdy = \frac{\left(e^b - e^a\right)^2}{e^{a+b}}$. It follows that equation (10) has a unique solution whenever $|\alpha| < \frac{e^{\frac{(a+b)}{2}}}{e^b - e^a}$.

The next theorem shows that the existence and uniqueness of the solution of nonlinear Fredholm integral equation.

3.4. Theorem. Suppose

(a) $\left\| \int_a^b K(x,y,f(y))dy \right\| \leq M\|f\|$ for all $f \in L^2([a,b])$,

(b) $|K(x,y,z_1) - K(x,y,z_2)| \leq N(x,y)|z_1 - z_2|$,

(c) $\int_a^b \int_a^b |N(x,y)|^2 dxdy = k^2 < \infty$, for all $x, y, z_1, z_2 \in [a,b]$.

Then the nonlinear Fredholm equation

$$f(x) = \alpha \int_a^b K(x,y,f(y))dy + \varphi(x) \tag{11}$$

has a unique solution $f \in L^2([a,b])$ for every $\varphi \in L^2([a,b])$ and α such that $|\alpha|k < 1$.

Proof. Define an operator $T: L^2([a,b]) \longrightarrow L^2([a,b])$ by $Tf = \alpha Af + \varphi$ where

$$(Af)(x) = \int_a^b K(x,y,f(y))dy.$$

Then

$$\|Tf_1 - Tf_2\| = |\alpha| \left\| \int_a^b K(x,y,f_1(y))dy - \int_a^b K(x,y,f_2(y))dy \right\|$$

$$\leq |\alpha| \left(\int_a^b \left(\int_a^b |K(x,y,f_1(y)) - K(x,y,f_2(y))|\, dy \right)^2 dx \right)^{\frac{1}{2}}$$

$$\leq |\alpha| \left(\int_a^b \left(\int_a^b N(x,y)|f_1(y) - f_2(y)|\, dy \right)^2 dx \right)^{\frac{1}{2}}$$

$$\leq |\alpha| k \|f_1 - f_2\|$$

If $|\alpha|k < 1$, then T is a contraction mapping.

Thus T has a unique fixed point and that fixed point is a solution of equation (11). ■

4. Volterra Integral Equations

As in Fredholm integral equations, Volterra equations have two kinds. The first kind is

$$f(x) = \int_a^x K(x,y)f(y)dy \tag{12}$$

and the second kind is

$$f(x) = \alpha \int_a^x K(x,y)f(y)dy + \varphi(x). \tag{13}$$

Now, we consider the Volterra equation of the second kind.

4.1. Theorem. Suppose $\varphi \in L^2([a,b])$ and the kernel K satisfies the condition

$$\int_a^b \int_a^b |K(x,y)|^2 dx\, dy < \infty. \tag{14}$$

Then the equation

$$f(x) = \alpha \int_a^x K(x,y) f(y) dy + \varphi(x) \tag{15}$$

has a unique solution in $L^2([a,b])$ for an arbitrary α. The solution is the form

$$f(x) = \varphi(x) + \sum_{n=1}^{\infty} \alpha^n \int_a^x K_n(x,t)\varphi(t)dt, \tag{16}$$

where the kernels $K_n(x,t)$ satisfy the recurrence relation

$$K_1(x,t) = K(x,t)$$

$$K_n(x,t) = \int_a^x K(x,\zeta) K_{n-1}(\zeta,t)\, d\zeta\,, n \geq 2. \tag{17}$$

Proof. Set $A(x) = \int_a^x |K(x,y)|^2 dy$ and $B(y) = \int_y^b |K(x,y)|^2 dx$. By (14), A and B are integral functions. Thus there exists a constant M such that $\int_a^b A(x)dx \leq M$ and $\int_a^b B(y)dy \leq M$.

We define the function λ on $[a,b]$ by $\lambda(x) = \int_a^x A(t)dt$.

Then $0 \leq \lambda(x) \leq M$ for all $x \in [a,b]$.

Let the operator equation be $Tf = \alpha W f(x) + \varphi$ where

$$(Wf)(x) = \int_a^x K(x,y) f(y) dy.$$

Then $T^n(f) = \varphi + \alpha W\varphi + \alpha^2 W^2\varphi + \cdots + \alpha^n W^n f.$

The operator W^m is of the form $(W^m f)(x) = \int_a^x K_m(x,y) f(y) dy$, where the kernel K_n are defined by (17).

For $m = 2$,

$$(W^2 f)(x) = \int_a^x K(x,z) \int_a^z K(z,y)\, f(y) dy dz.$$

This integral can be considered as a double integral over the triangular region $\{(y,z): a \leq y \leq z \text{ and } a \leq z \leq x\}$. By interchanging the order of integrating, we obtain

$$(W^2 f)(x) = \int_a^x \int_y^x K(x,z)K(z,y) dz\, f(y) dy = \int_a^x K_2(x,y) f(y) dy$$

where $K_2(x,y) = \int_y^x K(x,z)K(z,y) dz.$

Similarly, we get

$$(W^3 g)(x) = \int_a^x \int_y^x K(x,z)K_2(z,y)dz\, g(y)dy,$$

and so on.

Now, we estimate $\|W^m\|$ to examine K_m.

For $m = 2$, by Cauchy Schwarz's inequality, we get

$$|K_2(x,y)|^2 = \left|\int_y^x K(x,z)K(z,y)dz\right|^2$$

$$\leq \int_y^x |K(x,z)|^2 dz \int_y^x |K_1(z,y)|^2 dz \leq A(x)B(y),$$

$$|K_3(x,y)|^2 \leq \int_y^x |K(x,z)|^2 dz \int_y^x |K_2(z,y)|^2 dz$$

$$\leq A(x)B(y)\big(\lambda(x) - \lambda(y)\big).$$

By induction,

$$|K_m(x,y)|^2 \leq A(x)B(y)\frac{\big(\lambda(x)-\lambda(y)\big)^{m-2}}{(m-2)!} \text{ for } m \geq 2.$$

Therefore,

$$|T^m f_1(x) - T^m f_2(x)|^2 = |\alpha|^{2m} \left| \int_a^x K_m(x,y)\big(f_1(y) - f_2(y)\big)dy \right|^2$$

$$\leq |\alpha|^{2m} \int_a^x \frac{A(x)B(y)\big(\lambda(x) - \lambda(y)\big)^{m-2}}{(m-2)!} dy \int_a^x |f_1(y) - f_2(y)|^2 dy$$

$$\leq |\alpha|^{2m} \frac{A(x)\big(\lambda(x)\big)^{m-2}}{(m-2)!} \|f_1 - f_2\|^2 \int_a^x B(y)dy$$

$$\leq |\alpha|^{2m} \frac{A(x)\big(\lambda(x)\big)^{m-2} M}{(m-2)!} \|f_1 - f_2\|^2.$$

By integrating with respect to $x \in [a,b]$, we obtain

$\|T^m f_1(x) - T^m f_2(x)\|^2 \leq |\alpha|^{2m} \frac{M^m}{(m-1)!} \|f_1 - f_2\|^2$ for $m \geq 2$.

Since there exists $n \in N$ such that $|\alpha|^{2n} \frac{M^n}{(n-1)!} < 1$, T^n is a contraction mapping. By Theorem 2.2, (15) has a unique solution and that solution can be written as

$$\lim_{n\to\infty} T^n f = \varphi + \alpha W\varphi + \alpha^2 W^2\varphi + \alpha^3 W^3\varphi + \cdots.$$

So, $f(x) = \varphi(x) + \sum_{n=1}^{\infty} \alpha^n \int_a^x K_n(x,t)\varphi(t)dt.$ ■

4.2. Theorem. The homogeneous Volterra equation

$$f(x) = \alpha \int_0^x K(x,t)f(t)dt, \quad \forall x \in [0,1] \tag{18}$$

has only trivial solution $f = 0$.

Proof. From (18) we have

$$|f(x)| \leq |\alpha| \int_0^x |K(x,t)||f(t)|dt$$

$$\leq |\alpha| Mp \ , \tag{19}$$

where $p = \int_0^1 |f(t)|dt$, $|K(x,t)| \leq M$(constant).

By using (19) in (18), we obtain

$$|f(x)| \leq |\alpha| \int_0^x |K(x,t)||\alpha| Mpdt$$

$$\leq |\alpha|^2 M^2 px.$$

By continuing this process, we get

$$|f(x)| \leq |\alpha|^n M^n p \frac{x^{n-1}}{(n-1)!}$$

$$\leq \frac{|\alpha|^n M^n p}{(n-1)!} \to 0 \quad \text{as} \quad n \to \infty$$

This shows that $f(x) = 0$, for all $x \in [0,1]$. ■

5. Method of Solution for a Separable Kernel

Now, we state the solvability of the Fredholm integral equation of the second kind with separable kernel.

5.1. Definition. The kernel K is called ***separable*** if

$$K(x,t) = \sum_{k=1}^{n} M_k(x)N_k(t)$$

where the functions $M_k, N_k \in L^2([a,b])$.

For example, $\cos(x+t) = \cos x\, cost - sinx\, sint.$

For separable kernel, Fredholm integral equation of second kind can be written as

$$f(x) = \varphi(x) + \alpha \sum_{k=1}^{n} M_k(x) \int_a^b N_k(t) f(t) dt.$$

Let $c_k = \int_a^b N_k(t) f(t) dt$, $k = 1,2,3, \dots, n$. Then the solution is of the form

$$f(x) = \varphi(x) + \alpha \sum_{k=1}^{n} c_k M_k(x).$$

By multiplying $N_m(x)$ and integrating with respect to x to eliminate x, we get

$$c_m = \alpha \sum_{k=1}^{n} a_{mk}\, c_k + b_m, \qquad (20)$$

where $a_{mk} = \int_a^b N_m(x) M_k(x) dx$ and $b_m = \int_a^b N_m(x) \varphi(x)\, dx$.

Equation (20) can be written in the matrix form

$$(I - \alpha A)c = b,$$

where $A = (a_{mk})$, $b = (b_1, b_2, \dots, b_n)^T$, $c = (c_1, c_2, \dots, c_n)^T$.

If $\det(I - \alpha A) \neq 0$, the system has a unique solution.

If $\varphi(x) = 0$, then $b = 0$. Then the system has nontrivial solution if and only if $\det(I - \alpha A = 0$.

We illustrate the above method by solving the following examples.

5.2 Example. Consider $f(x) = \alpha \int_0^1 (1 - 3xt) f(t) dt$.

Let $K(x,t) = 1 - 3xt = \sum_{k=1}^{2} M_k(x) N_k(t)$.

Then $M_1(x) = 1$, $N_1(t) = 1$, $M_2(x) = -3x$, $N_2(t) = t$.

Since $a_{mk} = \int_0^1 N_m(x) M_k(x) dx$,

$$a_{11} = 1, \quad a_{12} = \frac{-3}{2}, \quad a_{21} = \frac{1}{2}, \quad a_{22} = -1.$$

Then the solution is the form

$$f(x) = \alpha \sum_{k=1}^{2} c_k M_k(x) \quad \text{where} \quad c_k = \int_0^1 N_k(t) f(t) dt.$$

By multiplying $N_m(x)$ and integrating with respect to x, we obtain

$$c_m = \alpha c_1 \int_0^1 N_m(x) dx - 3\alpha c_2 \int_0^1 N_m(x) dx.$$

For $m = 1$, $(1-\alpha)c_1 + \alpha\frac{3}{2}c_2 = 0.$

For $m = 2$, $-\alpha\frac{1}{2}c_1 + (1+\alpha)c_2 = 0.$

Let $A = \begin{pmatrix} -1 & \frac{3}{2} \\ \frac{-1}{2} & -1 \end{pmatrix}$. Then $(I - \alpha A)c = 0.$

If $\det(I - \alpha A) = 0$, the roots are $\alpha = 2$ and $\alpha = -2$.

If $\alpha = 2$, then $c_1 = 3c_2$. Hence the eigenfunction is

$f_1(x) = 2\big(c_1M_1(x) + c_2M_2(x)\big) = 2(c_1 - 3c_2x)$

$= p(1-x)$where $p = 6c_2$.

If $\alpha = -2$, then $c_1 = c_2$. The eigenfunction is

$f_2(x) = -2\big(c_1M_1(x) + c_2M_2(x)\big) = -2(c_1 - 3c_2x)$

$= q(1-3x)$ where $q = -2c_1$.

The nontrivial solutions are $p(1-x)$ and $q(1-3x)$.

5.3 Example. Consider $f(x) = \varphi(x) + \alpha\int_0^1(1-3xt)f(t)dt$.
If $\det(I - \alpha A) \neq 0$, then there is a unique solution of the form

$$f(x) = \varphi(x) + \alpha\sum_{k=1}^{2} c_kM_k(x)$$

where c_1 and c_2 are solutions of

$$(1-\alpha)c_1 + \alpha\frac{3}{2}c_2 = b_1 = \int_0^1 \varphi(x)\,dx,$$

$$-\alpha\frac{1}{2}c_1 + (1+\alpha)c_2 = b_2 = \int_0^1 x\varphi(x)\,dx.$$

If $\alpha = 2$, then the equation has a solution if and only if $\int_0^1(1-x)\varphi(x)dx = 0$.

This shows that $\varphi(x)$ is orthogonal to eigenfunction. Hence this solution is $f(x) = \varphi(x) - 2\int_0^1\varphi(t)dt + p(1-x)$ where $p = 6c_2$.

If $\alpha = -2$, the equation has a solution if and only if $\int_0^1(1-3x)\varphi(x)dx = 0$.

In that case, the solution is $f(x) = \varphi(x) - \frac{2}{3}\int_0^1\varphi(t)dt + q(1-3x)$ where $q = -2c_2$

. Conclusion

Banach fixed point theorem can be applied in various branches of science. In the present paper, some existence and uniqueness results to the solution in solving integral equations are studied by using Banach fixed point theorem.

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Length-weight Relationships and Condition Factor of Hilsa shad (*Tenualosa ilisha)* (Hamilton,1822) from Freshwater, Brackish water, and Coastal Environments, Ayeyarwady Delta Region

Kyi Thar Myint *

Abstract

This paper presents the length-weight relationships (LWRs) and condition factor of hilsa shad *Tenualosa ilisha* (Hamilton, 1822) from the three different salinity areas in the Ayeyarwady Delta Region from October 2018 to September 2019. A total of 1800 samples: 600 samples from Danuphyu (freshwater area), Ngapudaw (brackish water area) and Haingyi (coastal water area) were analyzed. The regression coefficient value "b" indicated that the males and females from Danuphyu, and the females from Haingyi have positively allometric growth (b>3). However, both males and females from Ngapudaw, and the males from Haingyi showed negative allometric growth (b<3). The correlation of length weight relation of males and females hilsa shad from different environments were found significantly difference (r = 0.858 - 0.928) and (P<0.01).The mean relative condition factor (Kn) of all the samples in different areas ranged from 0.61 to 0.67 for the males, and from 1.77 to 2.66 for the females indicated the general well-being of hilsa in the study areas were good.

Key words: Hilsa shad, Length - weight relationships (LWRs), Relative condition factor (Kn), Ayeyarwady Delta Region

Introduction

The length-weight relationships (LWRs) of fish is an important indicator to investigate the relation between the two variables of length and weight,use as an indication of growth, survival, maturity, reproduction and general well-being (Le Cren, 1951). The relative condition factor (Kn) is an important parameter to identify the variation of fish weight against a standard calculated weight to determine if the fishes are in poorer or better condition than the standard. Relative condition factor is used to compare the general well-being, fatness or the stats of maturity (Thomas, 1969). Hilsa shad, *T. ilisha* is a highly migrate species between the feeding ground and the spawning ground. It has been recognized it is the common species feeding in the northern part of the Bay of Bengal engulf by the lands of Myanmar, Bangladesh and India. The matured hilsa migrate upstream inland water for breeding and nursing. Juveniles and prematures fish migrate downstream to find feeding grounds in the Bay of Bengal (Rahman, 2012). Several researchers attempted to sustainable hilsa resources and fisheries management in the Bay of Bengal countries. In particular, the length-weight relation studied on *T. ilisha* has been worked by in India and Bangladesh (Ramakrishnaiah, 1972; Shafi and Quddus, 1974; De and Dutta,1990; Nurul Amin *etal*., 2005; Bhaumik *et al*., 2011; Flura *et al*., 2015). In Myanmar *Tenualosa ilisha* is most common species among the identified three species of the genus hilsa or (Nga tha lauk) under the family Clupeidae, which are *T.ilisha* (Hamilton, 1822), *T.toli* (Valenciennes,1847), and *T. kelee* (Cuvier,1829), (Department of Fisheries, DOF Myanmar). The species is highly esteemed locally and high demand for exporting. Currently, heavy fishing pressure along with irresponsible practices lead the noticeable decline of hilsa resources in Myanmar (Khin Maung Soe *et.al*. 2012).

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To extend sustainable management of hilsa resources, the crucial needs include understanding the dimension of growth (length-weight), survival, maturity, suite with the environments and general well-being and fishery of the species by space and time. There are works on LWRs for some fish species, however no reports related to hilsa shad was observed. Hence, this study has been carried out to initially find out the LWRs and relative condition factor (Kn) of hilsa shad from three different salinity areas in the Ayeyarwady Delta Region.

Materials and methods

Study sites and study period

In the Ayeyarwady delta region, following three areas are chosen as the main study sites (Fig.1).

- Danuphyu (freshwater area): Lat 17°25'-17°26' N; Long 95°59'-95°60'E
- Ngapudaw (estuarine area): Lat 16°54'-16°55' N; Long 94°69'-94°70' E
- Haingyi (coastal area): Lat 16°01'-16°02'N ; Long 94°34'-94°35' E,

The study period was covered twelve months from October 2018 to September 2019.

Fig. 1 Sample collecting sites in the Ayeyarwady Delta Region
Danuphyu (freshwater area) Ngapudaw (estuarine area) and Haingyi (coastal)

Samples and samples identification

Sampling was carried out twelve months from October 2018 to September 2019 in three different salinity areas in the Ayeyarwady Delta Region. Taxonomic identification was referred the standard manuals of (Talwar and Jhingran, 1991).

Monthly sampling of fifty specimens from each study areas during the study period could have gathered 600 samples in each of three study sites. As an overall, a total of 1800 samples were utilized. Sex was identified by the swelling and plumpness of the abdomen of the fish. Biometry was carried out at the landing sites or at the local collecting centers. Total length (TL) and standard length (SL) were measured by a vinyl measuring sheet, calibrated in centimeters.

Whole body weight (gm) also was measured by a digital balance (Electro Compact Scale SF - 400A) accurate to 1 gram (Fig. 2).

Fig. 2 Vinyl measuring sheet and the digital balance

Length-weight relationships (LWRs)

It was calculated by the formula $W = a L^b$ (Le Cren, 1951) which was transformed into linear logarithmic form as:

$$\text{Log}(W) = \text{Log}(a) + b \text{ Log}(L)$$

where W is the wet weight in gram. L is the total body length in centimeters. The regression coefficient "*a*" is intercept, and "*b*" is slope that indicates exponent or allometric growth. The value of "*b*" usually constant at 3 is an ideal fish. In the natural condition the value of "*b*" normally ranges between 2.5 and 4.

The trend of growth is determined by the deviation of "*b*" from the "idea value of 3". The growth is isometric if "*b*" valued 3 means increase of weight is proportional to the tube of length. The growth is positively allometric when "*b*" value is greater than 3 described growth of length and weight is proportional. The growth is negatively allometric when "*b*" valued less than 3, where fish becomes thinner or slender due to less weight gained even the length increase (Salam and Mohmood,1993).

Relative condition factor (Kn)

The relative condition factor (Kn) were calculated with the following formula (Le Cren, 1951).

Kn = Wo / Wc

It is the ratio of observed weight (Wo) of a fish at given length to the expected weight (Wc) of a same length as calculated by length weight regression.

Statistical analysis

Coefficient of determinant (R^2) of the linear regression parameters, "*a*" and "*b*" were calculated by the standard statistical procedure (Snedecor and Cochran, 1967).

The Statistical Package for Social Sciences (SPSS, version 23) and Microsoft Office Excel software (2010) were deployed in this study.

Results and discussion

Composition of males and females in the samples were clarified 316 females and 284 males from Danuphyu (freshwater area), 340 females and 260 males from Ngapudaw (brackish water area), and 330 females and 260 males from Haingyi (coastal area). Average total length of males was 26.89 cm ranging 6.2 - 46 cm, while the mean body weight 343 gm ranging 7.0 - 1075 gm. Average total length of females was 27.09 cm ranging 6.8 - 46 cm, while an average body weight showed 332 gm ranging 6.5-1056 gm (Table 1).

Table. 1 Sampling sites, numbers of samples, and biometry of hilsa shad *T. ilisha*

Study sites	Sexes	No of samples	Length (cm)		Weight (gm)	
			Range	Mean ± SD	Range	Mean ± SD
Danuphyu	Males	284	6.2-46	26.89 ± 11.86	7-1075	343.12 ± 246.7
	Females	316	6.8-46	27.09 ± 11.26	6.5-1056	332.42 ± 141.42
Ngapudaw	Males	260	35-50.5	40.74 ± 6.59	518-1546	792.05 ± 397.47
	Females	340	30.5-52.5	41.41 ± 6.05	601-1820	858.43 ± 419.57
Haingyi	Males	260	34.4-44.7	38.21 ± 5.26	491.5-1056	657.33 ± 320.13
	Females	340	34.1-45.5	37.76 ± 5.75	495.5-1193	653.91 ± 326.44

The calculated linear regression parameters of the determinant *a* , *b* and the coefficient of determination R^2 for the samples from the study areas were described (Table 2), (Fig. 3 and 4).

Table 2 Parameters of length-weight relationships and condition factors of Hilsa shad at different environments

Sites	Sexes	Samples size	Length -weight relationships (LWRs)			Relative condition factor (Kn)		r	p
			a	b	R^2	Range	Mean ± SD		
Danuphyu	Males	284	-2.28	3.20	0.97	0.67 - 3.86	1.04 ± 0.31	0.913	P < 0.01
	Females	316	-2.27	3.18	0.96	0.61 - 2.66	1.04 ± 0.30	0.928	P < 0.01
Ngapudaw	Males	260	-1.73	2.85	0.77	0.64 - 1.40	1.03 ± 0.20	0.890	P < 0.01
	Females	340	-1.87	2.95	0.73	0.62 - 1.89	1.04 ± 0.26	0.858	P < 0.01
Haingyi	Males	260	-1.68	2.82	0.73	0.61 - 2.45	1.04 ± 0.26	0.859	P < 0.01
	Females	340	-2.25	3.19	0.92	0.68 - 1.77	1.01 ± 0.14	0.928	P < 0.01

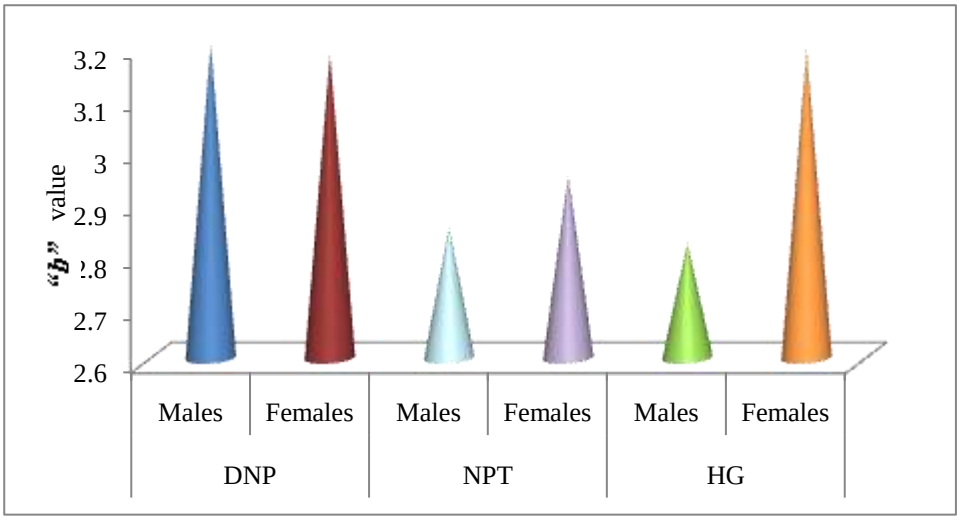

Fig. 3 Variation of determinant "*b*" value in different in different areas

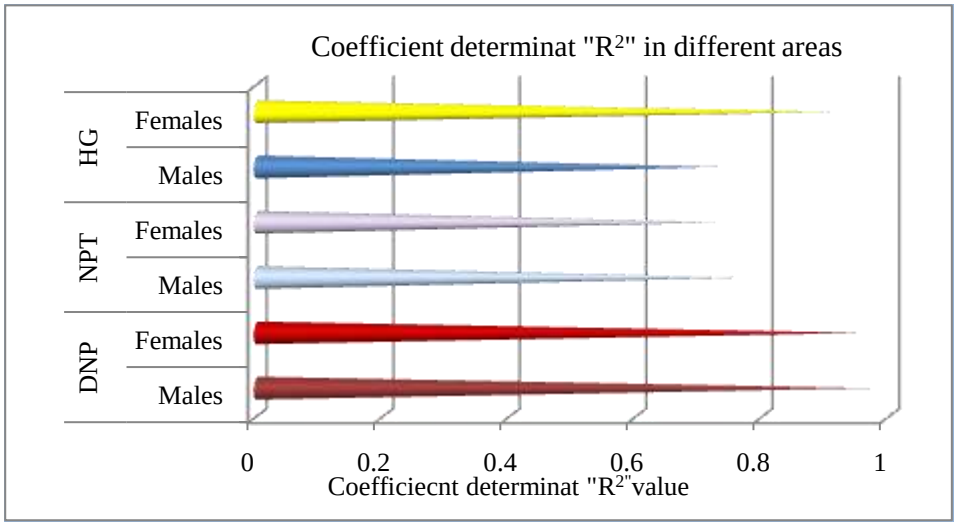

Fig. 4 Variations of coefficient determinant "R^2" of males and females hilsa in different areas

Size classes, length-weight relationships, and condition factor of Hilsa shad from Danuphyu (Freshwater area)

A total of 600 samples were identified, of which, 284 were males and 316 were females. These samples were segregated by size classes in total length (cm) and classified as the juveniles (5-10) cm, prematures (10.5 - 20) cm, matured (20.5-30) cm and the broods of 30.5 cm and above (Table 3).

Table 3 Composition of the size classes total length of the samples from Danuphyu

Danuphyu							
Maturity stages	Total length classes (cm)	Males		Females		Total	
		Samples size	%	Samples size	%	Samples size	%
Juvenile	5 to 10	31	10.9	19	6	50	8.33
Premature	10.5 to 20	76	26.8	97	30.7	173	28.83
Matured	20.5 to 30	51	17.9	67	21.2	118	19.67
Broods	30.5 and up	126	44.4	133	42.1	259	43.17
Total		284	100	316	100	600	100

The composition of juveniles was 8.33% while 28.83% of prematures, 19.67% of matured and 43.17% of broods were observed respectively. Such an abundance of different maturity stages classes from juveniles to the broods highlight the existing of breeding and nursery grounds of hilsa shad in Danuphyu, the freshwater area.

The linear regression coefficient value "*b*" of males (3.2) and females (3.18) indicated the trends of hilsa growth are positively allometric in both males and females. The coefficient of determination valued (R^2) indicate the length-weight relation is significantly correlated as the mathematic equation showed –

Log W=log -2.28 + 3.20 log (L) with R^2 0.97 (males) (Fig. 5)

Log W=log -2.27 + 3.18 log (L) with R^2 0.96 (females) (Fig. 6)

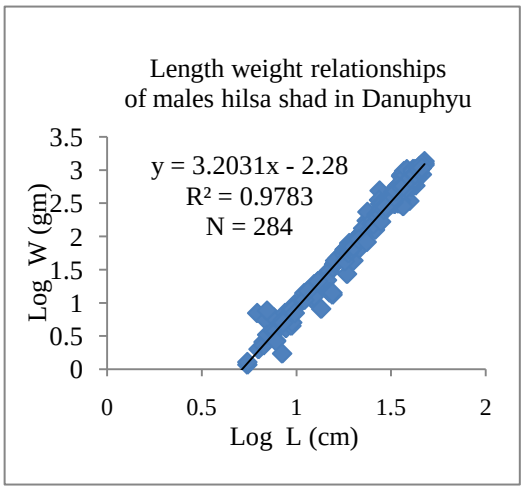

Fig. 5 LWRs of males hilsa at Danuphyu

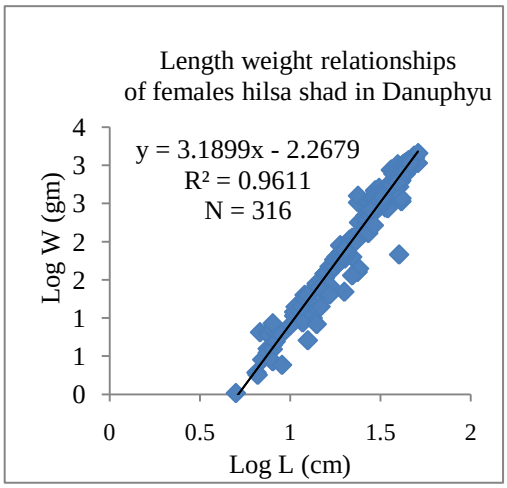

Fig. 6 LWRs of females hilsa at Danuphyu

Average relative condition factor (Kn) for males and females was 1.04, ranging from 0.61 to 3.86. It was Le Cren, 1951 describing that the Kn value larger than 1 (Kn>1) indicates the healthy condition of fish in the area with the favorable physicochemical environment and the availability of foods. The observation of this study is supporting to describe Danuphyu, freshwater area stands spawning and nursery ground of hilsa shads.

Size classes, Length-weight relationships, and condition factor of hilsa shad from Ngapudaw (Estuarine area)

A total of 600 samples consist of 260 males and 340 females were measured. Of which, 96.83% were the broods and only 3.17% were the matured respectively (Table 4).

Table 4 Composition of the size classes of total length of the samples from Napudaw

		Ngapudaw					
Maturity stages	Total length classes (cm)	Males		Females		Total	
		Samples No.	%	Samples No.	%	Samples No.	%
Juvenile	5 to 10	0	0	0	0	0	0
Premature	10.5 to 20	0	0	0	0	0	0
Matured	20.5 to 30	12	4.5	7	2.1	19	3.17
Broods	30.5 and up	248	95.5	333	97.9	581	96.83
Total		260	100	340	100	600	100

Average total length of males was 40.74 cm ranging 35-50.5 cm, while the mean body weight was 792.05 gm ranging 518-1546 gm. For the females, an average length was 41.41 cm ranging 30.5-52.5 cm with a mean body weight 858.43 gm ranging 601-1820 gm (Table 1).

The regression coefficient "*b*" of males and females hilsa from Ngapudaw was 2.85 for males and 2.95 for females that showed negatively allometric trends of growth (b < 3). The logarithmic linear regression of length weight relation and the coefficient of determination R^2 are described with the follows:

Log W= log -173 + 2.83 log (L) with R^2 0.77 (males) (Fig. 7)

Log W= log -1.87 + 2.95 log (L) with R^2 0.73 (females) (Fig.8)

The value of R^2 was 0.77 in males and 0.73 in females indicated a moderately correlation of length weight relationships in males and females.

Ricker (1973) reported that the regression coefficient "*b*" value represents the body form and it's related to the weight gained by the physicochemical factors, food supply, spawning conditions and sex etc.

The mean relative condition factor (Kn>1) for males and females, which indicated the good health condition of hilsa broods.

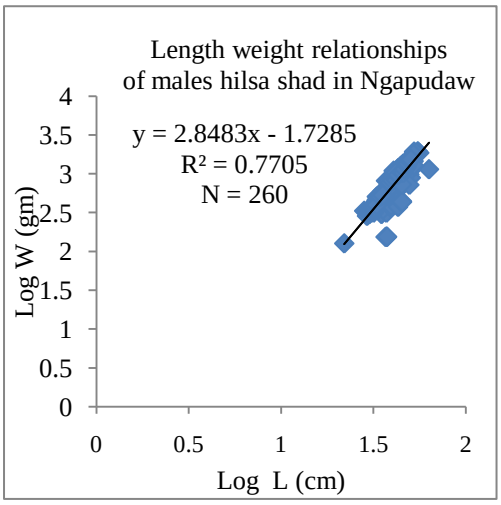

Fig. 7 LWRs of males hilsa at Ngapudaw

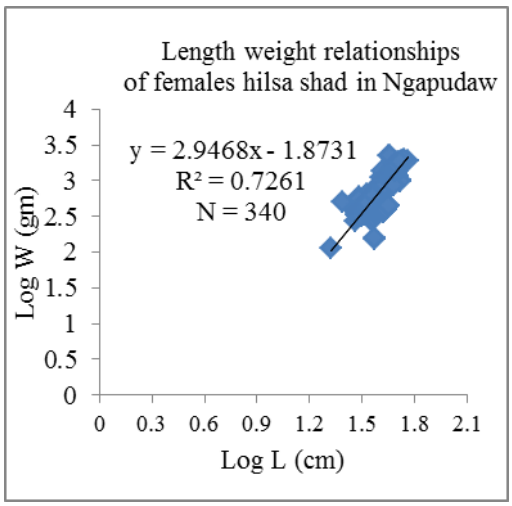

Fig. 8 LWRs of females hilsa at Ngapudaw

In the context of high composition of broods (96.8%) among the hilsa population is assumable that Ngapudaw area is on the route of migration, where the upstream and downstream hilsa by passing. The broods are in good condition of general well -being, however the growth is relatively slow. It is describing the broods showed slow growth while migration takes place. Also reported that when "*b*" is less than 3 become a relatively slow growth rate and tends to be thinner (Salam and Mohmood, 1993).

Size classes, length-weight relationships, and condition factor of hilsa shad from Haingyi (Coastal area)

A total of 600 samples consisted of 260 males and 340 were sampled with similar to the population from the estuarine area. The broods are main component of the population observed as 90% and 10% are the matured fish. (Table 5).

Average total length of males was 38.21 cm ranging 34.4 - 44.7 cm while an average weight was 657.33 gm with a ranged of 491.50 - 1056 gm. Average total length of females was 37.76 ranging 34.1-45.5 cm while average body weight of 653.91 gm ranging 495.5 - 1193 gm respectively (Table 1).

Table 5 Composition of the size classes total length of the samples from Haingyi

Haingyi							
Maturity stages	Total length classes (cm)	Males		Females		Total	
		Samples No.	%	Samples No.	%	Samples No.	%
Juvenile	5 to 10	0	0	0	0	0	0
Premature	10.5 to 20	0	0	0	0	0	0
Matured	20.5 to 30	22	8.5	38	11.2	60	10
Broods	30.5 and up	238	91.5	302	88.8	540	90
Total		260	100	340	100	600	100

In males, regression coefficient "*b*" value 2.82 (*b*<3) indicated the trend of growth is negatively allometric, which describes the growth of length and weight is not proportional. The matured and brood hilsa are on the way of migration, thus the growth is slow in upstream migrating fish and the structure become slender while downstream migration take place.

For the females, indication of *"b"* value as 3.19 described the growth is positively allometric, which express the proportional growth of length and weight. The logarithmic linear regression for the males and females hilsa in Haingyi is follows:

Log W = log-1.68 + 2.82 log (L), with R^2 = 0.73 (males) (Fig. 9)

Log W = log 2.25 + 3.19 log (L), with R^2 = 0.92 (females) (Fig.10)

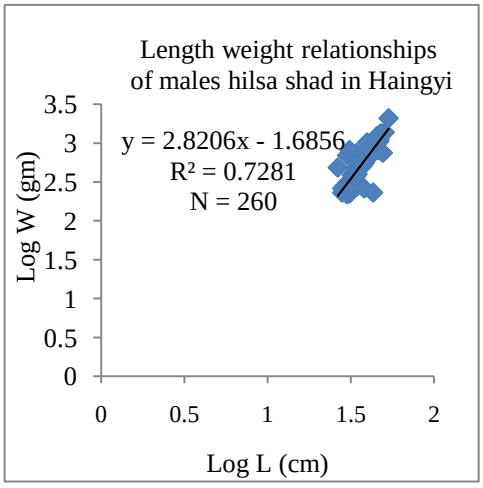

Fig.9 LWRs of males hilsa at Haingyi

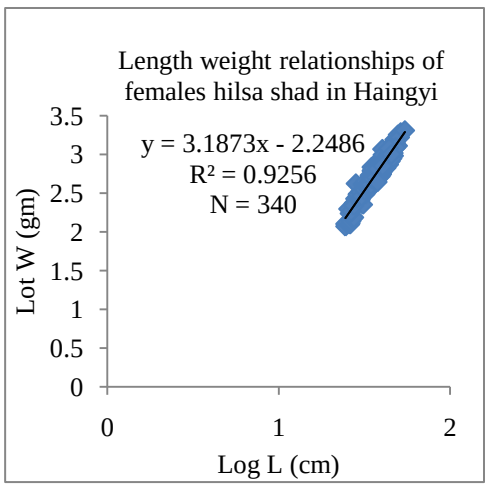

Fig.10 LWRs of females hilsa at Haingyi

The lower value of coefficient of determination (R^2=0.73) in males indicated the moderately correlation of length-weight relationships as well (Table 2). The larger value of coefficient of determination (R^2=0.92) in females indicates significant correlation of length weight relationships.

An average value of relative condition factor (Kn) for the males was 1.04 with a range of 0.61-2.45. For the females, average value was 1.01 with a range of 0.68-1.77 (mean 1.01). It's mentioned the condition of general well-being of males and females' hilsa in the area are good. However, the degree was varied from good to the excellent

condition. This may be due to the mixing of pre-spawning broods with excellent well-being headed to upstream spawning grounds, and the spent with normal well-being that migrate back from freshwater area to the coastal.

Conclusion

This study provides information on length-weight relation for *T. ilisha*, in three different salinity areas in the Ayeyarwady Delta Region. The length - weight relationships LWRs of hilsa shad in three different environments are significantly correlated. Referring the relative condition factor the growth pattern and the degree of well-being in all areas were varied from good to the excellent. It is obvious that all size classes from juveniles to the broods in the freshwater area, Danuphyu showed well growing as the regression coefficient of (b >3) with the favorable environment (Kn >1). The length weight relation correlation analysis of males and females hilsa shad from different environments were found in significant differences. This research work is believed to be a supportive for implementing sustainable hilsa resources management measures. The application of length-weight relationships and relative condition factors were identifiable the health of hilsa stock and its environment in places at different times.

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Growth Analysis of *Tectona grandis* L. Treated with *Spirulina* Biofertilizer

Tin Tin Maw[1], Ohn Maung[2]

Abstract

In this study, growth analysis of *Tectona grandis* L. treated with *Spirulina* biofertilizer was determined. The different concentration of *Spirulina* suspensions (1 gl^{-1}, 2 gl^{-1}, 3 gl^{-1}, 4 $gl^{-1}$and 5 gl^{-1}) were treated on bag experiment. According to bag experiment results, 3 gl^{-1}*Spirulina* suspension treatment was 40.60 cm plant height, 20.80 leaf number per plant, 388.30 cm^2 total leaf area and control was 34.60 cm plant height, 13.30 leaf number per plant, 161.39 cm^2 total leaf area. The result showed that 3 gl^{-1}*Spirulina* suspension treatments was the best plant height, leaf number per plant and total leaf area. According to these results, *Spirulina* suspension biofertilizer could actually improve plant height, leaf number and total leaf area.

Keywords:*Spirulina* suspensions, biofertilizer, *Tectona grandis* L.,

Introduction

Teak (*Tectona grandis* L.) is native to South and Southeast Asia, mainly Bangladesh, India, Indonesia, Malaysia, Myanmar, Thiland and Sri-Lanka but is naturalized and cultivated in many countries in Africa and the Caribbean. Myanmar's teak forests account for nearly half of the world's naturally occurring teak (Phillips, 2016). Teak grows in about 70 countries around the world. It has an attracted great investment and in many nations production and trade have become a major component of the forest economic.

Teak is used extensively in Myanmar to make doors and window frames, furniture and columns. It is resistant to termite attacks and damage cause by other insects. Mature teak fetches a very good price. The supply of quality teak logs from old-growth natural teak forest in Myanmar will decline as a result of the log export ban that has been in force since 2014. This has led to increased interest and managing teak plantations. Plantation teak could well be improved in future years (Kollert and Walotek, 2015).

Agricultural scientists and farmers were interested in natural and biofertilizers to substitute the chemical fertilizers. The main sources of biofertilizers were bacteria, fungi, cyanobacteria (blue green algae) and other macro and micro algae. Biofertiizers have definite advantage over chemical fertilizer. Continuous uses of chemical fertilizers adversely affect the soil structure whereas biofertilizers when applied to soil improve the soil structure. Thousands of algal species covering the earth are now being identified for foods, pharmaceuticals, biochemical and fertilizers (Henrikson, 1997)

In Myanmar, *Spirulina* (blue-green algae) is abundantly found in the Twin Taung, Twin Ma, TaungPyauk and Yekharlake in Sagaing Region. *Spirulina* farming in Myanmar was to be initiated at about 1986. An extent account on *Spirulina* farming and its potential uses have been reported by Min Thein (1987). Than Htun (1959) studied on the inter-relationship between photosynthesis and nitrogen fixation in blue-green alga. Recently, Thet Naing Htwe (2008) had studied the effect of *Spirulina* on the germination and growth of chick pea, soy bean and butter bean. They had also found the positive effect of *Spirulina* biofertilizer on germination and growth.

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Nobody has introduced growth analysis of *Tectona grandis* L. treated with *Spirulina* biofertilizer in Myanmar. In the present research paper, growth of *Tectona grandis* L. has been studied. The aims and objectives of this study are to determine the growth of *Tectona grandis* L. treated with *Spirulina* biofertilizer and to find out the appropriate *Spirulina* treatment for maximum growth of *Tectona grandis* L.

Materials and Methods

Spirulina powder was obtained from June Pharmaceutical and Food Stuff Industry Ltd, Yekhar, Sagaing Region. Nursery teak plants were obtained from the Agricultural Service, Taunggoke Township, Rakhine State. The bag experiment was conducted at Department of Botany, University of Taunggoke during June to September, 2019.

The *Spirulina* powder was weighted according to w/v ratio. The various weight of *Spirulina* powder was dissolved in pure water for about 2 days. And then, different concentrations of *Spirulina* suspension (1 gl^{-1}, 2 gl^{-1}, 3 gl^{-1}, 4 $gl^{-1}$and 5 gl^{-1}) were obtained.The bag (15 cm in diameter and 20 cm in height) were used and 1.5 kg of soil was filled into the each bag. Nursery teak plants were planted in these bags. And then, the bags were arranged in Completely Randomized Design (CRD) with five replications. In treatment plants, 50 ml of respective *Spirulina* suspensions were poured into each plant once a week and control plants were watered. Each bag was regularly watered with 100 ml once a day. The five replications were tested at the same condition. Leaf number was counted and plant height was measured every two weeks. After 12 weeks after sowing (WAS), leaf area was measured by graph paper method (Santra*et al*., 1999). Plants sample were collected and identified according to Dassanayake, 1987. All of the data were statistically analyzed by using‘t’ test method (Fowler *et al*., 1999).

Spirulina powder *Spirulina* suspensions Nursery teak plants

Figure (1). Preparation of *Spirulina* suspension and nursery teak plants

Results

In this study, morphological characters of *Tectona grandis* L. and growth analysis of *Tectona grandis* L. treated with *Spirulina* biofertilizer were described.

Morphological characters of *Tectona grandis* L.

Family - Lamiaceae

Scientific name – *Tectona grandis* L.

English name - Teak

Myanmar name -Kyun

Perennial, erect, large decicuous tree with grey to greyish brown branch known for its high quality wood; stems woody solid. Leaves simple, opposite, petiolate, petiole stout, exstipulate; broadly elliptic, obovade, glabrescent above and stellate pubescent below at the base rounded to acute; in apex obtuse to acute; leaf margin entire. Inflorescence is terminal and/or axillary, dichotomous and cymose panicles.Flowers are small, fragrant, bisexual, actinomorphic, white or rarely purplish colour occur in large inflorescences or panicles. Calyx campanulate with six unequal oblanceolate sepals; corolla funnel shaped, yellowish or whitish yellow, tube short with six subequal petals, imbricate in bud, broadly oblong lanceolate. Stamen six, alternating with petals, inserted near the base of corolla; filaments about 3 mm and anther oblong. Ovary globose, densely hairy, 4 locular and style about 4 mm long with bifid stigma. Fruit is a drupe, globose, enclosed by an accrescent calyx with thick shaggy exocarp of matted hairs.

Habit Flowers Fruits

Figure(2).Morphological characters of *Tectona grandis* L.

Growth analysis of *Tectona grandis* L. treated with *Spirulina* biofertilizer (Bag experiment)

In this experiment, the different concentrations of*Spirulina* suspension (1 gl^{-1}, 2 gl^{-1}, 3gl^{-1}, 4 $gl^{-1}$and 5 gl^{-1}) were treated with *Tectona grandis*L. Table 1,2 and 3, Figure 3 to 6 showed the effects of *Spirulina* suspension on plant height, leaf number and total leaf areain this result.

It was observed that plant height and leaf number of continual growth with time in all experimental bags. 3 gl^{-1}*Spirulina* suspension treatment was observed significant increase in growth compare to other treatments and control.

The leaf number of all treatments on *Tectona grandis* L. increased with plant age (Table2). The highest plant height 40.60 cm was recorded in 3 gl^{-1}*Spirulina* suspension treatment and plant height 34.60 cm in control.

The largest leaf number 20.80 per plant was found in 3 gl^{-1}*Spirulina* suspension treatment and 13.30 per plant in control. Total leaf area 388.30 cm^2 per plant was observed in 3 gl^{-1}*Spirulina* suspension treatment and total leaf area 161.39 cm^2 per plant in control.

Table (1). Effect of different concentrations of *Spirulina* suspension on mean plant height of *Tectona grandis* L. (Bag experiment)

Spirulina suspension treatments	Mean plant height ± sd (cm)			
	6WAS	8WAS	10WAS	12WAS
C (control)	14.60 ± 0.58	20.50 ± 0.45	27.70 ± 0.40	34.60± 0.37
T_1(1 gl^{-1})	16.60 ± 0.59	22.60 ± 0.58	29.20 ±0.25	37.40 ± 0.38
T_2(2 gl^{-1})	17.50 ±0.45	24.60 ± 0.37	30.46 ± 0.24	38.70 ± 0.40
T_3(3 gl^{-1})	18.80 ± 0.50	26.80 ± 0.51	33.00 ± 0.44	40.60 ± 0.39
T_4(4 gl^{-1})	17.00 ± 0.54	24.20 ± 0.25	30.50 ± 0.45	38.30 ± 0.41
T_5(5 gl^{-1})	16.20 ± 0.24	23.40 ± 0.37	29.42 ± 0.38	36.80 ± 0.24

sd = standard deviation, WAS = weeks after sowing

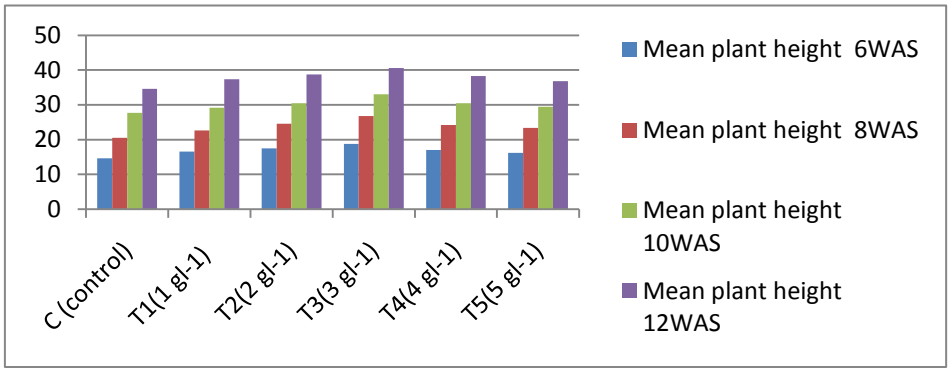


Figure (3).Comparison on mean value of plant height in different WAS (Bag experiment)

Table (2). Effect of different concentrations of *Spirulina* suspension on mean leaf number of *Tectona grandis* L. (Bag experiment)

Spirulina suspension treatments	Mean leaf number ± sd			
	6WAS	8WAS	10WAS	12WAS
C (control)	6.40 ± 0.49	9.40 ± 0.42	11.40 ± 0.40	13.30 ± 0.46
T_1(1 gl^{-1})	7.60 ± 0.80	10.40 ± 0.49	14.00 ± 0.63	16.70 ± 0.64
T_2(2 gl^{-1})	8.60 ±0.48	11.60 ± 0.48	16.00 ± 0.62	18.40 ± 0.50
T_3(3 gl^{-1})	10.80 ± 0.74	13.80 ± 0.74	18.40 ± 0.49	20.80 ± 0.75
T_4(4 gl^{-1})	8.40 ± 0.49	11.40 ± 0.48	15.60 ± 0.48	17.80 ± 0.74
T_5(5 gl^{-1})	7.60 ± 0.45	10.40 ± 0.47	14.40 ± 0.56	15.50 ± 0.66

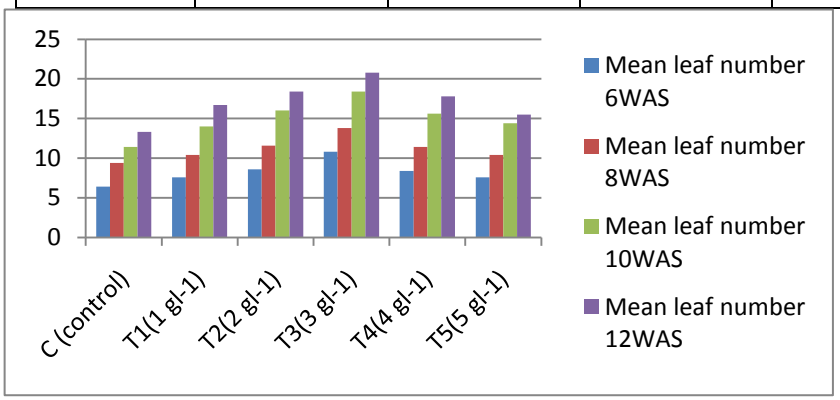


Figure (4). Comparison on mean value of leaf number per plant in different WAS (Bag experiment)

Table (3). Effect of different concentrations of *Spirulina* suspension on mean total leaf area of *Tectona grandis* L. at 12 WAS (Bag experiment)

Spirulina suspension treatments	Total leaf area plant^{-1} (cm^2)
C (control)	161.39 ± 1.84
T_1(1 gl^{-1})	223.58 ± 3.05
T_2(2 gl^{-1})	295.17 ± 4.15
T_3(3 gl^{-1})	388.30 ± 4.00
T_4(4 gl^{-1})	285.90 ± 3.67
T_5(5 gl^{-1})	233.26 ± 2.41

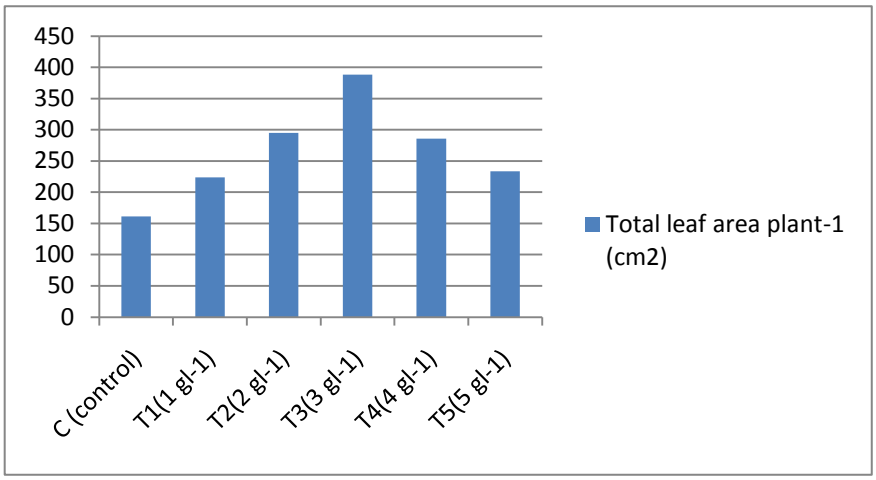
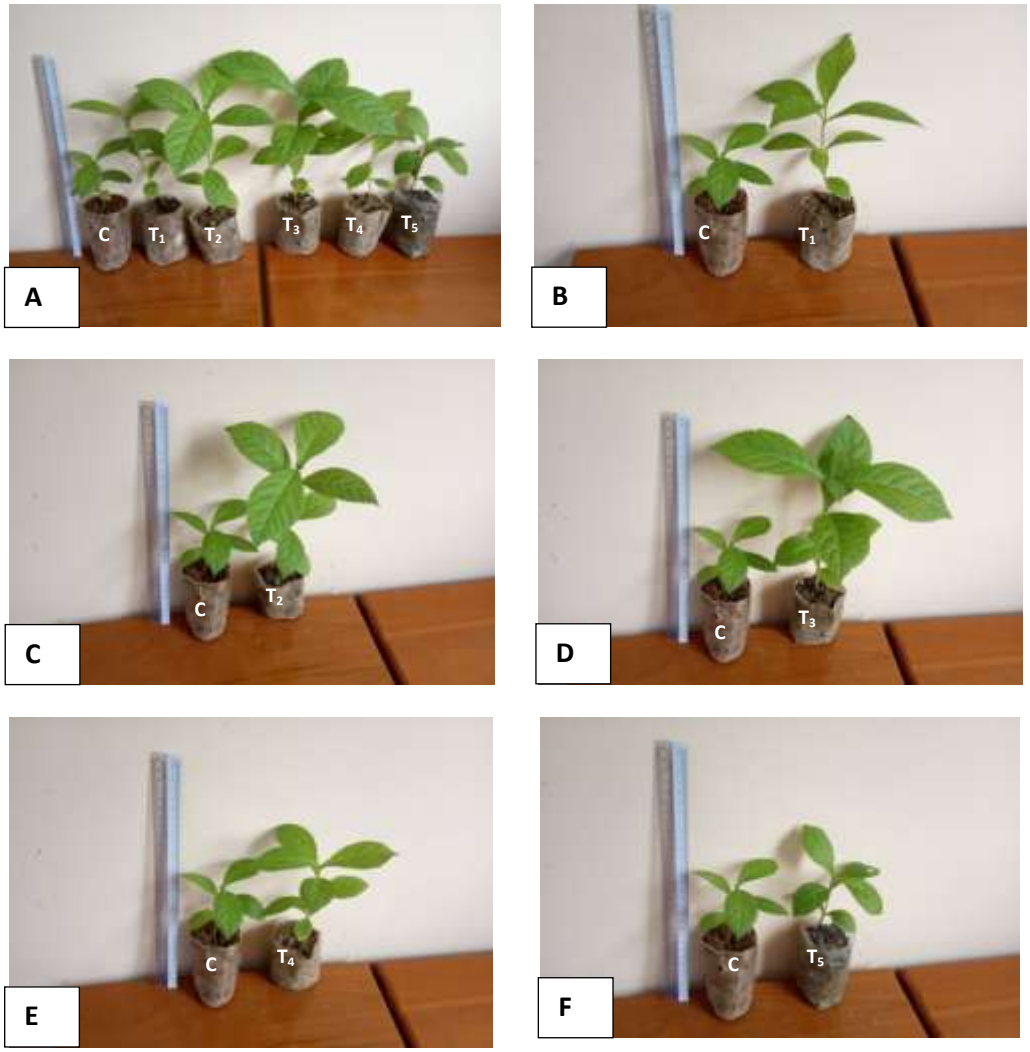
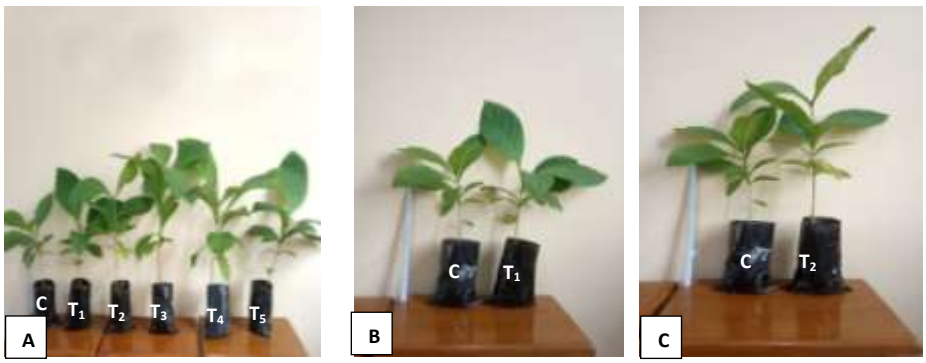


Figure (5). Comparison on mean value of total leaf area per plant in 12 WAS (Bag experiment)



Figure(6).Effect of different concentrations of *Spirulina* suspension on growth of *Tectona grandis* L. at 6 WAS (Bag experiment)

A. Control and different concentration of *Spirulina* suspension treatments
B. Control and $1gl^{-1}$ *Spirulina* suspension treatment
C. Control and $2gl^{-1}$ *Spirulina* suspension treatment
D. Control and $3gl^{-1}$ *Spirulina* suspension treatment
E. Control and $4gl^{-1}$ *Spirulina* suspension treatment
F. Control and $5gl^{-1}$ *Spirulina* suspension treatment



Figure(7).Effect of different concentrations of *Spirulina* suspension on growth of *Tectona grandis* L. at 8 WAS (Bag experiment)

A. Control and different concentration of *Spirulina* suspension treatments
B. Control and 1gl^{-1}*Spirulina* suspension treatment
C. Control and 2gl^{-1}*Spirulina* suspension treatment
D. Control and 3gl^{-1}*Spirulina* suspension treatment
E. Control and 4gl^{-1}*Spirulina* suspension treatment
F. Control and 5gl^{-1}*Spirulina* suspension treatment

Discussion and Conclusion

In the result of this study, growth analysis of *Tectona grandis* L. were presented. Bag exeperiments were carried out at Department of Botany, University of Taunggoke, Rakhine State.

Teak (*Tectona grandis* L.) is a tropical hard wood tree species in the family Lamiaceae. It is a large deciduous tree that occurs in mixed hard wood forest. The wood is used for boat building, exterior construction, veneer, furniture, carving, turnings and other small wood projects. Teak is a valuable timber yielding plant. Much of the world's teak is exported by Indonesia and Myanmar. Myanmar is a teak heavy weight, playing a significant role in the global teak trade. It has the largest area of natural teak forests and is the number one producer of teak log in the world. Teak consumption raises a number of environmental concerns such as the disappearance of rare old growth teak. However, its popularity has led to growth in sustainable plantation teak production through the seasonally tropics in forestry plantation. Teak plantations were widely established in Myanmar (Phillips, 2016).

In bag experiments, nursery plants were tested with different concentrations of *Spirulina* suspension (1 gl^{-1}, 2 gl^{-1}, 3 gl^{-1}, 4 gl^{-1}and 5 gl^{-1}). 3 gl^{-1}*Spirulina* suspension treatment was the highest plant height, leaf number and total leaf area compared to other treatments and control. The plant height in 3 gl^{-1}*Spirulina* suspension treatment was 40.60 cm and 34.60 cm in control. The leaf number of 3 gl^{-1}*Spirulina* suspension treatment

was 20.80 per plant and 13.30 per plant in control. The total leaf area of 3 gl^{-1}*Spirulina* suspension treatment was 388.30 cm^2 and 161.39 cm^2 in control. The results of the bag experiments showed different concentration of *Spirulina* suspension treatments were significantly affected on growth of *Tectona grandis* L. These finding were agreed with Kyaw Soe Naing (2008), Thet Naing Htwe (2008), Khin Lay NandarAung (2011), Win Mar (2012) and Aye MyaNyein (2012). Thet Naing Htwe (2008) stated that the best growth was 2 % *Spirulina* powder treatment in chick pea, 6 % treatment in soybean and 4 % reatment in butter bean. Win Mar (2012) reported that the best growth was 4 gl^{-1} *Spirulina* suspension treatment in cow pea.

In this study, it can be concluded that *Spirulina* biofertilizer actually promoted the growth of *Tectona grandis* L. Therefore *Spirulina* biofertilizer application was suitable in using for agriculture. According to literature and studying, the results of the continuous using by biofertilizer increase of soil organic matter, reduce soil erosion and higher soil biological activity and increase growth. The heavy application of chemical fertilizer in agriculture to increase production has resulted decline in soil fertility and consequently in lower soil productively. Now, agricultural scientists and farmers were interested in natural and biofertilizers to substitute the chemical fertilizer. Further experiments are carried out to test effect of more agal strain on the growth not only *Tectona grandis* L. but also the other plants too.

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မြန်မာစကားထာနှင့်ရခိုင်ပန်းဝှက်နှိုင်းယှဉ်လေ့လာခြင်း

တင်တင်နု *

စာတမ်းအကျဉ်း

ဤစာတမ်းသည် မြန်မာစကားထာနှင့်ရခိုင်ပန်းဝှက်တို့ကို နှိုင်းယှဉ်လေ့လာ တင်ပြထားသည့်စာတမ်းဖြစ်ပါသည်။ မြန်မာစကားထာနှင့်ရခိုင်ပန်းဝှက်များကို နှိုင်းယှဉ်လေ့လာတင်ပြရာတွင် အတ္ထဗေဒပညာရပ်၏ နည်းနာများကိုအခြေခံ၍ လေ့လာဖော်ထုတ်ထားပါသည်။ ဤစာတမ်းတွင် စကားထာ(ပန်းဝှက်)ဟူသည်၊ မြန်မာနှင့်ရခိုင်တူညီသော စကားထာ(ပန်းဝှက်)များ၊ မြန်မာနှင့်ရခိုင်ကွဲပြားသော စကားထာ(ပန်းဝှက်)များဟူ၍ခွဲခြားကာ လေ့လာတင်ပြထားပါသည်။ ဤကဲ့သို့လေ့လာခြင်းအားဖြင့် တိမ်မြုပ်ပျောက်ကွယ် လုနီးပါးဖြစ်နေသော မြန်မာစကားထာနှင့် ရခိုင်ပန်းဝှက်များကို ထိန်းသိမ်းရာရောက်သကဲ့သို့ မြန်မာနှင့်ရခိုင်တို့၏ တူညီမှု၊ကွဲပြားမှုတို့ကိုလည်း သိရှိလာမည် ဖြစ်ပါသည်။

သော့ချက်ဝေါဟာရများ – စကားထာ၊ ပန်းဝှက်၊ အနက်၊ ဆက်စပ်မှု၊ အတ္ထဗေဒ။

နိဒါန်း

မြန်မာလူမျိုးတို့၏ ရိုးရာဓလေ့ယဉ်ကျေးမှုများတွင် စကားထာဝှက်ခြင်းသည်လည်း တစ်ခုအပါအဝင်ဖြစ်ပါသည်။ မြန်မာတွင်စကားထာဝှက်ခြင်းကို ရှေးခေတ်ရှေးအခါက ရွှေနန်းတော်ထဲနှင့် ကျေးလက်တောရွာများတွင် ဝှက်ဆိုသောအလေ့ရှိခဲ့သည် ဟုသိရှိရပါသည်။ ထို့အတူရခိုင်လူမျိုးတို့တွင်လည်းပန်းဝှက်ကစားခြင်းကို ဝေသာလီကျောက်လှေခါးခေတ်မှ စခဲ့သည်ဟုသိရှိရပါသည်။ ထိုအချိန်မှစခဲ့သော စကားထာဝှက်(ပန်းဝှက်)ခြင်း ကစားနည်းသည် မြန်မာနှင့်ရခိုင်တို့၏ဓလေ့ရိုးရာကစားနည်းတစ်မျိုးဖြစ်လာခဲ့ပါသည်။သို့သော်ယခုအချိန်တွင် ထိုဓလေ့သည်ပျောက်ကွယ်လုနီးပါးဖြစ်နေပါသည်။ထို့ကြောင့်မြန်မာစကားထာနှင့်ရခိုင်ပန်းဝှက်များကို နောင်လာနောက်သားမျိုးဆက်သစ်များသိရှိစေရန်အတွက် လေ့လာခြင်းဖြစ်ပါသည်။ ထိုသို့လေ့လာရာတွင် စကားထာ(ပန်းဝှက်)ဟူသည်၊ မြန်မာနှင့်ရခိုင်တူညီသော စကားထာ(ပန်းဝှက်)များနှင့် မြန်မာနှင့်ရခိုင်ကွဲပြားသော စကားထာ(ပန်းဝှက်)များကို အတ္ထဗေဒရှုထောင့်မှ လေ့လာတင်ပြထားပါသည်။

စကားထာ (ပန်းဝှက်)ဟူသည်

စကားထာဟူသောဝေါဟာရကို မြန်မာအဘိဓာန်တွင် “အနက်အဓိပ္ပာယ် မြွုပ်ထားသော ဉာဏ်စမ်းစကား။ပဟေဠိ” (မြန်မာစာအဖွဲ့၊၂၀၀၃၊၇၉–၈၀)ဟု အနက်ဖွင့်ထားပါသည်။ မြန်မာ့စွယ်စုံကျမ်းအတွဲ(၃)တွင် “စကား၏အနက်အဓိပ္ပာယ်ကို ကွယ်ဝှက်၍ပုစ္ဆာထုတ်ခြင်း” (မြန်မာ့စွယ်စုံကျမ်း၊ ၁၉၅၆၊၂၉၅)ဟူ၍လည်းကောင်း၊ မြန်မာ့ရိုးရာစကားထာများတွင် “စကား+အတ္ထ=စကတ္ထမှတစ်ဆင့် စကားထာဖြစ်လာကြောင်း ဆိုကြပါသည်။ အဓိပ္ပာယ်မှာစကား၏အနက်” (ကြည်ဦး၊ ၁၉၉၆၊ ၂၃၊) ဟုဆိုပါသည်။ဒေးဗစ်ခရစ္စတယ်ကမူ စကားထာ၏သဘာဝကို “စကားထာများသည် အဖြေရှာရခက်ခဲစေရန် ရည်ရွယ်၍ပြောကြားသော ရှေးရိုးစဉ်လာစကားခွန်းများ ဖြစ်ကြပါသည်။ အရာဝတ္ထုများ၊ တိရစ္ဆာန်များ၊လူများနှင့်အဖြစ်အပျက်များကို အခြားအရာများဟူ၍ထင်ရစေရန် ဖော်ပြလေ့ရှိသည်။ စကားထာနားထောင်သူ၏တာဝန်မှာ အဓိပ္ပာယ်ထွေပြားမှုကိုရှင်း၍ မှန်ကန်စွာအဖြေထုတ်နိုင်ရန် ကြိုးစားရခြင်းဖြစ်သည်။” (crystal, 1996, 63) စသည်ဖြင့် စကားထာ၏အနက်အဓိပ္ပာယ်ကို အမျိုးမျိုးဖွင့်ဆိုကြပါသည်။

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*လက်ထောက်ကထိက၊မြန်မာစာဌာန၊ တောင်ကုတ်တက္ကသိုလ်

ပန်းဝှက်ဟူသောဝေါဟာရနှင့်ပတ်သက်၍ အသျှင်ဝါသဝပြုစုသောရခိုင်ဝေါဟာရ အဘိဓာန် အတွဲ(၁)တွင် "တစ်ဖက်သား၏ဉာဏ်ကိုစမ်းလိုသောကြောင့် အဖြေဖော်ပေးရန် အလို့ငှာ လျှို့ချက်ကွယ်ဝှက်သောစကားဖြင့်မေးသည်။ စကားထာဝှက်သည်။"(ဝါသဝ၊အသျှင်၊၂၀၁၄၊၃၇) ဟူ၍လည်းကောင်း အသျှင်ဓမ္မဝီယကလည်း ရခိုင်ပန်းဝှက်နှံ့သုတရတနာများ စာအုပ်တွင် "ရခိုင် ပန်းဝှက်တမ်း ဉာဏ်စမ်းကစားခြင်းကို မြန်မာတွင်စကားထာဟုခေါ်ပါသည်။ ပါဠိတွင် ပဟေဠိဟု ခေါ်ပါသည်။"(ဓမ္မဝီယ၊အသျှင်၊၂၀၁၅၊၁၅) စသည်ဖြင့်ပန်းဝှက်၏ အနက်အဓိပ္ပာယ်ကို အမျိုးမျိုး ဖွင့်ဆိုကြပါသည်။

ဤအဆိုအမိန့်များကိုဆက်စပ်၍ စကားထာ(ပန်းဝှက်)၏အနက်ကို ကောက်ချက်ချ ရသော် စကားထာဟူသည် ဖြေဆိုရန်စကားတစ်ခုအတွက် ထိုစကား၏အနက်အဓိပ္ပာယ်ကို ကွယ်ဝှက်၍ ပုစ္ဆာထုတ်ခြင်းပင်ဖြစ်သည် ဟုဆိုရပေမည်။ ဤကဲ့သို့ပုစ္ဆာထုတ်ခြင်းကို စကားဝှက် သည်ဟုခေါ်သည်။ တစ်ဦးတစ်ယောက်ကစကားဝှက်သည်ကို မဖြေနိုင်လျှင် ဉာဏ်ပူဇော်ခအဖြစ် ပန်းပေးရပါသည်။ ထိုသို့ပန်းပေးပြီးမှ ဖော်ရသောကြောင့် ရခိုင်ဒေသတွင်ပန်းဝှက်ဟု ခေါ်ခြင်း ဖြစ်ပါသည်။ စကားထာ(ပန်းဝှက်)ခြင်းဟူသည် ဝှက်သူကဖြေသူ၏စိတ်ကို ယောင်ဝါးဝါး ဖြစ်အောင်လည်းကောင်း၊ခန့်မှန်း၍ရအောင်သဲလွန်စပေး၍လည်းကောင်း၊ အနက်အဓိပ္ပာယ်တူချင်း ကို ကွယ်ဝှက်၍ ပုစ္ဆာထုတ်ခြင်းဖြစ်ပါသည်။

မြန်မာစကားထာနှင့်ရခိုင်ပန်းဝှက်နှိုင်းယှဉ်ခြင်း

မြန်မာစကားထာနှင့်ရခိုင်ပန်းဝှက်တို့ကို နှိုင်းယှဉ်လေ့လာသောအခါ စကားလုံးတို့၏ အနက်ဆက်စပ်မှုကို လေ့လာတင်ပြထားပါသည်။ "အနက်"ကို ခရီးဆောင်မြန်မာအဘိဓာန် တွင် "မူရင်းအဓိပ္ပာယ်။အစုအပေါင်းမှတစ်စိတ်တစ်ဒေသကို ထုတ်နုတ်ပြရာတွင်သုံးသော စကားလုံး" (မြန်မာစာအဖွဲ့၊၂၀၀၃၊၃၈၄)ဟူ၍လည်းကောင်း၊ "ဆက်စပ်မှု"ကို"တစ်ခုနှင့်တစ်ခု ပူးပေါင်းသည်၊ ဆက်သည်၊ နှီးနွယ်သည်" (မြန်မာစာအဖွဲ့၊၂၀၀၃၊၁၀၇)ဟူ၍ ဖွင့်ဆိုထားပါသည်။

ဒေါက်တာခင်အေးကမူ "ဘာသာစကားတစ်ခုတွင် စကားလုံးများကို အသုံးပြုရာ၌ အဆက်အစပ်မရှိဘဲ စကားတစ်လုံးချင်းသီးခြားသုံးပုံမျိုး အလွန်ရှားပါသည်။ စကားတစ်လုံးကို ဝါကျထဲတွင်အသုံးပြုသည်ဆိုရာ၌ ထိုစကားလုံး၏ရှေ့နောက်ဝဲယာရှိ စကားလုံးများနှင့် ဆက်စပ်၍အသုံးပြုမြဲဖြစ်သည်။ ယင်းကိုပင်အဆက်အစပ်ဟု ဆိုလိုခြင်းဖြစ်ပါသည်။" (ခင်အေး၊ဒေါက်တာ၊၂၀၀၄၊ ၉၈)ဟူ၍ ပညာရှင်တို့က အမျိုးမျိုးမိန့်ဆိုခဲ့ကြသည်။

ဤအဆိုအမိန့်များကိုဆက်စပ်၍ အနက်ဆက်စပ်မှုသဘောကို ကောက်ချက်ချရသော် အနက်ဆက်စပ်မှုဟူသည် စကားလုံးတစ်လုံးနှင့်တစ်လုံး အနက်ရိုးအရလည်းကောင်း၊ ဂုဏ်ရည်ပြ အနက်အရလည်းကောင်း၊ တင်စားမှုအရလည်းကောင်း၊ အခြေအနေအရလည်းကောင်း၊ အနက် အဓိပ္ပာယ်ချင်း နှီးနွယ်ဆက်စပ်မှုရှိခြင်းပင် ဖြစ်သည်ဟုဆိုရပေမည်။

တူညီမှုရှိသောမြန်မာစကားထာနှင့် ရခိုင်ပန်းဝှက်များ

မေး ⟶ ကန်ထဲမှာရေ၊ ရေထဲမှာမြွေ၊ မြွေခေါင်းမှာရွေ။ (မြန်မာ)

⟶ ကန်ထဲမာရီ၊ ရီထဲမာမြွီ၊ မြွီထက်မာရွီ။ (ရခိုင်)

အဖြေ ⟶ မီးခွက် (ဆီမီးခွက်)

ဤ "ကန်ထဲမှာရေ၊ ရေထဲမှာမြွေ၊ မြွေခေါင်းမှာရွေ" (ကန်ထဲမာရီ၊ ရီထဲမာမြွီ၊ မြွီထက်မာရွီ) ဟူသောမြန်မာစကားထာနှင့်ရခိုင်ပန်းဝှက်သည် ကန်ထဲတွင်ရေရှိပြီး ထိုရေထဲတွင်မြွေရှိသည့်အပြင် မြွေထက်တွင်ရွေရှိခြင်းကို ဆိုလိုခြင်းဖြစ်ပါသည်။

ဤစကားထာ(ပန်းဝှက်)၏ဆိုလိုရင်းမှာ ကန်ပုံသဏ္ဌာန်ထဲတွင် ရေရှိပြီးထိုရေထဲတွင် မြွေပုံသဏ္ဌာန်တစ်ခုရှိသည် ထိုမြွေပေါ်တွင်ချွေရောင်အရာရှိသည်။ ၄င်းအရာကိုအနက်ဖော်ပါ ဟုဆိုလိုခြင်းဖြစ်ပါသည်။ ဤစကားထာ(ပန်းဝှက်)၏အဖြေမှာ"မီးခွက်"(ဆီမီးခွက်) ဖြစ်ပါသည်။ အဘယ်ကြောင့်ဆိုသော် ရှေးမြန်မာလူမျိုးတို့နှင့်ရှေးရခိုင်လူမျိုးတို့သည် အလင်းရောင်ရရန်အတွက်ခွက်ထဲတွင်ရေနံဆီကိုထည့်ပြီး ရေနံဆီထဲတွင်အဝတ်စကိုထည့်ကာ မီးထွန်းလေ့ရှိသောကြောင့် ဖြစ်ပါသည်။ ထို့အပြင်ဤစကားထာ(ပန်းဝှက်)မှ ဆီထည့်နိုင်သောခွက်ကို ရေထည့်နိုင်သောကန်နှင့် အနက်တူချင်း တင်စား၍လည်းကောင်း၊ လေးထောင့်ပုံမီးခွက်ကို လေးထောင့်ပုံကန်နှင့် ပုံသဏ္ဌာန်တူချင်းတင်စား၍လည်းကောင်း၊ မီးထွန်းညှိရန်အတွက် ရေနံဆီထဲတွင်အဝတ်စကို လိမ်ပြီးခွေခွေလေးထည့်ထားပုံကို ခွေခွေလေးရှိနေသောမြွေ၏ပုံသဏ္ဌာန်နှင့် ပုံသဏ္ဌာန်တူချင်းတင်စား၍လည်းကောင်း၊ ရေနံဆီစိမ်ထားသောအဝတ်စကို မီးထွန်းလိုက်သောအခါ ထွက်ပေါ်လာသောမီးအရောင်ကို ရွှေ၏အရောင်နှင့် အရောင်တူချင်းတင်စားထားပါသည်။ ထိုသို့'ဆီမီးခွက်' ကို 'ကန်'နှင့် ပုံသဏ္ဌာန်တူချင်း၊ အနက်တူချင်းဆက်စပ်ပြီး ဆီမီးခွက်ထဲမှရေနံဆီကို 'ကန်ထဲမှရေ'၊ ရေနံဆီထဲမှ အဝတ်စကို 'ရေထဲမှမြွေ'နှင့် ပုံသဏ္ဌာန်တူချင်းဆက်စပ်ထားသည့်အပြင် အဝတ်စပေါ်မှမီးအရောင်ကို 'မြွေထက်ကရွှေ'နှင့် အရောင်တူချင်းဆက်စပ်ကာ စကားထာ(ပန်းဝှက်)ထားခြင်းဖြစ်ပါသည်။

အထက်တွင်ဖော်ပြခဲ့သော မြန်မာစကားထာနှင့် ရခိုင်ပန်းဝှက်တို့သည် တူညီမှုရှိသော စကားထာ(ပန်းဝှက်) ဖြစ်ကြောင်းတွေ့ရှိရပါသည်။ အဘယ်ကြောင့်ဆိုသော် 'ကန်'ဟူသော စကားလုံးကို မြန်မာစကားထာတွင်သာမက ရခိုင်ပန်းဝှက်တွင်ပါ အသုံးပြုထားသည့်အပြင် အနက်အဓိပ္ပာယ် ကောက်ယူပုံပါ တူညီနေကြောင်းတွေ့ရပါသည်။ ထို့ပြင်မြန်မာ'ရေ'ကို ရခိုင်'ရီ'၊ မြန်မာ'မြွေ'ကိုရခိုင်'မြို'၊ မြန်မာ'ရွှေ'ကိုရခိုင်'ရွိ'ဟူသော အသုံးအနှုန်းတို့သည် ကွဲပြားသည်ဟုထင်ရသော်လည်း လုံးဝကွဲပြားခြင်းမဟုတ်ဘဲ နေရာဒေသမတူသောကြောင့် သရသံကွဲပြားခြင်းဖြစ်ပြီးအနက်အဓိပ္ပာယ်မှာအတူတူပင် ဖြစ်ကြောင်းတွေ့ရှိရပါသည်။ ထိုသို့စကားလုံး အသုံးအနှုန်း နှင့် အနက်အဓိပ္ပာယ်ကောက်ယူပုံတို့ တူညီမှုများစွာရှိသောကြောင့် ဤမြန်မာစကားထာနှင့် ရခိုင်ပန်းဝှက်တို့ကိုတူညီမှုရှိသော စကားထာ(ပန်းဝှက်)ဟု ဆိုလိုရခြင်းဖြစ်ပါသည်။

မေး ⟶ တို့နွားတစ်ကောင်၊ ဘို့တစ်ထောင်။ (မြန်မာ)

⟶ ငါ့နွားတကောင်၊ ဘို့တထောင်။ (ရခိုင်)

အဖြေ ⟶ ကြက်ဟင်းခါးသီး (ဂြင့်ခါးသီး)

ဤ "တို့နွားတစ်ကောင်၊ ဘို့တစ်ထောင်" (ငါ့နွားတကောင်၊ ဘို့တထောင်) ဟူသော စကားထာ (ပန်းဝှက်)သည် နွားတစ်ကောင်တွင် ဘို့တစ်ထောင်ရှိခြင်းကို ဆိုလိုခြင်းဖြစ်ပါသည်။

ဤစကားထာ(ပန်းဝှက်)၏ဆိုလိုရင်းမှာ နွားဘို့ကဲ့သို့ ဘို့များစွာပါသောအရာကိုအနက်ဖော်ပါဟုဆိုလိုခြင်းဖြစ်ပါသည်။ ဤစကားထာ(ပန်းဝှက်)၏အဖြေမှာ "ကြက်ဟင်းခါးသီး"(ဂြင့်ခါးသီး)ဖြစ်ပါသည်။ အဘယ်ကြောင့်ဆိုသော် ကြက်ဟင်းခါးသီး(ဂြင့်ခါးသီး)တွင် အဖုအထစ်များစွာပါရှိသောကြောင့်ဖြစ်ပါသည်။ ထို့အပြင်ဤစကားထာ(ပန်းဝှက်)တွင် ကြက်ဟင်းခါးသီးမှအဖုအထစ်ကို 'ဘို့'ဟူ၍ နွား၏ဘို့နှင့်တင်စားပြီး ကြက်ဟင်းခါးသီးတစ်လုံးတွင် အဖုအထစ်များစွာပါရှိပုံကို 'တစ်ထောင်' (တထောင်)ဟူ၍ အများပြအသုံးနှင့် တင်စားထားသည့်အပြင်

သက်မဲ့ 'ကြက်ဟင်းခါးသီး' ကို သက်ရှိ 'နွား' နှင့်ပုံသဏ္ဌာန်တူချင်း တင်စားထားပါသည်။ ထိုသို့ 'ကြက်ဟင်းခါးသီး' ကို 'နွား'၊ 'တစ်လုံး' ကို 'တစ်ကောင်'၊ 'အဖု အထစ်' ကို 'ဘို့'၊ 'အများအပြား' ကို 'တစ်ထောင်' ဟူ၍တင်စားပြီး ထိုစကားလုံးတို့၏ အနက်နှင့်ပုံသဏ္ဌာန်တို့ကို ဆက်စပ်ကာ စကားထာ(ပန်းဝှက်)ထားခြင်းဖြစ်ပါသည်။

အထက်တွင်ဖော်ပြခဲ့သော မြန်မာစကားထာနှင့် ရခိုင်ပန်းဝှက်တို့သည် တူညီမှုရှိသော စကားထာ (ပန်းဝှက်) ဖြစ်ကြောင်းတွေ့ရှိရပါသည်။ အဘယ်ကြောင့်ဆိုသော် "နွား"၊ "ဘို့" ဟူသော စကားလုံးတို့ကို မြန်မာစကားထာနှင့် ရခိုင်ပန်းဝှက်နှစ်မျိုးလုံးတွင် သုံးထားသည့်အပြင် အနက်အဓိပ္ပာယ်ကောက်ပုံပါ တူညီနေပါသည်။ ထို့အပြင်ပိုင်ဆိုင်မှုကိုပြသော စကားလုံးကို မြန်မာက 'တို့' ဟုသုံးပြီးရခိုင်က 'ငါ့' ဟုကွဲပြားစွာသုံးသော်လည်း အနက်မှာအတူတူပင်ဖြစ်ပါသည်။ ထိုသို့ စကားလုံးအသုံးအနှုန်းနှင့် အနက်အဓိပ္ပာယ်တို့ တူညီမှုရှိသောကြောင့် ဤမြန်မာ စကားထာနှင့် ရခိုင်ပန်းဝှက်တို့ကို တူညီမှုရှိသောစကားထာ(ပန်းဝှက်) ဟုဆိုလိုခြင်း ဖြစ်ပါသည်

မေး ⟶ တက်လေးစင်းနဲ့အပြင်းလှော်၊ မယ်တော်ရှင်မ၊ ပေါင်းမိုးထဲက။ (မြန်မာ)

⟶တက်လေးချောင်းနန့်အပြင်းလှော်၊မယ်တော်သျှင်မ၊ ပေါင်းထဲက။ (ရခိုင်)

အဖြေ ⟶ လိပ် (ပြင်သာလိပ်၊ ပင်လယ်လိပ်)

ဤ "တက်လေးစင်းနဲ့အပြင်းလှော်၊ မယ်တော်ရှင်မပေါင်းမိုးထဲက" (တက်လေးချောင်းနန့်အပြင်းလှော်၊ မယ်တော်သျှင်မ၊ ပေါင်းထဲက)ဟူသော စကားထာ(ပန်းဝှက်)သည် တက်လေးစင်းနှင် မြန်မြန်လှော်ခတ်နေသော ပေါင်းမိုးထဲမှမယ်တော်ရှင်မကို ဆိုလိုခြင်းဖြစ်ပါသည်။

ဤစကားထာ(ပန်းဝှက်)၏ဆိုလိုရင်းမှာ ပေါင်းမိုးကဲ့သို့အမိုးအကာအောက်တွင်ရှိပြီး တက်လေးချောင်းကဲ့သို့အချောင်းလေးချောင်းဖြင့် လှော်ခတ်သွားလာနေသောမယ်တော်ရှင်မကို အနက်ဖော်ပါဟုဆိုလိုခြင်းဖြစ်ပါသည်။ ဤစကားထာ(ပန်းဝှက်)၏အဖြေမှာ"လိပ်"(ပြင်သာလိပ်၊ပင်လယ်လိပ်)ဖြစ်ပါသည်။ အဘယ်ကြောင့်ဆိုသော် လိပ်သည်အခွံမာ၏အထဲမှနေ၍ လက်နှင့်ခြေကိုအပြင်ထုတ်ကာလှုပ်ရှားသွားလာတတ်သော သတ္တဝါပင်ဖြစ်ပါသည်။ ထို့အပြင်ဤစကားထာ(ပန်းဝှက်)တွင်မာကျောပြီးလုံခြုံမှုရှိသောလိပ်၏အခွံကို "ပေါင်းမိုး"ဟူ၍ လေဒဏ်မိုးဒဏ်ကိုကာကွယ်ပေးနိုင်သောလှေအမိုးနှင့်အနက်တူချင်း၊ ပုံသဏ္ဌာန်တူချင်းတို့နှင့် တင်စားဆက်စပ်၍လည်းကောင်း၊ လိပ်၏ခြေလက်များကို "တက်လေးစင်း"(တက်လေးချောင်း)ဟူ၍ သက်မဲ့လှေမှတက်ချောင်းကလေးများဖြင့်အရေအတွက်တူချင်း၊ ပုံသဏ္ဌာန်တူချင်းတို့ကိုတင်စားဆက်စပ်၍လည်းကောင်း၊ လိပ်သွားလာလှုပ်ရှားသောအခါ ခြေလက်တို့ဖြင့်ယက်ကာသွားပုံကို "အပြင်းလှော်"ဟူ၍ လှေလှော်ပုံနှင့် ပုံသဏ္ဌာန်တူချင်းတို့ကိုတင်စားဆက်စပ်ကာ စကားထာ(ပန်းဝှက်) ထားခြင်းဖြစ်ပါသည်။

အထက်တွင်ဖော်ပြခဲ့သော မြန်မာစကားထာနှင့် ရခိုင်ပန်းဝှက်တို့သည် တူညီမှုရှိသော စကားထာ(ပန်းဝှက်)များဖြစ်ကြောင်းတွေ့ရှိရပါသည်။ အဘယ်ကြောင့်ဆိုသော်လိပ်၏ပုံသဏ္ဌာန်ကို သဲလွန်စပေးသောစကားလုံးများဖြစ်သော "တက်"၊ "အပြင်းလှော်"၊ "မယ်တော်"၊ "ပေါင်း(မိုး)ထဲက" ဟူသောစကားလုံးတို့ကို မြန်မာနှင့်ရခိုင်နှစ်ဘာသာလုံးတွင် အသုံးတူကြောင်းတွေ့ရပါသည်။ မြန်မာတွင်'စင်း'ဟူသောမျိုးပြအသုံးကို ရခိုင်က'ချောင်း'ဟူ၍ ကွဲပြားစွာသုံးထားကြောင်းတွေ့ရှိရပါသည်။ ထို့ပြင်မြန်မာတွင် 'နဲ့'ကိုရခိုင်တွင်'နန့်'၊ မြန်မာတွင်'ရှင်မ'ကိုရခိုင်တွင်'သျှင်မ'

ဟူ၍အသုံးကွဲသော်လည်း အနက်အဓိပ္ပာယ်မှာအတူတူပင်ဖြစ်ပါသည်။ ထိုသို့အနက်အဓိပ္ပာယ် ကောက်ယူပုံ၊ စကားလုံးအသုံးအနှုန်းနှင့် ပုံသဏ္ဌာန်တို့ပါ တူညီမှုများစွာရှိသောကြောင့် ဤမြန်မာ စကားထာနှင့် ရခိုင်ပန်းဝှက်တို့ကို တူညီမှုရှိသောစကားထာ(ပန်းဝှက်) ဟုဆိုလိုခြင်းဖြစ်ပါသည်။

မေး ⟶ အတောင်စိမ်းပြာငှက်သတ္တဝါ၊ အမောက်မြေမှာဝှက်။ (မြန်မာ)

⟶ အတောင်စိမ်းပြာငှက်၊ အဂေါင်းမြီမာဝှက်။ (ရခိုင်)

အဖြေ ⟶ ငှက်ပျောပင် (နပျိုးပင်)

ဤ "အတောင်စိမ်းပြာငှက်သတ္တဝါ၊ အမောက်မြေမှာဝှက်" (အတောင်စိမ်းပြာငှက်၊ အဂေါင်းမြီမာ ဝှက်)ဟူသော စကားထာ(ပန်းဝှက်)သည် စိမ်းပြာရောင်အတောင်ရှိပြီး အမောက်(ဦးခေါင်း)မြေ တွင်ရှိသောအရာကို ဆိုလိုခြင်းဖြစ်ပါသည်။

ဤစကားထာ(ပန်းဝှက်)၏ ဆိုလိုရင်းမှာ ငှက်အတောင်ကဲ့သို့ စိမ်းပြာရောင်အပြား ပုံသဏ္ဌာန်ရှိပြီး ဦးခေါင်းပိုင်းမြေတွင်ရှိသောအရာကို အနက်ဖော်ပါဟုဆိုလိုခြင်းဖြစ်ပါသည်။ ဤ စကားထာ(ပန်းဝှက်)၏အဖြေမှာ "ငှက်ပျောပင်"(နပျိုးပင်)ဖြစ်ပါသည်။ အဘယ်ကြောင့်ဆိုသော် ငှက်ပျောပင်သည်အစိမ်းရောင်ရှိပြီး ငှက်ပျောဖက်များသည်လည်း ငှက်အတောင်ကဲ့သို့အပြားလိုက် ရှိနေသည့်အပြင် မြေတွင်မြှုပ်ထားသောအပိုင်းသည် ဦးခေါင်းပိုင်းဖြစ်သောကြောင့်ဖြစ်ပါသည်။

ထို့အပြင်ဤစကားထာ(ပန်းဝှက်)တွင် အစိမ်းရောင်ရှိသောငှက်ပျောပင်ကို 'စိမ်း'ဟူ၍ အစိမ်းရောင် နှင့်အရောင်တူချင်း တင်စားဆက်စပ်၍လည်းကောင်း၊ ငှက်ပျောပင်ကို'ငှက်'ဟူ၍ ငှက်နှင့်အသက် ရှိပုံချင်းတင်စားဆက်စပ်၍လည်းကောင်း၊ အပြားလိုက်ဖြစ်နေသော ငှက်ပျောဖက်ကို 'အတောင်' ဟူ၍ဖြန့်ထားသောငှက်အတောင်နှင့် ပုံသဏ္ဌာန်တူချင်းတင်စား ဆက်စပ်၍ လည်းကောင်း၊ ငှက်ပျောပင်ခေါင်းပိုင်းကို 'အမောက်'(အဂေါင်း)ဟူ၍ ဦးခေါင်းပိုင်းတွင်ရှိသော အရာနှင့် နေရာတူချင်း တင်စားဆက်စပ်၍လည်းကောင်း၊ ဦးခေါင်းပိုင်းမြေတွင်ရှိခြင်းကို 'မြေမှာဝှက်' (မြီမာဝှက်) ဟူ၍ မြေထဲတွင်ရှိခြင်းနှင့် တင်စားဆက်စပ်ကာ စကားထာ(ပန်းဝှက်) ထားခြင်းဖြစ်ပါသည်။

အထက်တွင်ဖော်ပြခဲ့သော မြန်မာစကားထာနှင့် ရခိုင်ပန်းဝှက်တို့သည် တူညီမှုရှိသော စကားထာ (ပန်းဝှက်)ဖြစ်ကြောင်းတွေ့ရှိရပါသည်။ အဘယ်ကြောင့်ဆိုသော်'အတောင်'၊'စိမ်း'၊ 'ငှက်'၊'ဝှက်'ဟူသော စကားလုံးအသုံးတို့ကို မြန်မာစကားထာနှင့် ရခိုင်ပန်းဝှက်နှစ်မျိုးလုံးတွင် သုံးထားသည့်အပြင် အနက်အဓိပ္ပာယ်ကောက်ယူပုံပါ တူညီမှုရှိသောကြောင့်ဖြစ်ပါသည်။ ထို့အပြင် ဦးခေါင်းပိုင်းကိုရည်ညွှန်းသောစကားလုံးကို မြန်မာက'အမောက်'ဟု သွယ်ဝိုက်ကာသုံးထားသော်လည်းရခိုင်က'အဂေါင်း'(ဦးခေါင်း)ဟု တိုက်ရိုက်သုံးထားသည့်အပြင် မြန်မာက'ငှက်ပျောပင်' ကို ရခိုင်က'နပျိုးပင်'၊ မြန်မာ'မြေ'ကိုရခိုင်'မြီ'ဟူ၍ အသုံးအနှုန်းကွဲပြားရခြင်းမှာ နေရာဒေသမတူသော ကြောင့်ကွဲပြားခြင်းဟုဆိုနိုင်ပါသည်။ သို့သော်အနက်အဓိပ္ပာယ်မှာ အတူတူပင်ဖြစ်ပါသည်။ ထိုသို့ စကားလုံးအသုံးအနှုန်းများနှင့် အနက်အဓိပ္ပာယ်တို့ တူညီမှုများစွာရှိသောကြောင့် ဤမြန်မာ စကားထာနှင့်ရခိုင်ပန်းဝှက်တို့ကို တူညီမှုရှိသောစကားထာ(ပန်းဝှက်)ဟု ဆိုလိုရခြင်းဖြစ်ပါသည်။

ကွဲပြားမှုရှိသောမြန်မာစကားထာနှင့် ရခိုင်ပန်းဂုက်များ

မေး ⟶ ထုလို့မပြား၊ ထောင်းလို့မကြေ၊ ရာကုဋေပွား၊ လူ့ထိပ်ဖျား။ (မြန်မာ)

အဖြေ ⟶ ဆံပင်

ဤ "ထုလို့မပြား၊ထောင်းလို့မကြေ၊ရာကုဋေပွား၊လူ့ထိပ်ဖျား" ဟူသောမြန်မာစကားထာသည် ထု၍လည်းမပြား၊ထောင်း၍လည်းမကြေဘဲ လူ့ထိပ်ဖျားတွင်ပွားများစွာရှိနေသောအရာ ကို ဆိုလိုခြင်းဖြစ် ပါသည်။

ဤစကားထာ၏ဆိုလိုရင်းမှာ လူ၏ထိပ်ဖျားတွင်ရှိပြီး ထု၍လည်းမရ၊ထောင်း၍လည်း မရသောအရာကိုအနက်ဖော်ပါဟု ဆိုလိုခြင်းဖြစ်ပါသည်။ ဤစကားထာ၏အဖြေမှာ "ဆံပင်"ဖြစ်ပါသည်။ အဘယ်ကြောင့်ဆိုသော် ဆံပင်သည်မည်မျှပင် ထောင်းထုသော်လည်း ပြားမသွား၊ကြေမသွားသည့်အပြင် လူတို့၏အထွဋ်အထိပ်ဖြစ်သောခေါင်းပေါ်တွင်ရှိပြီး ရေတွက်၍ မရအောင်များ ပြားသောကြောင့်ဖြစ်ပါသည်။ ထို့အပြင်ဤစကားထာတွင် ဆံမျှင်လေးများသည် သေးငယ်သောကြောင့်ဘာမျှလုပ်၍မရပုံကို "ထု၊မပြား"၊"ထောင်း၊မကြေ"ဟူ၍ မည်မျှပင် ထုထောင်းသော်လည်း မူလအတိုင်းရှိနေပုံနှင့်တင်စား၍လည်းကောင်း၊ ရေတွက်၍ မရသည့် အပြင်ပြန်လည် ရှင်သန်ပွားများ လာတတ်သောဆံပင်များကို "ရာကုဋေပွား" ဟူ၍ အများပြစကားလုံးနှင့် တင်စား၍လည်းကောင်း၊ ဆံပင်သည် လူတို့၏အထွဋ်အမြတ်ဖြစ်သော ခေါင်းပေါ်တွင်ရှိပုံကို "လူ့ထိပ်ဖျား"ဟူ၍ အမြင့်ဆုံး တွင်ရှိပုံနှင့် တင်စားထားခြင်းဖြစ်ပါသည်။ ထိုသို့ဘာမျှလုပ်၍ မရသော ဆံပင်ကို "ထု၊မပြား"၊ "ထောင်း၊မကြေ"ဟူသော စကားလုံးတို့၏ အနက်နှင့် ဆက်စပ်ပြီး ပြန်လည် ရှင်သန်ပွားများလာ သောဆံပင်များကို "ရာကုဋေပွား"ဟူသော စကားလုံးတို့၏အနက်နှင့် ဆက်စပ်ထားသည့်အပြင် လူ၏ခေါင်းကို "လူ့ထိပ်ဖျား"ဟူသော စကားလုံးတို့၏ အနက်နှင့် ဆက်စပ်ကာ စကားထာဂုက် ထားခြင်းဖြစ်ပါသည်။

မေး ⟶ ကြံမဲတရုံ၊ ခွတ်မကုန်။ (ရခိုင်)

အဖြေ ⟶ ဆံပင်

ဤ "ကြံမဲတရုံ၊ ခွတ်မကုန်" ဟူသောရခိုင်ပန်းဂုက်သည် ခုတ်၍မကုန်နိုင်သော အမည်းရောင်ကြံတောကို ဆိုလိုခြင်းဖြစ်ပါသည်။

ဤပန်းဂုက်မှ "ကြံမဲတရုံ" ဟူသည် အမည်းရောင်ရှိသော ကြံတောကို ဆိုလိုခြင်းဖြစ်ပြီး "ခွတ်မကုန်" ဟူသည် ခုတ်၍မကုန်ခမ်းနိုင်ခြင်းကို ဆိုလိုခြင်းဖြစ်ပါသည်။

ဤပန်းဂုက်၏ဆိုလိုရင်းမှာ ကြံကဲ့သို့မည်းနက်ရှည်လျားပြီး ခုတ်၍မကုန်နိုင်သောအရာကို အနက်ဖော်ပါဟု ဆိုလိုခြင်းဖြစ်ပါသည်။ ဤပန်းဂုက်၏အဖြေမှာ "ဆံပင်"ဖြစ်ပါသည်။ အဘယ်ကြောင့်ဆိုသော် ဆံပင်သည်ရှည်ရှည်မျှောမျှောနှင့် အမည်းရောင်ရှိသည့်အပြင်မည်မျှပင်ဖြတ်သော်လည်းပြန်လည်ရှင်သန် လာတတ်သောကြောင့်ဖြစ်ပါသည်။ ထို့အတူကြံသည်လည်းတစ်နှစ်စိုက်လိုက်လျှင် လေးငါးနှစ်လောက်အထိ ပြန်လည်ထွက်လာတတ်သည့်အပြင် အမည်းရောင်ရှိသောကြောင့်ဖြစ်ပါသည်။ ထို့အပြင်ဤပန်းဂုက်တွင် ဆံပင်၏အရောင်အမည်းရောင်ကို "ကြံမဲ"ဟူ၍ကြံ၏အရောင်အမည်းရောင်နှင့် တင်စား၍လည်းကောင်း၊ ရေတွက်၍မရသောဆံပင်ကို "တရုံ"ဟူ၍စု

ပြုံနေခြင်းနှင့်တင်စား၍လည်းကောင်း၊ မည်မျှပင်ဖြတ်သော်လည်းပြန်လည်ပေါက် လာတတ်သော ဆံပင်ကို "ခွတ်မကုန်"ဟူ၍ ခုတ်၍မကုန်ခမ်းနိုင်ပုံနှင့် တင်စားထားခြင်းဖြစ်ပါသည်။ ထိုသို့ဆံပင် အရောင်ကို "ကြံမဲ"ဟူ၍ အရောင်တူချင်းဆက်စပ်ထားပြီး များပြားသောဆံပင်ကို "တရုံ" ဟူ၍ အနက်တူချင်းဆက်စပ်ထားသည့်အပြင် ပြန်လည်ရှင်သန်လာသောဆံပင်ကို "ခွတ်မကုန်" ဟူ၍ အနက်တူချင်းဆက်စပ်ကာ ပန်းဝှက်ထားခြင်းဖြစ်ပါသည်။

အထက်တွင်ဖော်ပြခဲ့သော မြန်မာစကားထာနှင့်ရခိုင်ပန်းဝှက်တို့သည် "ဆံပင်"ကိုဝှက်ထား သည်ဆိုသော်လည်းအယူအဆကွဲပြားမှုရှိကြောင်းတွေ့ရှိရပါသည်။ အဘယ်ကြောင့်ဆိုသော်မြန်မာ စကားထာတွင် ဆံပင်၏ဂုဏ်ရည်၊ဆံပင်များပြားပုံနှင့် ဆံပင်ရှိသောနေရာတို့ကို သဲလွန်စပေးကာ ဝှက်ထားသော်လည်း ရခိုင်ပန်းဝှက်တွင်ဆံပင်အရောင်၊ ဆံပင်ပုံသဏ္ဌာန်နှင့်ဆံပင်များပြားပုံတို့ကို သဲလွန်စပေးကာ ဝှက်ထားကြောင်းတွေ့ရှိရပါသည်။ ဆံပင်များပြားပုံကို မြန်မာက"ရာကုဋေ"ဟူ၍ ကိန်းဂဏန်းအရေအတွက်နှင့် ဖော်ပြထားသော်လည်း ရခိုင်က"တရုံ"ဟူ၍ စုပြုံ၍ရှိနေခြင်းဟူသော အနက်ဖြင့်ဖော်ပြထားသည်ကိုတွေ့ရပါသည်။ ထို့အတူမြန်မာစကားထာတွင် ဆံပင်၏ဂုဏ်ရည်ကို ဖော်ပြသောအခါ"ထု၊မပြား"၊"ထောင်း၊မကြေ"ဟူသော စကားလုံးတို့၏အနက်နှင့် ဆက်စပ်၍ လည်းကောင်း၊ဆံပင်တည်ရှိသောနေရာကို "လူ့ထိပ်ဖျား"ဟူသော စကား၏အနက်နှင့် ဆက်စပ်ကာဖော်ပြထားသော်လည်းရခိုင်ပန်းဝှက်တွင်မူ ဆံပင်၏အရောင်နှင့်ပုံသဏ္ဌာန်ကို ဖော်ပြ သောအခါ "ကြံမဲ"ဟူသောစကားလုံး၏အနက်နှင့်ဆက်စပ်၍လည်းကောင်း၊ ပြန်လည် ရှင်သန် ပေါက်လာသောဆံပင်ကို "ခွတ်မကုန်"ဟူသောစကားစု၏ အနက်အဓိပ္ပာယ်တို့နှင့် ဆက်စပ်ကာ ဖော်ပြထားသည်ကိုတွေ့ရှိရပါသည်။ ထိုသို့ကွဲပြားရခြင်းမှာ နေရာဒေသမတူသောကြောင့် စိတ်ကူး စိတ်သန်းများကွဲပြားခြင်း ဟုဆိုနိုင်ပါသည်။ ထိုသို့စကားလုံးအသုံးအနှုန်းနှင့် အနက်အဓိပ္ပာယ် ကောက်ယူပုံတို့ကွဲပြားရုံသာမက အယူအဆအမြင်တို့ပါ ကွဲပြားမှုများစွာရှိသောကြောင့် ဤမြန်မာ စကားထာနှင့်ရခိုင်ပန်းဝှက်တို့ကို ကွဲပြားမှုရှိသောစကားထာ(ပန်းဝှက်) ဟုဆိုလိုရခြင်းဖြစ် ပါသည်။

မေး ⟶ နတ်သမီးတံတွေးပေါက်၊ ကြက်မကောက်နိုင်။ (မြန်မာ)

အဖြေ ⟶ နေပြောက်

ဤ " နတ်သမီးတံတွေးပေါက်၊ ကြက်မကောက်နိုင်" ဟူသောမြန်မာစကားထာ သည် နတ်သမီး တံတွေးကို ကြက်မကောက်နိုင်ခြင်းကို ဆိုလိုခြင်းဖြစ်ပါသည်။

ဤစကားထာ၏ ဆိုလိုရင်းမှာ မြေတွင်ကောင်းကင်မှ နတ်သမီးတံတွေးကဲ့သို့ အစက် အပြောက်များ ကျရောက်နေသော်လည်း ကြက်ကောက်ယူစားသောက်၍ မရသောအရာကို အနက်ဖော်ပါဟုဆိုလိုခြင်းဖြစ်ပါသည်။ ဤစကားထာ၏ အဖြေမှာ "နေပြောက်" ဖြစ်ပါသည်။ အဘယ်ကြောင့်ဆိုသော် ကောင်းကင်ကထွက်လာသော နေမင်း၏အရောင်သည် မြေပြင်သို့ ရောက်ရှိသောအခါအစက်အပြောက်အဖြစ် ကျရောက်လာသောကြောင့်ဖြစ်ပါသည်။ ထို့အပြင် ဤစကားထာတွင် ကောင်းကင်၌ရှိသောနေမင်းကို "နတ်သမီး"ဟူ၍ ကောင်းကင်တွင် ရှိသော နတ်သမီးနှင့်တင်စား၍ လည်းကောင်း၊ ဖြာထွက်နေသော နေရောင်အစက်အပြောက် ကလေး

များကို "တံတွေးပေါက်" ဟူ၍ တံတွေးထွေးလိုက်သောအခါ ဖြာထွက်သွားသော တံတွေးစက် ကလေးများဖြင့် တင်စား၍လည်းကောင်း၊ထိတွေ့ကိုင်တွယ်၍မရသော နေရောင်အစက် အပြောက် ကလေးများကို 'ကြက်မကောက်နိုင်'ဟူ၍လည်းကောင်း မြေပြင်တွင်ရှိသော အရာသည် မည်မျှပင် သေးငယ်သော်လည်း ကောက်ယူစားသောက်နိုင်သော ကြက်တောင်မကောက်ယူနိုင်ပုံနှင့် တင်စားထားခြင်းဖြစ်ပါသည်။ ထိုသို့'နေမင်း' ကို'နတ်သမီး'နှင့်နေရာတူ၊ ဂုဏ်ရည်တူချင်း ဆက်စပ်ထားပြီး 'နေရောင်အစက်အပြောက်'ကို'တံတွေးပေါက်'နှင့်ပုံသဏ္ဌာန်တူချင်း ဆက်စပ်ထားသည့်အပြင် ထိတွေ့ကိုင်တွယ်၍မရသောနေပြောက်ကို 'ကြက်မကောက်နိုင်'နှင့် အနက်တူချင်းဆက်စပ်ကာ စကားထာဝှက်ထားခြင်းဖြစ်ပါသည်။

မေး ⟶ မင်းကြီးလက်စွပ်၊ အလယ်ဆိပ်ထရံ၊ ပြပြက်ကပ်။ (ရခိုင်)

အဖြေ ⟶ နေပြောက်

ဤ"မင်းကြီးလက်စွပ်၊အလယ်ဆိပ်ထရံ၊ပြပြက်ကပ်" ဟူသောရခိုင်ပန်းဝှက်သည် မင်းကြီးလက်စွပ် အလယ်အခန်းကန့်နံရံတွင် ကပ်နေခြင်းကို ဆိုလိုခြင်းဖြစ်ပါသည်။

ဤပန်းဝှက်မှ "မင်းကြီးလက်စွပ်"ဟူသည် ဘုရင်၏အဖိုးတန်လက်စွပ်ကို ဆိုလိုခြင်းဖြစ် ပြီး"အလယ်ဆိပ်ထရံ"ဟူသည် အိမ်ဦးခန်းနှင့်အိပ်ခန်းကြားဆီးကာထားသော ဝါးထရံကိုဆိုလို ခြင်းဖြစ်သည့်အပြင် "ပြပြက်ကပ်" ဟူသည် အပြားလိုက်ကပ်နေခြင်းကို ဆိုလိုခြင်းဖြစ်ပါသည်။

ဤပန်းဝှက်၏ ဆိုလိုရင်းမှာ အဖိုးတန်ရတနာများနှင့် စီခြယ်ထားသော မင်းကြီးလက်စွပ် ကဲ့သို့အရောင်တောက်ပဖြာထွက်နေသောအရာသည် အိမ်ဦးခန်းနှင့်အိပ်ခန်းကြားဆီးကာထားသော အလယ်ထရံတွင် အပြားလိုက်လာကပ်နေသည်။ ၄င်းအရာကိုအနက်ဖော်ပါဟု ဆိုလိုခြင်းဖြစ်ပါ သည်။ဤပန်းဝှက်၏အဖြေမှာ"နေပြောက်"ဖြစ်ပါသည်။ အဘယ်ကြောင့်ဆိုသော်ရှေးရခိုင်တိုင်းရင်း သားတို့သည် အိမ်ကိုဝါးထရံဖြင့်ကာတတ်ကြပါသည်။ ထိုသို့ဝါးထရံဖြင့်ကာထားသောကြောင့် နေထွက်လာသောအခါ နေ၏အလင်းရောင်သည် အိမ်ဦးခန်းဝါးထရံကိုဖောက်ကာ အလယ်အိပ် ခန်းထရံတွင် လာကပ်နေသောကြောင့်ဖြစ်ပါသည်။ ထို့ပြင်ဤပန်းဝှက်တွင် နေ၏အလင်းရောင် တောက်ပဖြာထွက်ပုံကို "မင်းကြီးလက်စွပ်" ဟူ၍မင်းကြီး၏လက်စွပ်မှ အရောင်တောက်ပဖြာထွက် ပုံနှင့်တင်စား၍လည်းကောင်း၊ အတွင်းဖက်အထိထိုးဖောက်ကျရောက်နေသော နေရောင်အစက် အပြောက်ကလေးများကို "အလယ်ဆိပ်ထရံ၊ပြပြက်ကကပ်"ဟူ၍ အလယ်ထရံတွင်ကပ်နေခြင်းနှင့် တင်စားထားခြင်းဖြစ်ပါသည်။ ထိုသို့ဖြာထွက်နေသောနေကို"မင်းကြီးလက်စွပ်"နှင့် တန်ဖိုးတူချင်း၊ ဂုဏ်ရည်တူချင်းဆက်စပ်ပြီး ထိုးဖောက်နိုင်သောနေစွမ်းအားကို "အလယ်ဆိပ်ထရံ" နှင့်ဂုဏ်ရည် တူချင်းဆက်စပ်ထားသည့်အပြင် နေရောင်အစက်အပြောက်များကျရောက်ပုံကို "ပြပြက်ကပ်"နှင့် ပုံသဏ္ဌာန်တူချင်းဆက်စပ်ကာ ပန်းဝှက်ထားခြင် ဖြစ်ပါသည်။

အထက်တွင်ဖော်ပြခဲ့သော မြန်မာစကားထာနှင့်ရခိုင်ပန်းဝှက်တို့သည် 'နေပြောက်'ကိုဝှက် ထားသည်ဆိုသော်လည်း စကားလုံးအသုံးအနှုန်းနှင့် အတွေးအမြင်တို့ ကွဲပြားကြောင်းတွေ့ရှိရပါ သည်။ အဘယ်ကြောင့်ဆိုသော် မြန်မာစကားထာတွင် နေပြောက်၏ပုံသဏ္ဌာန်နှင့် နေပြောက်၏ ဂုဏ်ရည်တို့ကို သဲလွန်စပေးကာဝှက်ထားသော်လည်း ရခိုင်ပန်းဝှက်တွင်နေ၏အရောင်တောက်ပ ပုံ၊ နေ၏ဂုဏ်ရည်နှင့် နေပြောက်ပုံသဏ္ဌာန်တို့ကို သဲလွန်စပေးကာဝှက်ထားကြောင်း တွေ့ရှိရပါ

သည်။ ဤတွင်နေ၏ဂုဏ်ရည်နှင့် နေပြောက်ပုံသဏ္ဌာန်တို့ကို မြန်မာနှင့်ရခိုင်နှစ်မျိုးလုံးတွင် သဲလွန်စပေးထားသည်ဆိုသော်လည်း အသုံးအနှုန်းမှာကွဲပြားကြောင်းတွေ့ရှိရပါသည်။ နေပြောက်၏ပုံသဏ္ဌာန်ကို မြန်မာက 'နတ်သမီးတံတွေးပေါက်'ဟူသော စကား၏အနက်နှင့်ဆက်စပ်ကာ ဖော်ပြထားသော်လည်း ရခိုင်က'ပြပြက်ကပ်'ဟူသော စကား၏အနက်နှင့်ဆက်စပ်ကာဖော်ပြထားပြီး နေ၏ဂုဏ်ရည်ကို မြန်မာက'ကြက်မကောက်နိုင်'ဟူသော စကား၏အနက်နှင့်ဆက်စပ်ဖော်ပြထားသော်လည်း ရခိုင်က'အလယ်ထရံ' ဟူသောစကား၏ အနက်နှင့်ဆက်စပ်ကာဖော်ပြထားပါသည်။ ထို့အတူနေ၏အရောင်တောက်ပပုံကို ရခိုင်ပန်းဝှက်တွင်'မင်းကြီးလက်စွပ်' ဟူသော စကား၏အနက်နှင့်ဆက်စပ်ကာ ဖော်ပြထားသည်ကိုတွေ့ရပါသည်။ ထိုသို့ကွဲပြားရခြင်းမှာ နေရာဒေသလူနေမှုအသိုင်းအဝိုင်း မတူသောကြောင့် အတွေးအမြင်များကွဲပြားခြင်းဟု ဆိုနိုင်ပါသည်။ ထိုသို့စကားလုံးအသုံးအနှုန်းနှင့် အနက်အဓိပ္ပာယ်ကောက်ယူပုံတို့ ကွဲပြားရုံသာမကအတွေးအမြင်တို့ပါ ကွဲပြားမှုများစွာရှိသောကြောင့် ဤမြန်မာစကားထာနှင့်ရခိုင်ပန်းဝှက် တို့ကိုကွဲပြားမှုရှိသော စကားထာ(ပန်းဝှက်) ဟုဆိုလိုခြင်းဖြစ်ပါသည်။

မေး ⟶ အပင်မြင့်မြင့် ညမှပွင့်။ (မြန်မာ)

အဖြေ ⟶ ကြယ်

ဤ "အပင်မြင့်မြင့်ညမှပွင့်" ဟူသောစကားထာသည် မြင့်မားသောအပင်မှပန်းသည် ညရောက်သောအခါမှပွင့်ခြင်းကို ဆိုလိုခြင်းဖြစ်ပါသည်။

ဤစကားထာ၏ဆိုလိုရင်းမှာ မြင့်မားသောအပင်ပေါ်တွင်ရှိပြီး ညမှပွင့်သောပန်းကို အနက်ဖော်ပါဟုဆိုလိုခြင်းဖြစ်ပါသည်။ ဤစကားထာ၏အဖြေမှာ "ကြယ်"ဖြစ်ပါသည်။ အဘယ်ကြောင့်ဆိုသော် ကြယ်သည်ညမှလင်းလက် တောက်ပသောအရာဖြစ်သည့်အပြင် မြင့်မားသောကောင်းကင်တွင်ရှိသောကြောင့်ဖြစ်ပါသည်။ ထို့အပြင်ဤစကားထာတွင် မြင့်မားသောကောင်းကင်ကို "အပင်မြင့်မြင့်"ဟူ၍ ရှည်လျားမြင့်မားသောအပင်နှင့် အနက်တူချင်းတင်စား၍လည်းကောင်း၊ ညမှထွက်ပေါ်တတ်သောကြယ်၏ လင်းလက်တောက်ပမှုကို "ညမှပွင့်"ဟူ၍ ညမှပွင့်သောပန်းနှင့် ဂုဏ်ရည်တူချင်းတင်စား၍လည်းကောင်း ဖွဲ့ဆိုထားသည်။ ထို့သို့လူတို့နှင့်အလှမ်းဝေးကွာပြီး မြင့်မားသော နေရာတွင်ရှိသည့်အပြင် ညမှလင်းလက်တောက်ပတတ်သောကြယ်ကို "အပင်"၊ "မြင့်မြင့်"၊ "ည"၊ "ပွင့်"ဟူသော စကားလုံးတို့၏အနက်နှင့် ဂုဏ်ရည်တို့ကိုဆက်စပ်ကာ စကားထာ ဝှက်ထားခြင်း ဖြစ်ပါသည်။

မေး ⟶ အာကာပြင်မာ၊ ဆန်စိကြဲ။ (ရခိုင်)

အဖြေ ⟶ ကြယ်

ဤ "အာကာပြင်မာ၊ ဆန်စိကြဲ" ဟူသောရခိုင်ပန်းဝှက်သည် ကောင်းကင်ပြင်တွင် ဆန်စေ့များပြန့်ကြဲနေခြင်းကို ဆိုလိုခြင်းဖြစ်ပါသည်။

ဤပန်းဝှက်မှ "အာကာပြင်မာ"ဟူသည် ကောင်းကင်ပြင်မှာကို ဆိုလိုခြင်းဖြစ်ပြီး "ဆန်စိကြဲ"ဟူသည် ဆန်စေ့ကဲ့သို့သောအရာများ ပြန့်ကြဲစွာရှိနေခြင်းကို ဆိုလိုခြင်းဖြစ်ပါသည်။

ဤပန်းဝှက်၏ဆိုလိုရင်းမှာ ကောင်းကင်ပြင်တွင် ဆန်စေ့များပြန့်ကြဲနေသကဲ့သို့ ရှိနေသော အရာကိုအနက်ဖော်ပါဟုဆိုလိုခြင်းဖြစ်ပါသည်။ ဤပန်းဝှက်၏အဖြေမှာ "ကြယ်" ဖြစ်ပါသည်။ အဘယ်ကြောင့်ဆိုသော် ကောင်းကင်ပြင်တွင် ဆန်စေ့ကဲ့သို့သေးငယ်ပြီး အဖြူရောင် ပြန့်ကြဲစွာ ရှိနေသောအရာမှာ ကြယ်ပင်ဖြစ်ပါသည်။ ထို့အပြင်ဤပန်းဝှက်တွင် ကြယ်၏ အရောင်နှင့်ကြယ်၏ ပုံစံကို"ဆန်စိ"ဟူ၍ အဖြူရောင်သေးငယ်သော ဆန်စေ့နှင့်ပုံစံတူ၊ အရောင် တူချင်းတင်စားထားပြီး ကောင်းကင်တွင် ကြယ်များတည်ရှိနေပုံကို "ကြဲ"ဟူ၍ ရှုပ်ထွေးခြင်းမရှိဘဲ ပြန့်ကြဲစွာရှိနေခြင်း ဟူသောအနက်နှင့် အနက်တူချင်းတင်စားထားသည်။ ထိုသို့ကောင်းကင်ပြင်တွင် ဖြူဖွေးသေးငယ်ပြီး ပြန့်ကြဲကာရှိနေသောကြယ်ကို 'အာကာ'၊'ဆန်စိ'၊'ကြဲ' ဟူသော စကားလုံးတို့၏အနက်နှင့် ပုံစံတို့ကို ဆက်စပ်ကာပန်းဝှက် ထားခြင်းဖြစ်ပါသည်။

အထက်တွင်ဖော်ပြခဲ့သော မြန်မာစကားထာနှင့် ရခိုင်ပန်းဝှက်တို့သည် "ကြယ်" ကိုဝှက်ထားသည် ဆိုသော်လည်း စကားအသုံးအနှုန်းနှင့် အမြင်တို့ကွဲပြားသော စကားထာ (ပန်းဝှက်) ဖြစ်ကြောင်း တွေ့ရှိရပါသည်။ အဘယ်ကြောင့်ဆိုသော်မြန်မာစကားထာတွင် ကောင်းကင်ကို တိုက်ရိုက်မဖော်ပြထားဘဲ "အပင်မြင့်မြင့်" ဟူ၍ ရှည်လျားမြင့်မားသော အပင်နှင့်တင်စားကာ ဖော်ပြထားပြီး ကြယ်၏ဂုဏ်ရည်နှင့် ကြယ်ထွက်ပေါ်တတ်သောအချိန်ကို "ညမှပွင့်"ဟူ၍ ညမှပွင့်တတ်သော ပန်းနှင့်တင်စား ထားသည်။ ရခိုင်ပန်းဝှက်တွင်မူ ကောင်းကင် ကို"အာကာ"ဟူ ၍ ပါဠိစကားလုံးအတိုင်း တိုက်ရိုက်သုံးထားပြီး ကြယ်၏အရောင်နှင့် ကြယ်ထွန်းလင်းနေသောပုံစံကို "ဆန်စိကြဲ"ဟူ၍ ဆန်၏အရောင်နှင့် အရောင်တူချင်း၊ ပြန့်ကြဲနေပုံတူချင်းတို့နှင့် တင်စားထားသည်ကိုတွေ့ရပါသည်။ ထိုသို့အသုံးအနှုန်းတို့သာမက အမြင်တို့ပါကွဲပြားမှုရှိသောကြောင့် ဤမြန်မာစကားထာနှင့်ရခိုင်ပန်းဝှက်တို့ကို ကွဲပြားမှုရှိသော စကားထာ(ပန်းဝှက်)ဟု ဆိုလိုရခြင်းဖြစ်ပါသည်။

ခြုံငုံသုံးသပ်ချက်

ဤစာတမ်းသည် မြန်မာစကားထာနှင့် ရခိုင်ပန်းဝှက်များကို နှိုင်းယှဉ်လေ့လာတင်ပြထားသောစာတမ်းဖြစ်ပါသည်။ ထိုသို့လေ့လာသောအခါမြန်မာစကားထာနှင့် ရခိုင်ပန်းဝှက်တို့၏ တူညီသော စကားထာ(ပန်းဝှက်)များအနက်(၄)ခုနှင့် ကွဲပြားသောစကားထာ (ပန်းဝှက်)များအနက်(၃)ခုတို့ကို လေ့လာတင်ပြခဲ့ပါသည်။ မြန်မာနှင့်ရခိုင်တူညီသော စကားထာ(ပန်းဝှက်)များတွင် အများအားဖြင့် စကားလုံးအသုံးအနှုန်းနှင့် အနက်အဓိပ္ပာယ်ကောက် ယူပုံတို့တူညီနေကြောင်း လေ့လာတွေ့ရှိရပါသည်။ ထိုသို့တူညီရခြင်းမှာ မြန်မာနှင့်ရခိုင်တို့သည် ဆင်းသက်လာသော ဘာသာစကားမျိုးရိုး တူညီနေသည့်အပြင် အနီးစပ်ဆုံးဘာသာစကားဖြစ်သောကြောင့်ဟုဆိုနိုင်ပါသည်။ မြန်မာနှင့်ရခိုင် ကွဲပြားသော စကားထာ(ပန်းဝှက်)များတွင် အခေါ်အဝေါ်၊ အတွေးအမြင်၊ အယူအဆ၊ ခံစားပုံနှင့် စကားလုံးအသုံးအနှုန်းတို့ ကွဲပြားကြောင်း တွေ့ရှိရပါသည်။ ထိုသို့ကွဲပြားရခြင်းမှာ ကျင်လည်ရာပတ်ဝန်းကျင်ကိုမူတည်ပြီး စိတ်ကူး

စိတ်သန်းနှင့် အတွေးအခေါ်တို့ ကွဲပြားသွားသောကြောင့် အနက်အဓိပ္ပာယ်ကောက်ယူပုံတို့ပါ ကွဲပြားရခြင်းဖြစ်ကြောင်းလေ့လာသိရှိရပါသည်။

နိဂုံး

မြန်မာစကားထာနှင့်ရခိုင်ပန်းဂုက်များသည် မိမိတို့၏ယဉ်ကျေးမှု၊ရေမြေသဘာဝ၊ ခလေ့စရိုက်နှင့် ပတ်ဝန်းကျင်အပေါ်အခြေခံ၍ ၄င်းတို့၏ဉာဏ်ပညာနှင့်ပေါင်းစပ်ကာ အနက်အဓိပ္ပာယ်ကွယ်ဂုက်၍ ပဟေဠိပြုထားခြင်းဖြစ်ပါသည်။ ထို့အပြင်မြန်မာနှင့်ရခိုင်တို့သည် စကားထာ(ပန်းဂုက်)များကိုအ နက်ဂုက်ရာတွင် သဲလွန်စပေး၍လည်းကောင်း၊ ထင်ယောင်ထင်မှားဖြစ်အောင်လမ်းလွှဲ၍လည်း ကောင်းအဓိပ္ပာယ်ပရိယာယ်များကို စနစ်တကျအသုံးပြုကာဂုက်ထားသည်ကိုတွေ့ရပါသည်။ ဤ စာတမ်းတွင်စကားထာ(ပန်းဂုက်) တစ်ခုချင်းစီ၏အနက်အဓိပ္ပာယ်များကို အကျယ်တဝင့်ဖော်ပြ ထားရုံသာမက စကားထာ(ပန်းဂုက်)တို့၏ အမေးနှင့်အဖြေတို့ဆက်စပ်မှုများကိုပါ လေ့လာဖော်ပြ ထားပါသည်။

ကျေးဇူးတင်လွှာ

ဤစာတမ်းဖြစ်မြောက်ရေးအတွက် ကူညီပေးပါသော တောင်ကုတ်တက္ကသိုလ်၊ ဒုတိယပါမောက္ခချုပ် ဒေါက်တာသန်းထွဋ်လွင်၊ မြန်မာစာဌာနမှ ပါမောက္ခ(ဌာနမှူး) ဒေါက်တာသန်းထိုက်နှင့် တောင်ကုတ်တက္ကသိုလ် သုတေသနဂျာနယ်ဖြစ်မြောက်ရေးအဖွဲ့တို့ကို ကျေးဇူးတင်ရှိပါသည်။

ကျမ်းကိုးစာရင်း

ကြည်ဦး။ (၁၉၉၆)။ ***မြန်မာ့ရိုးရာစကားထာများ***။ စတုတ္ထအကြိမ်။ ရန်ကုန်၊ စန္ဒာဝင်းစာပေ။

ခင်အေး၊ ဒေါက်တာ။ (၂၀၀၄)။ ***အတ္ထပေဒနိဒါန်း***။ ရန်ကုန်၊ ပညာတန်ဆောင် ပုံနှိပ်တိုက်။

ဓမ္မပီယ၊(အသျှင်–)။ (၂၀၁၅)။ ***ရခိုင်ပန်းဂုက်နှင့်သုတရတနာများ***။ ရန်ကုန်၊ ဝေဘူလစာပေ။

ဗသိန်း၊မောင်။ (၂၀၁၇)။ ***ရခိုင်ဘာသာစကားနှင့်အပြောအခြံခံရခိုင်အရိုးအသား*** ။ ရန်ကုန်၊ ဝေဘူလစာပေ။

မြန်မာစာအဖွဲ့။ (၂၀၀၃)။ ***ခရီးဆောင် မြန်မာအဘိဓာန်***။ ရန်ကုန်၊ မြန်မာစာအဖွဲ့ဦးစီးဌာန။

မြန်မာစာအဖွဲ့။(၂၀၁၈)။ ***မြန်မာအဘိဓာန်***။ ဒုတိယအကြိမ်၊ ရန်ကုန်၊ မြန်မာစာအဖွဲ့ဦးစီးဌာန။

မြန်မာ့စွယ်စုံကျမ်း။ အတွဲ(၃)။ (၁၉၅၆)။ ရန်ကုန်၊ မြန်မာနိုင်ငံ ဘာသာပြန်စာပေအသင်း။

ဝါသဝ၊အသျှင်။(၁၉၉၆)။***ရခိုင်ဝေါဟာရအဘိဓာန်ကျမ်း၊အတွဲ–၁*** ။ ရန်ကုန်၊ ရွှက်စိမ်းစာပေ။

အောင်မြင့်ဦး၊ ဒေါက်တာ။ (၂၀၁၈)။ ***သုတေသနဟူသည်***။ ရန်ကုန်၊ ဧရာဝဏ်စာပေတိုက်။

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The Role of Logical Thinking in Philosophic Life

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Abstract

This paper is an attempt to show the importance of logical thinking in daily life (Philosophic life)-why is it important to think logically in everyday life. Logical thinking is important to make the right decisions in solving problems in daily life. Descriptive method and evaluative method will be used in this paper. The contribution of this paper is to become as a good life. By training thanking, that can lead a positive life.

Key Words: Logical Thinking, Right Decision, Good Life

Introduction

Philosophy means "Love of Wisdom" in its broadest terms based on its etymological composition of the Greek terms "Philein" (to love) and "Sophia" (wisdom). In Indian philosophy each philosophical system is called "darshana", Literally "view" that eventually developed into sutras. In the Myanmar, the word Philosophy comes from Pali word "dathana" based on India "darshana". It means "out look" and refers to the various views that have been put forward by wise men in answer to questions about the world and life. In every field of activity, there is a philosophy of it that involves questioning its fundamental concepts, principles and methods.

Philosophy, generally, differs from other disciplines in that it always seeks the final or ultimate reasons of all things and even though it may not succeed it opens up new avenues of thought for other new and progressive ideas. Philosophy studies the "is" in the search to find the "Ought", its ultimate concern is with "what ought to be "rather than" what is". It is therefore a normative study. In this respect philosophy is more of an activity rather than a field of study with a properly demarcated subject matter like history, geography, science. But, this activity consists of asking fundamental questions that are generally classified into four kinds and this has led to a systematic study of philosophy under four main heads (a) Metaphysics (or ontology) (b) Epistemology (c) Axiology (Ethics, Aesthetics) (d) Logic. It should also be noted that logic is sometimes considered as a tool of Philosophy, a tool with which we philosophize rather than a part of philosophy.

Philosophy and Logic

Logic is the branch of philosophy concerned with analyzing the patterns of reasoning by which a conclusion is properly drawn from a set of premises, without reference to meaning or context. It is the science that investigates the principles governing correct or reliable inference.

Human knowledge is obtained from two sources, perception and conception (reasoning). Perceptual knowledge is obtained through our sense-organs-eyes, ears, nose, tongue and body. But, if we had to rely on knowledge obtained through the senses alone it

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would be very limited especially for human beings. But, human beings have the advantage of a mind that can think and reason. Human beings now possess a store of knowledge.

What Logic Is

The word logic comes from the Greek word "logos" which means thought (or) reason. Logic is a study that has something to do with reason or reasoning. Reasoning is a kind of thinking. The word "thought" or "thinking" may refer to any process that takes place in the minds of human beings. Such mental processes are "thought" occurring in the mind. But, such kind of thinking cannot be called "reasoning".

The Nature of Logical Thinking

Logic come from Greek words "Logos" which has a variety of meanings including word, thought, idea, argument, account, reason or principle is the study of reasoning or the study of principles and criteria of valid inference and demonstration it attempts to distinguish good reasoning from bad reasoning.

Aristotle defined logic as "new and necessary reasoning ", "new" because it allows us to learn what we do not know "necessary" because its conclusions are inescapable. It asks questions like "What is correct reasoning?, What distinguishes a good argument from a bad one?, How can we detect a fallacy in reasoning?"

Logic investigates and classifies the structure of statements and arguments both through the study of formal systems of inference and arguments in natural language.

Logical Thinking and Argument

To know some definitions of it technical terms at this point of our study. A premise (or premises) is a statement which is used as a reason for the conclusion. The conclusion is a statement that is derived from the premise or premises.

An argument is a piece of reasoning which is made up of at least one premise and a conclusion.

Example: "X is taller than Z, because he is taller than Y and Y is known to be taller than Z".

This is a piece of reasoning or an argument. It is composed of three statements.

We can express the above in the following;

X is taller than Y.
Y is taller than Z. } premises

Therefore, X is taller than Z. - conclusion

Many of us are familiar with the above type of reason, we keep using such arguments is daily life.

Another way of understanding the process of reasoning is to distinguish knowledge derive through reasoning from sense perception. Such knowledge like "The sun is shining now", it is called perceptual knowledge. It is also "direct knowledge" because it is known directly by the perceiver without the aid of any intermediary conditions. But, reasoned knowledge is different from perceptual knowledge because it is not received "directly". We know that "all jasmine" flowers are white, not because we have perceived each and every single one of them. The word "all jasmines" refer not only to the present jasmines but also to those in the past and future.

Logic and Nature of Validity

A technical word used by logic to denote, "good", "sound", "correct" forms of reasoning. That is "validity" instead of saying, that an argument or inference is good, we say that it is valid. On the other hand, bad, unsound, or incorrect argument is called an invalid.

A valid argument is one in which the truth of the conclusion necessarily follows from the truth of its premises.

Example: X is shorter than Y.

Y is shorter than Z.

Therefore, X is shorter than Z. It is a valid argument.

An invalid argument is the premises do not imply the conclusion.

Example: All Europeans are mortal.

All Myanmar are mortal.

Therefore, All Myanmar are Europeans.

These arguments the conclusions are not fully supported by their respective premises. In other words, the truths or falsities of their conclusions have nothing to do with the truth or falsity of their respective premises.

Since, validity has nothing to do with the actual truth or falsity of the premises and conclusion, we therefore come to know that validity of arguments has nothing to do with their matter or content. It has to do only with the form of inferences.

Deduction can be defined as a process of reasoning in which the conclusion is draw from premises are either less general than premises.

Example: A is son of B.

Therefore, A is younger than B.

Induction is an inference in which the conclusion states more than what is given by the premises.

Example: Some sparrows can fly.

Therefore, all sparrows can fly.

A logical mind can find truth through its own creative reasoning. A person with logical mind would respond to my alternate "It must have rained last night since the side walk is all wet " with " Well, the fact that the side walk is wet could be". A logical mind is a process of creative thinking bounded by valid inference schemes.

There are two ways of developing a logical mind one is to study the broad act lines of the different logical systems that are needed in various types of conclusions in academic inquiry. Deductive logic (classical deduction probabilistic deduction) this is the kind of logic needed for arriving at conclusions based on one or more general statements. Inductive logic (probabilistic induction, defensible induction) this is the kind of logic needed for arriving at generalizations based on a sample.

Speculative –deduction (This is also called explanation based argument, used typically in the defense of scientific theories.

Logic and Life

Logic can helps us in various ways to deal with conflict and decisions in a more reasonable and satisfactory way than would be possible without the understanding and skills provided by such study.

The study of logic and be of relatively direct value is the area of relations between individual persons and between groups of individuals. Two inescapable facts of human existence as we all must live today are-

(1) the reality of conflicts much too often hostile and even violent between individuals and groups of individuals and
(2) the necessity to make difficult judgments and decisions that affect our own lives and well-being as well as the lives and well-beings of others.

When faced with a difficult decision having potentially significant effects, we usually want to make every effort to consider the pros and cons of the various alternatives from which ultimately we must choose.

Logical systems should have three things. They are consistency(which means that none of the theorems of the system contradict one another); soundness (which means that the system's rules of proof will never allow a false inference from a true premise); and completeness (which means that there are no true sentences in the system that cannot, at least in principle, be proved in the system).

Assuming question concerns the practical importance of logic in dealing with all our daily routines and ongoing activities; I would only add that it is actually quite impossible to make any decision with logic. More to the point, it is exceedingly difficult if not impossible to even have an "everyday life" without constantly making decision, from the trivial and mundane to the urgent, critical and cataclysmic and everywhere in between. In both cases, where we're going is the result of most or all of the choices we've make up to that point in time and space, and where we'll end up will be the result of the choices we make from the here.

If we make decisions based on our purposes, plans, and promises, relative to our values, beliefs, knowledge, understanding, and wisdom, however, then we reason about our options and make decisions based on rules or principles inference for weighing, assessing and evaluating options and alternatives and their outcomes. You may adopt a more rigorously analytic approach and actually rely on deduction, induction structured modes of inferences.

Conclusion

Logic is to teach us to avoid mistakes in our own reasoning and to detect errors in the reasoning and thought of other people. The study of logic cultivates the power of abstract thinking, and trains and develops the reasoning powers.

In everyday life, human beings are consciously or unconsciously thinking or reasoning in many ways about what they experience- they reason and think about what they need, what they want or what they must do. You have to study the basic principles of reasoning to provide norms for correct reasoning or in logical terms how to think validity. It is concerned with how we ought to reason if we wish to reason correctly or validity, deductive reasoning is concerned with valid reasoning, that is, how we reason

from what we already know in order to apply and utilize this knowledge correctly to new cases which we later come across in experience.

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Characterization of Natural Dyes from Rind of *Garcinia mangostana* L. (Ming Kwut Thi)

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Abstract

This research paper concerned with characterization, extraction and utilization of natural dyes from the organic material. Rind of mangosteen (*Garcinia mangostana* L.) was selected to extract the dyes because it contains substantial amount of red pigment. Ferric chloride test, dilute HCl test and H_2SO_4 test were performed for the detection of red pigment (anthocyanin). Separation techniques of paper chromatography (PC) and thin layer chromatography (TLC) were also conducted for the estimation of anthocyanin compound. From these analyses, anthocyanin extracted from rind of mangosteen was found to be pelargonidin and apigeninidin. The anthocyanins were extracted from the rind of mangosteen in the optimal environment such as optimal solvent (absolute ethanol and HCL 1.5 %(v/v) ratio), the ratio of raw material and solvent was used at 1:10, the extraction time was 40 mins, extraction temperature was 60 °C. Obtained extracted natural dye was used for colouring of yogurt and bakery.

Keywords: Rind of mangosteen, natural dyes, red pigment, anthocyanin, pelargonidin, apigeninidin

Introduction

Natural source of food additives plays prominent role in improving human health condition. Recently, consumers are more concerned about their health rather than price of products they use, since they are more knowledgeable and aware about the product in today's market.

Unfortunately, there are unlimited number of products, which remarkably affect the human immune system and health. Many examples are used as food additive, only to make the food attractive in order to get higher price in the market. Many business practitioners invest in making synthetic food coloring as a food additive and introducing it to the market to attract consumers.

Traditionally, people use natural food colouring, which had been obtained from nature. In reality, consumer's choice has been increasing in recent years towards using natural food additive.

A natural dye means an extracted coloured component from organic materials such as a plant, animals and minerals. Plant is a major source that can produced natural dye. Natural colorants from plant sources are receiving growing interest from both food manufacturers and consumers in the continuing replacement of synthetic dyes. (Arnell.J. 2011) Mangosteen (*Garcinia mangostana* L.) is a tropical fruit in Clusiaceae. The Mangosteen fruit is dark purple to red-purple fruit. The edible fruit aril is white, soft, and juicy with a sweet, slightly acid taste and a pleasant aroma (Marton.J., 1987).

Many studies have demonstrated that the dark purple pericarp of mangosteen fruit contain a variety of bioactive secondary metabolites such as anthocyanin and xanthone.

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Anthocyanin is natural pigment and used quite safely in food; create more attractive colours for food products. Among the natural food colours, the anthocyanins is the most popular colour (Zerena, A. S., K. and U. Sanker, 2012).

Till now, the rind of mangosteen is thrown away. That is why the research on the anthocyanin extraction from the rind of mangosteen is necessary, it will reduce the waste and rise the value of this fruit.

The purpose of this study is to explore and utilize the fresh rind of mangosteens as an upcoming raw material for the production of natural dye. Only the rind of mangosteen is used to extract natural dye. The discarded rind contains rich anthocyanins that produce the impressive red colour extraction. The red pigment can also be associated with the benefit of reducing health hazards, lowering toxicity levels and avoiding allergic reactions.

Botanical Aspect of Mangosteen

Scientific name	: *Garcinia mangostania* L.
Family	: Clusiaceae
Genus	: *Garcinia*
Species	: *mangostana*
English name	: Mangosteen
Myanmar name	: Ming Kwut Thi

Figu  tee 

Anthocyanidins are the derivatives of 3,5, 7- trihydroxy-flavylium chloride of trihydroxy-benzopyrylium chloride. There are various types of anthocyanins: (a) pelargonidin, (b) Cyanidin, (c) delphinidin, (d) peonidin, (e) malvidin, (f) hirsutidin, etc. These group differ in the number, nature and position of other hydroxyl groups, methoxy groups and sugar residue.

Chemically anthocyanins are glycosides which have been formed by a reaction between a sugar and an anthocyanidin. The most common sugars found in the anthocyanins are glucose, galactose, rhamnose and gentiobiose. Thus sugars-free anthocyanins are called anthocyanidins.

Most of the attractive colours of the flowers, fruits, leaves, fruit juice, etc., are due to the presence of anthocyanin pigment.

Anthocyanins are soluble in water, hence there are found dissolved in the cell sap. Generally, anthocyanins are red in acid pH and blue in alkaline solution. The difference shades of the flower colour depend upon the presence of anthocyanins in different media of the cell sap (acidic, alkaline or neutral). Colour of the foliage from green to red and

purplish red during autumn is due to the formation of anthocyanin (Suitanbawa, M.U.S., 1980).

Materials and Methods

Collection and Preparation of Sample

Mangosteen fruits were purchased from a local market in Taunggoke Township, Rakhine state. Fruits were rinsed with distilled water to remove impurities. The rind was separated from the fruits manually. The rinds were chopped into small pieces and dried. The dried rind was ground into powder.

Determination of Moisture Content of Sample

1 g of chopped sample was weighed and paced in porcelain basin. Then the sample was dried until constant weight was obtained. From the weight loss, moisture content of sample was calculated and the experiments were repeated three times and average content was presented in Table (1). Moisture content of powdered sample was also determined and result was showed in Table (1).

Detection of Anthocyanin

Dried powdered sample (3 g) was extracted in 30 mL of amyl alcohol for three weeks and filtered. Yellow brown colour filtrate was tested for anthocyanin.

Ferric chloride test

3 mL of amyl alcohol extract was placed in a test tube. A little sodium acetate and a small quantity of ferric chloride solution (5 %) were added to the test tube. The solution was turn to green colour.

Dilute HCl test

Dilute HCL (2 %) was added to 3 mL of amyl alcohol extract. A red colour was produced. NaOH (5 %) was added to the resulted solution. The colour change to green. And then the solution was acidified again. Red colour reappears.

H_2SO_4 test

A little dilute sulphuric acid was added to the test solution. The mixture was warm gently, cooled and shaken with amyl alcohol. The anthocyanin separates in the alcohol layer.

Separation of Anthocyanin

Extraction of anthocyanin for separation

Anthocyanin was extracted from 10 g of powder sample with 50 cm^3 of 1 % HCl absolute methanol for a week. Then the mixture was centrifuged. The supernatant was taken in a small beaker and volume was reduced by evaporating on water bath.

Separation of anthocyanin by paper chromatography (PC)

Whatmann No. 1 filter paper was used as chromatographic paper. The line was drawn on the base of the filter paper and anthocyanin extract was spotted on the mark of the paper. The loaded paper was run in beaker containing forestal solvent. Then the beaker was tightly sealed with black plastic. At the end of run (approximately for 10 h), the paper was removed from the beaker and hung to dry. From the colour of the spot and R_f value, type of anthocyanin was determined.

Separation of anthocyanin by thin layer chromatography (TLC)

The line was draw on the base of TLC plate. Anthocyanin extract was applied on the mark point of the TLC plate in the form of spot by using micropipette. Spotted plate was placed in the beaker containing forestal solvent. The beaker was covered with black plastic. After the development is completed (about 5 minutes), the plate was dried quickly with drier (cool air) and the R_f value of colored spot was determined.

Extraction of Anthocyanin from Rind of Mangosteen for Food Grade Application

The anthocyanin was extracted from the 20 g of prepared sample with 200 mL of optimal solvent (absolute ethanol and HCl 1.5 %, v/v ratio). Extraction time was 40 minutes and extraction temperature was 60 ºC. After then the extract and residue was separated by centrifugation. Obtained anthocyanin extract was stored in refrigerator for application.

Figure 2. Extraction of anthocyanin

Results and Discussion

Moisture content in chopped rind and dried powder rind of mangosteen are shown in Table 1. Moisture measurement at the end of drying is essential to followed drying course to achieve or not. Moisture content of rind of mangosteen before drying was found to be 50 %. Moisture content of rind after drying was found to be 30 %. Losses of moisture after drying is 20 %. Moisture content of dried sample is acceptable for further processing.

Table 1. Moisture Contents in Chopped Rind and Dried Powdered Rind of Mangosteen

I = Chopped Rind of Mangosteen, II =Dried powdered Rind of Mangosteen

No.	Sample Weight (g)		Dried (Constant Weight) (g)		Moisture Content (%)		Average Moisture Content (%)	
	(I)	II	(I)	(II)	(I)	(II)	(I)	(II)
1.	1		0.5	0.3	50	30		
2.	1		0.5	0.3	50	30	50	30
3.	1		0.5	0.3	50	30		

Amyl alcohol extract of sample was confirmed for anthocyanin by using Ferric Chloride test, Dilute HCl test and H_2SO_4 test.

In the presence of sodium acetate and a small quantity of ferric chloride (5 %), amyl alcohol extract showed green colour. This observation is due to the presence of pelargonidin.

Amyl alcohol extract with little of dilute HCL solution showed red colour. It is due to oxonium salt of anthocyanin. Therefore, pelargonidin may be present in amyl alcohol extract of the sample. When dilute NaOH was added to the above solution, the colour of solution changes to green. And so, anthocyanin may be present in the solution. When the solution is acidified again with dilute HCL (2 %), red colour of the solution reappears. Therefore, it can be remarked that pelargonidin present in the sample solution.

In H_2SO_4 test, after the warming, cooling and shaken the solution (sulphuric acid and test solution) with amyl alcohol, anthocyanin separates in alcohol layer.

Table 2. Anthocyanin Test Results of Rind of Mangosteen Solvent - Amyl alcohol

No.	Tests	Test Reagent	Observation	Remark
1	Ferric chloride test	Sodium acetate Ferric chloride	Green colour	Pelargonidin
2.	Dilute HCl test	Dilute HCl (2 %)	Red colour	Pelargonidin
		NaOH (5 %)	Green Colour	
		Dilute HCl (2 %)	Red colour	
3.	H_2SO_4 test	H_2SO_4 and amyl alcohol	Separate two layers	Anthocyanin

Figure (3) shows the colour in paper chromatography. Yellow colour was observed in visible light. R_f value was found to be 0.75. Solvent used for separation is forestall. This observation suggested the presence of apigeninidin in the rind of mangosteen. It is common anthocyanin compound belonging to the 3-deoxyanthocyanidins. 3-deoxy-pelargoniden is another name of apigeninidin.

Figure 3. Colour Spot of anthocyanin on chromatographic paper

Figure (4) shows colour spot of anthocyanin on the TLC plate. It was also observed that yellow coloured spot. Calculated amount of R_f value is 0.75. Therefore, it can be also suggested presence of apigeninidin in the extract.

Figure 4. Colour spot of anthocyanin on TLC plate

Figure (5) shows extracted natural dye (anthocyanin) intended as food additive. Used solvent for extraction is ethanol with HCl 1.5 % (v/v ratio), the ratio of rind and solvent is 1:10, the extraction temperature is 60 °C and extraction time is 40 mins. According to reference (Zerena, A. S., K. and U. Sanker, 2012), it is optimal condition of anthocyanin extraction.

Figure 5. Extracted natural dye (Anthocyanin)

Figure (6) and (7) show application of natural dye (anthocyanin) as food dye. Raddish brown colour of food product was obtained

Figure 6. Colour changes of yogurt by using food dye

Figure 7. Colour changes of bakery by using food dye

Conclusion

The present study suggested that natural dyes should be exploited to prevent toxicity among users and pollution of the environment. The rind of mangosteen contains rich anthocyanins that produced the impressive red clour extraction. From the observation of anthocyanin detection, it can be concluded that anthocyanin in the mangosteen rind selected for present work is pelargonidin. From the colour and R_f values of paper and thin layer chromatography, anthocyanin in the present sample is apigeninidin. It has been found biodegradable, nontoxic and generally have higher compatibility with the environment as compared to synthetic dye. According to the literature, the optimal condition of anthocyanin was received when ethanol was used as solvent with 1.5 % HCl, the ratio of solute to solvent was 1:10, the extraction temperature was 60 °C, and extraction time was 40 mins. Anthocyanin extracted from rind of mangosteen can be used for food colouring.

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Effect of Vermicompost and Effective Microorganisms (EM) on Growth and Yield of *Hibiscus sabdariffa* L. (Roselle)

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Abstract

The experiment was conducted in Taunggoke University Campus, Taunggoke Township, Rakhine State by studying the effect of EM and vermicompost on the vegetative growth and yield of *Hibiscus sabdariffa* L. The study involved the use of vermicompost and effective microorganisms (EM). This experiment included 4 treatments with 5 replications was set up in CRD with T_1 (Control), T_2 (EM – 2 ml/2l), T_3 (Vermicompost – 5 t/ac) and T_4 (Vermicompost – 5 t/ac + EM – 2 ml/2l).The soil sample was collected before cultivation. The result of soil analysis showed that the nitrogen content was medium, phosphorous and potassium, low, soil pH, neutral in accordance with the reference value. The germination rate of roselle (*Hibiscus sabdariffa* L.) seeds used in this experiment was 100 %. The vegetative growth of *Hibiscus sabdariffa* L. revealed that maximum leaf width, leaf length, initial and final leaf area were 3.36 cm, 3.84 cm, 14.5 cm^2 and 24.0 cm^2 in the T_3 (Vermicompost– 5 t/ac), respectively. The result of earliest first flowering day and the best yield was T_3 (vermicompost– 5 t/ac). Among them, T_3 (Vermicompost – 5 t/ac) was suitable for roselle (*Hibiscus sabdariffa* L.) growing.

Keywords: vermicompost, EM, CRD

Introduction

Roselle (*Hibiscus sabdariffa* L.) is an herbaceous, dicotyledonous, annual or biennial plant belonging to the family Malvaceae, 82 genera and 1500 species. *Hibiscus sabdariffa* L. commonly known as Roselle is native to India and Malaysia where it is commonly cultivated, and must have been carried at an early date to Africa (Mukhtar, 2008).

It is an erect, mostly branched, annual shrub, stem reddish in colour, with a deep penetrating taproot; Leaves are variously colored, dark green to red, alternate, long-petiolate, palmately divided into 3-7 lobes, with serrate margins; flower is large, short-peduncle, red yellow with dark center; calyx fleshy lobes lanceolate, purple; corolla purple with darker centre. This plant grows mainly in warm humid tropical and subtropical climates (Bahaeldeen *et al*.,2012).

This crop is used in a variety of ways for home consumption, medicinal and industrial uses. The crop is however most suited for tropical climate with high humidity and temperature of about 25°C to 35°C. The plant requires an optimum pH of 6-7 and rainfall of about 450-500mm which should be well distributed over 90-120 days during the growing season. Roselle plant is a short day plant. Roselle tolerates a warm, humid tropical and subtropical climate and is susceptible to frost. It is an annual or biennial plant cultivated for its stem, fiber, edible calyces, leaves and seeds (Haru *et al*., 2011).

Vermicompost is called worm compost, vermicast, worm castings, worm humus or worm manure. The end-product of the breakdown of organic waste by some species of earthworm become a nutrient-rich, natural fertilizer. It is a simple biotechnological process of composting(Gandhi *et al.*, 1997). Vermicompost is used for all crops, agricultural, horticultural, ornamental and vegetables. It is a good water-holding capacity

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and reduces the use of irrigation water. And then, vermicompost is the growth medium as compost which improves the quality of the soil (Zajonc and Sidor, 1990).

Effective microorganisms (EM) are a significant advancement in soil microbial science. It is the development of soil quality and the growth and yield of crops. It improves soil structure, making penetration easier and water holding capacity greater (Higa, 1991).

The aims and objectives of this research were to find out the effect of vermicompost (biofertilizer) and Effective Microorganisms (EM) on *Hibiscus sabdariffa* L., and to improve the uses of organic (biofertilizers) fertilizers.

Materials and Methods

Experimental Site

The experiment was conducted at Taunggoke University Campus, Taunggoke Township, Rakine State.

Analysis of soil sample

Soil sample was collected from the growing area of Taunggoke University Campus before the soil preparation. The collected soil samples were analyzed in the soil laboratory, Land Use Division, Department of Agriculture, Yangon Region.

Soil Preparation

The soil from the growing area was mixed with ash in the ratio of 5:1 and the soil mix was watered and left for a week for thorough homogenization. Then the soil mixture was put into the polypropylene woven bag (30 cm x 30 cm).

Planting material

Roselle seeds which were used by the farmers in this area were used as the planting material for this research. Vermicompost and effective microorganisms (EM) purchased from vegetables, fruits and research and development centre (VFRDC).

Germination Test

Germination test was carried out before sowing seeds in the field. Full cheek seeds without shrinkage were selected for germination test. The selected seeds were germinated in the germinating tray containing sand medium. Four plots were divided in the tray. One plot contained five rows and one row had ten seeds. Therefore, the total numbers of two hundred. After one week, the numbers of germinating seedlings were recorded. The germination rate was calculated following the formula developed by Soupe (2009).

$$\text{Germination rate (\%)} = \frac{\text{Total No. of Germinated Seedlings}}{\text{Total No. of Cultivated Seeds}} \text{ x } 100$$

Planting of *Hibiscus sabdariffa* L. and Experimental Layout

Ten seeds of *Hibiscus sabdariffa* L. were germinated in a polyethylene bag. Two weeks after sowing seeds, different organic fertilizer treatments: T_1 - control (without fertilizer), T_2 (EM – 2 ml/2l), T_3 (Vermicompost – 5 t/ac) and T_4 (Vermicompost – 5 t/ac + EM – 2 ml/2l) were treated to the assigned plantlet. Each treatment had five replicates were laid out in a completely randomized design (CRD). The spacing between bags was 30 cm and between rows was 30 cm. Hence the total experimental area was 89100 cm^2.

Watering was done every day. Spraying of the organic pesticide such as Tamar pesticide was carried out every 2 weeks. Weeding was also carried out whenever it was necessary.

Determination of single Leaf Area

According to the method of Santra *et al*., (1999); the single leaf area was calculated by using graph paper method. The required materials were graph paper and pencil. The leaf blades were placed on a sheet of graph paper. The outline of the leaf blades was traced with a pencil and the area of leaf was counted from the graph paper (Figure 1).

Figure (1). Measuring and calculating the single leaf area

Data Collection

The chemical analysis of soil, germination rate, vegetative growth such as plant height, petiole length, and number of leaves per plant, leaf width, leaf length and single leaf area, reproductive growth like first flowering days, pods weight per plant, pods yield per treatment and pod yield were recorded. The collected data were analyzed using IRRISTAT software (6.0). Least significant differences (LSD) at 5% level of significant was used to compare mean differences.

Results

Analysis of soil

Physico-chemical analysis of the soil revealed that soil was neutral with pH of 6.99. Available nitrogen was 88, medium. It had available phosphorus of 9, low, available potassium, 90, low, and organic matter, 1.92 %, low (Table 1).

Germination test

Among 50 seeds in each plot, plot 1, 2, 3 and 4 had 50 germinated plants (100% of germination), respectively. Therefore average germination rate is 100 % (Table 2).

Table (1). Analyzed results of the experimental soil

Parameters	**Composition**	
pH	6.99	Neutral
Available N (mg/kg)	88	Medium
Available P (mg/kg)	9	Low
Available K (mg/kg)	90	Low
Organic matter (%)	1.92	Low

Table (2). Germination rate of *Hibiscus sabdariffa* L.

Plot	No. of sown seeds	Germinated plants	Germination %
1	50	50	100.00
2	50	50	100.00
3	50	50	100.00
4	50	50	100.00
Total	200	200	100.00

Plant height

The result of the plant height response to different organic fertilizer treatments showed that T_4 (Vermicompost+ EM) had the longest height 35.41 cm followed by T_3 (Vermicompost) 24.60 cm, T_2 (EM) had 21.72 cm and T_1 (Control) 20.59 cm respectively. The growth in plant height has increased weekly (Table 3 and Figure 2).

Table (3).Effect of vermicompost and effective microorganisms (EM) on plant height of *Hibiscus sabdariffa* L.

Treatments	Plant height (cm)								
	14 DAS	21 DAS	28 DAS	35 DAS	42 DAS	49 DAS	56 DAS	63 DAS	Mean
T_1 (Control)	8.64	11.99	14.70	17.42	23.60	27.40	29.63	31.32	20.59
T_2 (EM)	9.18	12.44	15.64	18.22	22.24	24.62	32.26	39.14	21.72
T_3 (Vermicompost)	9.70	11.92	15.42	18.16	24.86	29.72	38.48	48.52	24.60
T_4 (Vermicompost +EM)	9.34	11.75	20.42	27.52	36.28	45.42	60.58	71.94	35.41
F-Test	3.77	2.77	3.70	3.94	4.94	4.51	5.79	7.32	-
CV %	ns	ns	*	**	**	**	**	**	-
5 % LSD	29.70	16.70	16.20	14.20	13.50	10.30	10.40	11.10	-

CV% = coefficient variation (%), LSD = least significant difference,
DAS = days after sowing

Petiole length

The results of petiole length response to different composts treatments revealed that T_1 (Control) and T_2 (EM) had the longest length 2.25 cm followed by T_4 (Vermicompost +EM) 2.11 cm and T_3 (Vermicompost) 2.05 cm had 19.07 cm respectively. The growth in petiole length has increased weekly (Table 4 and Figure 2).

Table 4. Effect of vermicompost and effective microorganisms (EM) on petiole length of *Hibiscus sabdariffa* L.

Treatments	Petiole length (cm)								
	14 DAS	21 DAS	28 DAS	35 DAS	42 DAS	49 DAS	56 DAS	63 DAS	Mean
T_1 (Control)	0.9	1.1	1.3	1.9	2.6	2.9	3.4	3.8	2.25
T_2 (EM)	0.9	1.1	1.3	1.9	2.5	2.9	3.5	3.9	2.25
T_3 (Vermicompost)	0.9	1.0	1.2	1.9	2.3	2.5	3.0	3.6	2.05
T_4 (Vermicompost +EM)	0.9	1.1	1.2	1.8	2.4	2.6	3.3	3.6	2.11
F-Test	ns	ns	ns	ns	ns	*	*	ns	-
CV %	15.7	13.4	17.4	25.0	27.2	18.8	14.3	10.9	-
5 % LSD	0.20	0.21	0.32	0.69	0.97	0.76	0.60	0.50	

Number of leaves per plant

The results of number of leaves per plant response to different organic compost treatments showed that T_2 (EM) had the much leaves number 8.65. The second highest leaf

number was observed 8.16 in T_4 (Vermicompost +EM), the third highest leaf number T_1 (Control), 8.10 and the least number was 7.88, T_3 (Vermicompost). The growth in number of leaves has increased weekly (Table 5).

Table (5). Effect of vermicompost and effective microorganisms (EM) on number of leaves per plant of *Hibiscus sabdariffa* L.

Treatments	Number of leaves per plant								
	14 DAS	21 DAS	28 DAS	35 DAS	42 DAS	49 DAS	56 DAS	63 DAS	Mean
T_1 (Control)	4.0	5.6	5.4	7.2	8.4	10.0	11.0	13.2	8.10
T_2 (EM)	4.0	5.2	5.2	6.6	9.0	10.8	11.8	16.6	8.65
T_3 (Vermicompost)	4.0	5.0	5.2	7.0	8.0	9.8	12.4	11.6	7.88
T_4 (Vermicompost +EM)	4.0	5.1	5.3	6.8	8.1	9.9	11.6	14.5	8.16
F-Test	ns	ns	ns	ns	ns	ns	*	*	-
CV %	0.0	6.9	9.2	19.4	24.4	18.5	25.0	9.9	-
5 % LSD	0.0	0.53	0.70	1.96	3.01	2.75	4.28	1.98	

Leaf width

The mean value of leaf width among the different organic compost treatments gave that T_3 (Vermicompost) was highest leaf width 3.36 cm. It was followed by T_4 (Vermicompost +EM) 3.30 cm and T_2 (EM) 3.25 cm. T_1 (Control) had least leaf width of 3.06 cm respectively. The growth in leaf width has increased weekly (Table 6 and Figure 2).

Table (6). Effect of vermicompost and effective microorganisms (EM) on leaf width of *Hibiscus sabdariffa* L.

Treatments	Leaf width (cm)								
	14 DAS	21 DAS	28 DAS	35 DAS	42 DAS	49 DAS	56 DAS	63 DAS	Mean
T_1 (Control)	2.0	2.2	2.4	2.7	3.1	3.4	4.2	4.5	3.06
T_2 (EM)	2.1	2.3	2.5	2.8	3.6	3.8	4.0	4.9	3.25
T_3 (Vermicompost)	2.1	2.4	2.5	2.9	3.5	4.2	4.4	4.9	3.36
T_4 (Vermicompost +EM)	2.2	2.4	2.6	3.1	3.4	3.7	4.1	4.9	3.30
F-Test	ns	ns	ns	ns	ns	*	ns	*	-
CV %	21.0	13.7	15.2	15.4	14.8	11.8	8.8	7.9	-
5 % LSD	0.65	0.47	0.55	0.65	0.72	0.65	0.54	0.55	

Leaf length

The result of the mean leaf length among the different organic compost treatments showed that T_3 (Vermicompost) had highest leaf length 5.13 cm. It was followed by T_4 (Vermicompost +EM) 3.79 cm, T_2 (EM) 3.73 cm and T_1 (Control) had least leaf length of 3.64 cm respectively. The growth in leaf length has increased weekly (Table 7 and Figure 2).

Table (7). Effect of vermicompost and effective microorganisms (EM) on leaf length of *Hibiscus sabdariffa* L.

Treatments	Petiole length (cm)								
	14 DAS	21 DAS	28 DAS	35 DAS	42 DAS	49 DAS	56 DAS	63 DAS	Mean
T_1 (Control)	2.4	2.7	2.9	2.9	3.7	4.1	5.0	5.4	3.64
T_2 (EM)	2.3	2.5	2.7	3.5	3.8	4.3	5.0	5.7	3.73
T_3 (Vermicompost)	2.2	2.4	2.6	3.3	4.0	4.6	5.5	6.1	3.84
T_4 (Vermicompost +EM)	2.3	2.6	2.8	3.5	3.9	4.2	5.2	5.8	3.79
F-Test	*	*	*	*	ns	ns	*	*	-
CV %	7.7	7.8	11.2	18.3	21.5	14.9	10.0	10.7	-
5 % LSD	0.26	0.29	0.45	0.87	1.21	0.94	0.76	0.89	

Single leaf area

The biggest initial and final single leaf area were 14.5 cm^2 and 24.0 cm^2 in T_3 (Vermicompost), followed by T_4 (Vermicompost +EM) had 13.3 cm^2 and 23.0 cm^2 and then T_2 (EM) had 8.4 cm^2 and 18.6 cm^2, T_1 (Control) had 9.7 cm^2 and 17.5 cm^2 respectively (Table 8).

Table (8). Effect of vermicompost and effective microorganisms (EM) on single leaf area of *Hibiscus sabdariffa* L.

Treatments	Single leaf area (cm^2)	
	Initial	Final
T_1 (Control)	9.7	17.5
T_2 (EM)	8.4	18.6
T_3 (Vermicompost)	14.5	24.0
T_4 (Vermicompost +EM)	13.3	23.0
F-Test	ns	**
5% LSD	35.6	6.1
CV %	5.63	1.78

Plant height Petiole length Leaf width Leaf length

Figure (2). Vegetative Growth of *Hibiscus sabdariffa* L.

Reproductive Growth

First flowering days

The mean number of the earliest first flowering days is 78.20 days in T_3 (Vermicompost) followed by 79.00 days T_1 (Control) and T_4 (Vermicompost +EM) and 81.20 days in T_2 (EM) respectively. According to the statistical analysis, first flowering days was not significant (Table 9 and Figure 3).

Table (9). Effect of vermicompost and effective microorganisms (EM) on first flowering days of *Hibiscus sabdariffa* L.

Treatments	First Flowering Days
T_1 (Control)	79.00
T_2 (EM)	81.20
T_3 (Vermicompost)	78.20
T_4 (Vermicompost +EM)	79.00
F- Test	ns
5% LSD	3.30
CV %	3.83

Pods Weight per plant and Pod yield per treatment

The pods weight per plant of *Hibiscus sabdariffa* L. had the highest 30.18 g T_3 (Vermicompost) followed by 17.55 g T_4 (Vermicompost +EM), 16.41 g T_2 (EM) and 15.06 g T_1 (Control) respectively (Table 10 and Figure 3).

T_3 (Vermicompost) had highest pod yield per treatment 2414.4 g. T_4 (Vermicompost +EM), second highest yield 1404 g. It had the third highest yield T_2 (EM) 1312.8 g and the least yield by T_1 (Control) 1204.8 g (Table 10).

Table (10). Effect of vermicompost and EM on pods weight per plant and Pod yield per treatment of *Hibiscus sabdariffa* L.

Treatments	pods weight per plant (g)	Pod yield per treatment (g)
T_1 (Control)	15.06	1204.8
T_2 (EM)	16.41	1312.8
T_3 (Vermicompost)	30.18	2414.4
T_4 (Vermicompost +EM)	17.55	1404

Pod yield

T_3 (Vermicompost) had highest pod yield 1168.57 t/ac. T_3 (30g compost plant^{-1}) had second highest yield 679.54 t/ac. It had the third yield 635.40 t/ac in T_2 (EM) and the least yield 583.12 t/ac in T_1 (control) respectively. (Table 11).

Table (11). Effect of vermicompost and effective microorganisms (EM) on pod yield of *Hibiscus sabdariffa* L.

Treatment	Pod yield (t/ac)
T_1 (Control)	583.12
T_2 (EM)	635,40
T_3 (Vermicompost)	1168.57
T_4 (Vermicompost +EM)	679.54

Hibiscus sabdariffa L. with flower

Measuring the pods weight per plant

Figure (3). Reproductive growth of *Hibiscus sabdariffa* L.

Discussion and Conclusion

The experiments were carried out with vermicompost and effective microorganisms (EM) for growing of *Hibiscus sabdariffa* L. Before cropping plant, chemical properties of soil analysis showed that nitrogen content of soil was medium, phosphorus, potassium and organic matter, low and pH, neutral according to references value. The vermicompost used in this experiment was obtained from VFRDC (Vegetables and Fruits Research and Development Center). The analyzed contents of applied vermicompost in this experiment were the pH of 6.8, N_2 1.02%, P_2O_5 280.85 ppm, K_2O 240.00 mg/100 g.

The highest vegetative growth such as leaf width, leaf length and leaf area were T_3 (Vermicompost). Moreover the greatest pod weight per plant, pod yield per treatment and pod yield were observed in T_3 (Vermicompost). The positive relationship between leaf area and yield was investigated in this research paper. Thorne and Evans (1964) reported that the greatest potential for yield was achieved by the high density of leaves area per unit land area.

Vermicomposts, whether used as soil additives or as components of horticultural media enhanced rates of seedling growth and development (Atiyeh *et al*., 2000). The worm castings contain higher percentage of both macro and micronutrients than the garden compost (Crescent, 2003).

In this paper, second highest yield was investigated in T_4 (Vermicompost+EM). A significant increase in shoot biomass, number of pods and grain yield was recorded due to EM application in farmyard manure as well as in soil amended with the recommended dose of NPK fertilizers (Javaid and Bajwar, 2011).

The third greatest yield was in T_2 (EM). EM application exhibited variable effects on plant vegetative and reproductive growth in different soil amendment systems. EM cultures to the soil/plant ecosystem can improve soil quality, soil health, and the growth, yield, and quality of crops (Higa, 1991). T_1 (Control) was the least yield because plants with less nutrients were not grown as well.

It can be concluded that *Hibiscus sabdariffa* L. was observed the best yield in T_3 (Vermicompost). So, vermicompost was the suitable for growing of *Hibiscus sabdariffa* L. The advantages of bio-fertilizers (vermicomposting) to reduce nitrogen can stabilize production and increase production, increase farmers' income and reduce the cost of procurement. The utilization of synthesis (chemical) fertilizers was the pollution load on environments. According to these results, the application of vermicompost results in several benefits to farmers, industries, environment and overall national economy.

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ရွှေတောင်နန္ဒသူ၏ ငွေတောင်ရကန်လာ စာဆို့စွမ်းရည် လေ့လာချက်

လွင်လွင်လှိုင် Ä

စာတမ်းအကျဉ်း

ဤစာတမ်းသည် စာဆိုရွှေတောင်နန္ဒသူ၏ ငွေတောင်ရကန် (၁၁၃၈)မှ စာဆို၏ အရေးအဖွဲ့စွမ်းရည်ကို လေ့လာတင်ပြထားသော စာတမ်းဖြစ်ပါသည်။ စာဆို၏ အရေးအဖွဲ့စွမ်းရည်ကို လေ့လာရာတွင် အခြားရကန်များဖြစ်သော စာဆိုဦးယန်၏ တေမိရကန် (၁၁၄၂)၊ စာဆိုဦးတိုး၏ ရာမရကန် (၁၁၄၃) တို့မှ အရေးအဖွဲ့ အချို့နှင့် နှိုင်းယှဉ်ပြထားပါသည်။ ထို့အပြင် ငွေတောင်ရကန်အတွင်းမှ ဥပမာပေးအဖွဲ့များ၊ လူ့သဘာဝအဖွဲ့များ၊ အလှဘွဲ့များ၊ ဟာသရသအဖွဲ့ကောင်းများကို ထုတ်ယူတင်ပြပြီး နောက်နှောင်းရကန်စာဆိုတို့ နည်းယူရသော ရကန်စာဆို တစ်ဦးဖြစ်ကြောင်း သိရှိစေရန် ရည်ရွယ်ပါသည်။

သော့ချက်ဝေါဟာရများ – အခွိုင်းအနှိုင်း၊ လူ့သဘာဝ၊ အလှ၊ ဟာသ။

နိဒါန်း

ရကန်သည် ကုန်းဘောင်ခေတ်တွင်ပေါ်ထွန်းလာသော ကဗျာပုံသဏ္ဌာန်တစ်မျိုးအဖြစ် အများနှစ်သက် သဘောကျမှုကို ခံယူရသော ကဗျာဖြစ်သည်။ ရကန်သည် သဘော၊ သဘာဝအားဖြင့် သူတစ်ပါးအား မိမိလောက်မတတ်၊ မိမိလောက် မလိမ္မာဟု ချိုးဖဲ့ရေးသား သော စာမျိုးဖြစ်သည်။ အကြောင်းအရာ အနက်အဓိပ္ပာယ်အားဖြင့်လည်းကောင်း၊ အရေးအသား အဖွဲ့အစပ်အားဖြင့်လည်းကောင်း တစ်ဖက်သား မခံချင်အောင် ရန်ထောင်ရန်ပျိုးသော စာပေဖြစ် သည်။ ထိုအကြောင်းအရာကိုပင် ဖတ်ရှုကြားနာသူတို့ စိတ်ဝင်စားဖွယ်၊ နှစ်သက်ဖွယ်ဖြစ်စေရန် သရော်ဟန်၊ ထေ့ဟန်ဖြင့် ရွှင်ရွှင်မြူးမြူး ဟာသရသမြောက် အောင် ရေးဖွဲ့ထားသော စာပေဖြစ်သည်။ ရွှေတောင်နန္ဒသူ၏ ငွေတောင်ရကန်မတိုင်မီက ရေးဖွဲ့ခဲ့သော ရကန်များရှိခဲ့ သည်ဟုဆိုသော်လည်း ရှာဖွေမတွေ့ရသောကြောင့် ငွေတောင်ရကန်သာလျှင် တွေ့ရှိသမျှ ရကန် တို့တွင် အစောဆုံးဟု ပညာရှင်တို့က သတ်မှတ်ခဲ့ကြသည်။ ငွေတောင်ရကန်မတိုင်မီက ရေးဖွဲ့ ခဲ့သော ရကန်တို့သည် အဖွဲ့အနွဲ့ပုံသဏ္ဌာန် မည်သို့ရှိခဲ့ကြောင်း မသိရသော်လည်း ငွေတောင် ရကန်မှစ၍ ရကန်ဟူသော အမည်နာမနှင့်အညီ မိမိရကန်နှင့် မိမိကိုယ်ကို ချီးမွမ်းခြင်း၊ ကိုယ်ရည်သွေးခြင်းများပြုလုပ်ပြီး အခြားသော ခေတ်ပြိုင်ရကန်များနှင့် ရကန်စာဆိုများကို ကန်ကျောက်နှိမ်နင်းခဲ့ကြသည်။ ငွေတောင်ရကန်တွင် ရကန်၏သဘောသဘာဝကို အခိုင်း အနှိုင်း ဥပမာပေးအဖွဲ့များဖြင့် သရုပ်ဖော်ရင်း ဇာတ်ဆောင်ဖြစ်သော ကိန္နရီမလေးများ၏အလှကို ထင်ထင်ရှားရှားဖော်ပြခဲ့သည်။ ထို့ပြင်ဇာတ်လမ်းပါ လူ့သဘာဝအဖွဲ့များကိုလည်း ဟာသရသ မြောက်အောင် ရေးဖွဲ့ထားသောကြောင့် ဤ ရကန်ကို လေ့လာတင်ပြရခြင်းဖြစ်ပါသည်။

Äကထိက၊ မြန်မာစာဌာန၊ တောင်ကုတ်တက္ကသိုလ်

ရကန်ဟူသည်

ရကန်ဟူသည် ကဗျာတည်းဟူသောပင်မကြီးမှ ဖြာထွက်လာသော အကိုင်းအခက်တစ်ခုဖြစ်သည့် သီချင်းကဗျာအမျိုးအစားတွင် ပါဝင်ပါသည်။ ရကန်ဟူသော ဝေါဟာရ၏ အဓိပ္ပာယ်ကို မြန်မာစာပေသမိုင်းတွင် **"စာအဖွဲ့အစွဲ၊ ဝါကျပဒကာရုန်၊ အခံအုပ်အချိတ်အဆက်တို့ဖြင့် ကန်၍ဖွဲ့ခြင်းကြောင့် ရကန်ဟုခေါ်သည်"** (စာ–၁၉၄) ဟုရေးသား ဖော်ပြထားပါသည်။ မောင်ခင်မောင် (ဓနုဖြူ)၏ မြန်မာ စာပေခရီးတွင် **"ရိုဂံ"** ဟူသော သက္ကတစကားမှ ဆင်းသက်၍ **"လွန်စွာရယ်ရွှင်ခြင်း"** ဟု အဓိပ္ပာယ် ရကြောင်း (စာ–၁၁၉) ဖော်ပြထားသည်။ ထို့ပြင် မြန်မာစာအဖွဲ့က ပြုစုသော မြန်မာအဘိဓာန်တွင် လည်း **"ကာရန်ကို ကန်၍ စာဆိုပြိုင်ဘက်ကို နှိမ်နင်း ကန်ကျောက်စပ်ဆိုလေ့ရှိသော ကဗျာတစ်မျိုး"** (စာ–၃၀၂) ဟု အနက်ဖွင့်ထားပါသည်။

ငွေတောင်ရကန်

မူရင်းဇာတ်မှာ ဇင်းမယ်ပဏ္ဏာသလာ သုဓန–ဒွေးမယ်နော်ဇာတ် ဖြစ်ပါသည်။ ဥတ္တရပဉ္စလပြည်ရှိ အာဒိစ္စဝံသ မင်းကြီးနှင့် စန္ဒဒေဝီမိဖုရားတို့မှ ဖွားမြင်သော ဘုရားလောင်းမင်းသားကား သုဓန အမည်ရှိ၏။တစ်နေ့သ၌ ဒုမကိန္နရာမင်းကြီး၏ သမီးတော် ခုနစ်ဖော်တို့ ကေလာသတောင်ထွတ်ရှိ လေးထောင့်ကန် ကြီးသို့ ရေချိုးဆင်းလာသည်ကို မုဆိုးတွေ့ပြီး နဂါးပတ်ကျောက်ကွင်းဖြင့်ဖမ်းရာ ဒွေးမယ်နော်မင်းသမီးအားဖမ်းမိခဲ့၏။ ထို့နောက် သုဓနမင်းသားအား ဆက်သရာ နှစ်သက်သဖြင့် အတူပေါင်းဖက်နေထိုင်ခဲ့ကြ၏။တစ်နေ့သုဓနမင်းသား စစ်ထွက်သွားစဉ် ဖခင်အာဒိစ္စဝံသမင်းကြီး အိမ်မက်သည်ကို အကြောင်းပြု၍ အကောက်ကြံသော ပုရောဟိတ်အမတ်သည် ဒွေးမယ်နော်အား ယဇ်ပူဇော်ရန် စီမံသဖြင့် ဒွေးမယ်နော်မှာ ငွေတောင်ပြည်သို့ ပြန်ပြေးခဲ့သည်။ သုဓနမင်းသား စစ်ချီရာမှပြန်ရောက်၍ အကြောင်းစုံသိမြင်ပြီး ဒွေးမယ်နော်စံရာ ငွေတောင်ပြည် သို့လိုက်သွားကာ ယောက်ခမတော်မင်းကြီး၏ စွမ်းရည်စမ်းသပ်မှုကို အောင်မြင်ပြီးပြန်လည်ပေါင်း ဖက်ရသော ဇာတ်လမ်းဖြစ်ပါသည်။

ငွေတောင်ရကန်မှာမူဇာတ်လမ်းစဆုံးမယူဘဲသုဓနမင်းသားဒွေးမယ်နော်စံရာငွေတောင်ပြည် သို့ ရောက်ခန်းမှစ၍ အဆုံးထိ ရေးဖွဲ့ထားကြောင်း တွေ့ရပါသည်။

ငွေတောင်ရကန်မှ စာဆို့စွမ်းရည်

ငွေတောင်ရကန်စာဆို ရွှေတောင်နန္ဒသူကား ဆင်ဖြူရှင်မင်းတရားကြီး၊ စဉ့်ကူးမင်းနှင့် ဘိုးတော်ဘုရား လက်ထက်တို့တွင် စာဆိုတော်အဖြစ် ထင်ရှားသူဖြစ်သည်။ ဆင်ဖြူရှင်လက်ထက် စလင်းမြို့တွင် အမှု များလျှောက်လဲရာ၌ နာမည်ကျော်စောသောကြောင့် ဘုရင်မင်းမြတ်က အမိန့်တော်ခန့်ပြီး လွှတ်တော် တွင်လျှောက်လဲစေခဲ့သည်။ စဉ့်ကူးမင်းလက်ထက်တွင် ဦးစွာ ဆင်ချေးတိုက်ဝန်ခန့်သည်။ထို့နောက်များမကြာမီအနောက်ဝန်ထောက်ခန့်သည်။ရွှေတောင်နန္ဒသူ ဟူသောဘွဲ့ကို မည်သည့်မင်းလက်ထက်တွင်ရသည်ကို အတိအကျမသိရသော်လည်း စဉ့်ကူးမင်း လက်ထက်၌ပင်ရဟန်တူသည် (စာ–၁၆၄)ဟု စာဆိုတော်များ အတ္ထုပ္ပတ္တိတွင် ဖော်ပြထားပါသည်။

ရွှေတောင်နန္ဒသူသည်ရကန်လောကၦ်**"ဆရာတစ်ဆူ"** အဖြစ်ထင်ရှား ထိုက်သူဖြစ်ပေသည်။ ပထမတန်းစား ရကန်ဟူ၍ ထင်ရှားသော ဦးတိုး၏ ရာမရကန်သည်ပင် ရွှေတောင်နန္ဒသူ၏ အရေးအဖွဲ့အချို့ကို နည်းယူရေးစပ်ထားကြောင်း တွေ့ရှိရပါသည်။ ဦးတိုးကိုယ်တိုင်ကပင် ရာမရကန်အခန်း (၂၁) ဒဿဂီရိနှင့် ဂန္ဓိအချီအချပြောခန်းတွင် –

"ဝါးတစ်လုံးကိုသုံးပေသည့်ပညာ တို့ဆရာမှာလည်း"(စာ–၂၂)

အစချီသည့် အုန်းသီးတစ်လုံးအဖွဲ့တွင် ဝါးတစ်လုံးအဖွဲ့ကိုရေးသည့် ပုဂ္ဂိုလ်သည် မိမိဆရာဖြစ်ကြောင်း ဝန်ခံထားသည်။ ထို ပုဂ္ဂိုလ်ကား အခြားမဟုတ်၊ ငွေတောင်ရကန်ဆရာရွှေတောင်နန္ဒသူပင်ဖြစ်သည်။ ဦးတိုးသာမက တေမိရကန် စာဆို ဖြစ်သော ဦးယန်ကလည်း –

"ဉာဏ်ပဒေသာ၊ စကားယဉ်ရှာလွန်းလို့၊ နားယဉ်သူနာစရာ ဆရာကြီးနည်းလေ" (စာ–၂၀)

ဟူ၍ ရေးဖွဲ့ခဲ့သည်။ တစ်ဖန် ငွေတောင်ရကန်မှ အရေးအဖွဲ့အချို့ကိုလည်း သူ၏တေမိရကန်၌ နည်းယူ ရေးဖွဲ့ထားသည်ကိုလည်း တွေ့ရပါသည်။ သာဓကအားဖြင့် –

– **နားမျက်ချစ်ဆေး** (ငွေတောင်ရကန်၊ ပိဒ်ရေ ၂)၊ **သျှိုမျက်ချစ်ဆေး**(တေမိရကန်၊ နိဂုံးခန်း)

– **ငွေဥနှင့်စီရရီ** (ငွေတောင်ရကန်၊ ပိဒ်ရေ ၂) ၊ **ငွေဥလိုစီရရီ** (တေမိရကန်၊ သတ္တမခန်း)

– **စကားချွေကြီးပင်လယ်ဝေ** (ငွေတောင်ရကန်၊ပိဒ်ရေ ၃)၊**စကားချွေကြီးနာစရာ**(တေမိရကန်၊တတိယခန်း)

ဟူ၍မြင်တွေ့ရပါသည်။ ထိုအချက်များကြောင့် ရွှေတောင်နန္ဒသူ အား ရကန်လောကၦ် ဆရာကြီးအဖြစ် ယူဆထိုက်ပေသည်။

ဥပမာပေးစွမ်းရည်

ငွေတောင်ရကန်မှစာဆို၏ ဥပမာပေးအဖွဲ့များသည် ရကန်စာပေ၏ အင်္ဂါရုပ်ဖြစ်သော ကိုယ်ရည်သွေးအဖွဲ့၊ အကန်အကျောက်အဖွဲ့များကိုပိုမို၍ အားကောင်းစေသော အခိုင်းအနှိုင်းများ ဖြစ်ကြောင်း တွေ့ မြင်ရပါသည်။

ရှေးဦးစွာ ရွှေတောင်နန္ဒသူက သူ၏စာသည် ပညာမရှိသူနားတိမ်သူများအတွက်မဟုတ်၊ ထိုသို့ သောသူများနှင့်သင့်လျော်မည် မဟုတ်ကြောင်း –

"နားတပိသာကို စာအခွက်တစ်ဆယ် နားကငယ်သောအခါ
ပင်လယ်နှင့်ပျဉ်းကော သဘော်နှင့်လှော်တက်၊ ဂုဏ်မဖက်သည့်နယ်
စာနက်နှင့်နားတိမ်ကို အလိမ်မသင့် ကျေးဇူးဖင့်၍ အခွင့်မတော်ဘူးတည့်" (စာ–၂၆)

ဟူ၍ သူ၏စာကို နက်နဲသောစာ (စာနက်) ဟူ၍တင်စားပြီး သူတစ်ပါး၏ နားကိုနားတိမ်ဟူ၍ ထိထိ မိမိ ကိုယ်ရည်သွေး ကန်ကျောက်ခဲ့သည်။ ထို့ပြင် –

"ဂဠုန်လို့စကား ရိတ်သံပင်ကြားသော် နဂါးနှစ်လုံး ဦးခြားနုံး၍
ဘရုန်းဘရင်း ဓားနှင့်မြှောင်းသည့်နယ် သတင်းနှင့် သေငယ်သေလိမ့်" (စာ–၂၁)

ဟူ၍ သူ၏ရကန်ကို ဂဠုန်၊ သူတစ်ပါး၏ ရကန်ကို နဂါးဖြင့်လည်းကောင်း ခိုင်းနှိုင်းကာ သူနှင့်သူ၏ ရကန်ကို ကြောက်ရွံ့လေးစားကြရကြောင်း မိမိကိုယ်ကို ကိုယ်ရည်သွေးရင်း သူတစ်ပါးကိုတစ်ပြိုင်နက် ကန်ကျောက်နိုင်ခဲ့သည်။

ထိုမျှသာမကသေး

"ပိုင်းညက်နှင့်ဝါပေါက် ယောက်သွားနှင့်ပုလဲ ကတဲနှင့်ဂေါမိတ် ပိတ်ကောင်း နှင့် ကပ်ဖျင် ဆင်ရွေးနှင့်သန္တာ ဥပမာကဲ့သို့ ပါရမီမစုံ နားနှင့်ကြဲလျှင် ဂုဏ်တူယောင် ယောင်" (စာ–၂၄)

ဟူ၍ မိမိဂုဏ်အရည်အသွေးနှင့် အခြားစာဆိုတို့၏ ဂုဏ်အရည်အသွေးကို ထင်ရှားအောင် ဥပမာများဖြင့် အစုံလိုက်၊ အတွဲလိုက်ရေးဖွဲ့ထားသည်ကို တွေ့ရပါသည်။ ဤသို့သော အရေး အဖွဲ့မျိုးကို ဦးတိုးက ရာမရကန် (၁)ဘုရားရှိခိုးခန်းတွင် –

"ဘော်ငွေနှင့် ခဲမဖြူ၊ ဒါရှုနှင့်ကညင်ဆီ၊ ကြေးနီနှင့် မိုးကြိုး၊ ကတိုးနှင့် ကြောင်သို၊ ရှိန်းခိုနှင့်အုတ်ရှစ်၊ မြစစ်နှင့် ဖန်စိမ်း၊ တိမ်းညက်နှင့် ပိန္နဲ၊ ကတဲနှင့်ဂေါမူယာ၊ ခတ်ပြာနှင့် ရွှေဝါ၊ ဒုတ္တာနှင့်နီလာ၊ မဟူရာနှင့် မီးသွေး၊ ဆင်ရွေးနှင့် ပတ္တမြား၊ ယောက်သွားနှင့် ခရုသင်း၊ ပယင်းနှင့် ပွဲ့ယက်၊ တွင်းထွက်နှင့် မန္နာလီ၊ သီရိမြင်သူ၊ သွင်းတူရိုးခိုး၊ ဂုဏ်ဆိုးဂုဏ်ကောင်း၊ မပေါင်းသာ မယှဉ်သာ၊ အဘိုးထားကွာကြ သည်" (စာ–၅)

ဟူ၍ နည်းယူကာ ဖွဲ့ခဲ့သည်။ ရွှေတောင်နန္ဒသူထက်ပို၍ ဝေဝေဆာဆာ သာလွန်အောင်ရေးဖွဲ့နိုင် ကြောင်း တွေ့မြင်ရသည်။ ရွှေတောင်နန္ဒသူသည် ကိုယ်ရည်သွေးရာ၊ ကန်ကျောက်ရာတွင် ရိုးရိုး အခိုင်းအနှိုင်း၊ ဥပမာပေးရုံမက အလင်္ကာမြောက်သည့်အထိ တန်ဆာဆင်နိုင်ခဲ့သည်။

ရှေးဦးစွာ ကေလာနန်းသူလေးများ၏ နုသော၊ နွဲ့သော အလှကို –

"ဖယောင်းဖြူကို နေပူပြေပြေမှာ ရွှေလင်ပန်းနှင့်ကျင်း၍ ဖွင့်လျှင် နေရင့်တိုင်း အအိပေါသို့" (စာ–၅၃)

ဟူ၍ နေထိသော ဖယောင်းနှင့် ဥပမာပေး၍ တင်စားခဲ့သည်။ ဒွေးမယ်နော်တို့ ညီအစ်မခုနစ်ဖော်ကို လည်း –

"မြဒါလီသွယ် ကြီးငယ်လိုက်သင့် ဆင့်လို့ကုံးသည့်နှယ်" (စာ–၅၅)

ဟူ၍ မိန်းကလေးတို့ တမြတ်တနိုးဆင်ယင်ကြသော လည်ဆွဲနှင့် ဥပမာပေးထားသဖြင့် စီရရီ၊ ဆင့်ရရှင့်နှင့် လိုက်ဖက်ညီကာ ပေါ်လွင်သော ဥပမာဖြစ်ခဲ့သည်။ တစ်ဖန် သုခနမင်းသား အပေါ်တွင် စိတ်အာရုံညွတ်နေကြသော အပျိုတော်တို့၏ စိတ်အတွင်းဖြစ်အင်ကိုလည်း –

"အကြင်ယောကျ်ား ကြံကိုစားလျှင် အဖျားမှာမှ သည်လောက်ရသာ ရှိပြီဟာကို အရင်းမှတခို သည်ထက်ချိုလိမ့်မည် နဂိုကိုအလျင်း စိတ်မပြေသို့" (စာ–၉၆)

ဟူ၍ ရုပ်အဆင်းနှင့် ကြံအချိုကို ယှဉ်တွဲဥပမာပေးခဲ့သည်။ ဆက်လက်၍ ဒွေးမယ်နော်၏ ဖခင်က သုခနမင်းသားအား ဆင်ကြမ်းစီးခိုင်းသောအခါ လူအများ ကြောက်ရွံ့ ထိတ်လန့် ကြပုံကို –

"တယောင်းမတန် အခြားဆံကြောင့် တအိုးတန်လုံးအများဆုံးသည့်နှယ်" (စာ–၁၁၅)

ဟူ၍ တစ်ယောက်ကြောင့် အများဒုက္ခရောက်ရကြောင်းကို သိသာလွယ်သော ယောင်းမ၊ ဆန်တို့နှင့် ဥပမာပေးတင်စားခဲ့ပါသည်။

စာဆိုရွှေတောင်နန္ဒသူသည် လောကီ၊ လောကုတ္တရာ ဗဟုသုတပြည့်စုံသူပီပီ အခိုင်းအနှိုင်း၊ ဥပမာပေးများကို အတွေးကောင်းကောင်း၊ အရေးကောင်းကောင်းဖြင့် ရကန်တွင်း၌ အံဝင်ခွင်ကျ ထည့်သွင်း ရေးဖွဲ့ခဲ့သည်။ စာဆို၏ ဥပမာပေးများသည် အခိုင်းအနှိုင်းစုံလင်သည်သာမက

လူထုနှင့် နီးစပ်သောနေ့စဉ်မြင်တွေ့နေကျဖြစ်သော သိသာသည့် ဥပမာများဖြစ်၍ ရကန်၏ အရည်အသွေးမှာ ထင်ရှားခဲ့ရပါသည်။

လူ့သဘာဝအဖွဲ့စွမ်းရည်

အနုပညာတစ်ရပ်ကို ဖန်တီးကြသောပညာရှင်များသည် မိမိဖန်တီးသော ဇာတ်လမ်းတွင်းမှ ဇာတ်ကောင်(ဝါ)ဇာတ်ဆောင်များကို ပီပြင်အောင်၊ သဘာဝကျအောင် သရုပ်ဖော်တတ်ကြသည်။ ဖန်တီးသောအနုပညာတစ်ရပ်၏တန်ဖိုးကိုလည်း ပါဝင်လှုပ်ရှားကြသော ဇာတ်ကောင်တို့၏ အပြောအဆို၊ အပြုအမူ၊ အနေအထိုင်၊ အကြံအစည်စသည့် ကာယကံ၊ ဝစီကံ၊ မနောကံ သုံးပါးစလုံး၏ သဘာဝ ပီပြင်မှုဟူသောပေတံဖြင့် တိုင်းတာ တန်ဖိုး ဖြတ်ကြ သည်။ လူ့သဘာဝပီပြင်သောဖန်တီးမှုကို တန်ဖိုး ထားနှစ်သက်ကြသည်။ ထိုသဘောကို နားလည်သော ရွှေတောင်နန္ဒသူသည် ငွေတောင်ရကန်တွင် ဇာတ်ကောင်များကို ကိုယ်ပိုင် ဉာဏ်ဖြင့် ထည့်သွင်းကာ လူ့သဘာဝကိုသရုပ်ဖော်ခဲ့သည်။

ရှေးဦးစွာ မိန်းကလေးတို့၏သူတစ်ပါးထက်ပို၍ ထူးချင်၊ ကဲချင်၊ လှချင်ကြသော သဘာဝ၊ အပြိုင်အဆိုင်ရှိလာလျှင် မိမိကသာအနိုင်ရယူချင်သောဆန္ဒ၊ သူ့ထက်ငါကောင်း ပြင်ဆင်ပြိုင်ဆိုင် တတ်ကြသောသဘာဝကိုစာဆိုက–

> **“ရတနာရောင်လျှမ်း၊ ခုနစ်ဆောင်နန်းမှာ၊ နံ့သာကိုအသွေး၊ အမွှေးကိုအလိမ်း၊ ခပ်သိမ်းစုံစွာ ကွမ်းဝါကိုအပြင် လွင်မှုန့်ကိုအကြိတ်၊ တဘက်မြိတ်ဆံ၊ နန်းတွင်း နားယဉ်ယဉ်၊ ပဉ္စသီကိုအလှူပ်”** (စာ–၈၆)

ဟူ၍အပြိုင်အဆိုင် ဖီးကြ၊ လိမ်းကြ၊ ပြင်ကြ၊ ဆင်ကြပုံကိုသရုပ်ဖော်ထားသည်။မိန်းမတို့သဘာဝကို ပြုံးချင်စဖွယ်ဖြစ်အောင် တင်ပြထားခြင်းဖြစ်သည်။

မိန်းကလေးတို့၏ သိချင်၊ တတ်ချင်၊ စပ်စုချင်သောစိတ်ကိုလည်းစာဆိုက မမှေလျော့ခဲ့။ သုဓနုမင်းသားအားကွမ်းတည်သွားကြသောအပျိုတော်တို့အားအခြားအပျိုတော်များကသုဓနုမင်းသား အကြောင်းမေးမြန်းစုံစမ်းကြပုံကို –

> **“ညည်းတို့တတွေအပါးသို့ကျအောင်ရောက်ရပေသည် မျက်နှာနေမျက်နှာထား ရွှင်ရွှင်လားဘဲ့နယ် ညှိုးငယ်လားရှင် ဝတ်လဲတော်ဘယ်အဆင်း သင်တိုင်းတော်မှာ လျော်ပါစုံ့ ခါးကျဉ်ကျဉ်ရင်ကက ယဉ်လှတယ်လို့ သူတို့ပြောက အစ်မတို့စိတ်တွင် ဘဲ့နယ်ထင်ခဲ့သည် မေးတော်တွင်စုသိတ် မုဆိတ်တော်မြဲမြံ့ အပုံလားအနည်းလား သွားပါနှင့်အုံး ဆုံးအောင်ပြောပါ”** (ငွေတောင်၊ စာ–၁၄၁)

ဟူ၍ဆန့်ကျင်ဘက်ကိုစိတ်ဝင်စားကြသော မိန်းကလေးသဘာဝကို သရုပ်ဖော်ထားသည်။ တစ်ယောက်တစ်ပေါက်ဝိုင်းဝန်းမေးမြန်းဟန်၊ လက်ကိုဆွဲ၍ ကိုယ်ကိုတား၍ မေးမြန်းနေပုံမှာ အသံရော၊ ဟန်ရော၊ ရုပ်ရော၊ ထင်ယောင်မြင်ယောင်လာစေသည့်အဖွဲ့ဖြစ်ပါသည်။

ထို့နောက်တဖန် စာဆိုသည်အန္တရာယ်နှင့်တွေ့လျှင် ကြောက်ရွံ့တုန်လှုပ်တတ်သော၊ သူတစ်ပါးအားအပြစ်တင်ငြူစူတတ်သောလူ့သဘာဝအလုံးစုံကိုဖော်ထုတ်ပြခဲ့သည်။ သုဓနုမင်းသား အားဒွေးမယ်နော်ဖခင် ဒုမရာဇာမင်းကြီးကမြင်းကြွမ်းစီးစေသောအခါ လူအများမှာ အံ့သြထိတ်လန့် ကြသည်၊ ငြူစူပြစ်တင်ကာ မြည်တွန်တောက်တီးကြပုံကို–

> **“လူပြည်ကသူ့သမက်တစ်ယောက်တွက်ကြောင့် ငြိမ်သက်လှစွာနတ်ပေါင်းနေသည့် တောင်ကေလာကို ပွတ်စာတက်အောင် ဆိုးခေါင်တိုင်ဆင်ကြီးကိုစီးစေအုန်း၊ နင်းစေအုန်း အိမ်ရာဆုံးနှင့် တောင်လုံးစင်ရော့မည်”** (ငွေတောင်၊ စာ–၁၁၈)

ဟုသဘာဝကျကျရေးဖွဲ့ပြခဲ့သည်။

လူ့သဘာဝအန္တရာယ်နှင့်ကြုံလာလျှင် အရှေ့အနောက်၊ အမှားအမှန်မဝေခွဲနိုင်ဘဲ ကြောက်လန့်တကြား စိတ်မထိန်းနိုင်ဖြစ်ကြသည်။ သုဓနမင်းသားလေးတင်သောအခါ မြည်ဟီးသော အသံကြောင့် ကြောက်လန့်တကြား ဖြစ်ကြသောလူတို့၏အဖြစ်ကိုလည်း –

"ဦးခေါင်းနထင်ကွဲချင်လုလု ငုံ့သူနောက်ကိုမှောက်သူကထပ် ဝပ်သူကတဆင့် သေသင့်ပြီလည်းသိ အယူရှိကြ၍ မိဘဘိုးဘွားကယ်ပါလား၊ယူပါလား ဖန်များတဆို ငိုသူဟစ်သူအော်သူကျော်သူ ဟူတိုရကားပြေးလွှားလဲပြို့" (စာ–၁၃၁)

ဟူ၍ အန္တရာယ်နှင့်ကြုံလာလျှင်လေ့လာမှု၊ ဆင်ခြင်မှုကင်းမဲ့အောင်ပင် ကြောက်လန့်တတ်ကြသော လူ့သဘာဝကိုဖွဲ့ပြခဲ့သည်။ ထို့ပြင်စာဆိုသည် လောကဥပမာလျှာနှင့်သွားဟုဆိုကြသော လင်မယားတို့၏သဘာဝကိုလည်းထောက်ပြခဲ့သည်။ လင်နှင့်မယားတို့၏ တစ်ဦးပေါ်တစ်ဦး အနိုင်ယူချင်စိတ်၊ သတ် ပုတ်ချင်စိတ်ရှိကြပုံကို သုဓနမင်းသားမြင်းကြမ်းစီးခန်းတွင်–

"သားငယ်မြေးငယ် မဖယ်မလည် သည်ခိုက်တွင်ရှိ အမိနှင့်ပေါ့တန်မလားလို့ လင်များက ထုသည်လည်း ဥပမာကား မျက်ပါးရပ်ရွေ့ခတ်သည့်ပမာဏာသို့"(စာ–၁၀၉)

ဟူ၍ လင်မယားသဘာဝကိုပီပြင်စွာသရုပ်ဖော်ခဲ့သည်။ စာဆိုရွှေတောင်နန္ဒသူသည် ငွေတောင်ရကန်တွင်းမှ သူဖန်တီးထားသောဇာတ်ကောင်တစ်ဦးချင်းစီကို လူ့သဘာဝပီပြင်အောင် ပုံသွင်းခဲ့သည်။ သူ့နေရာနှင့်သူ၊ သူ့ဇာတ်ကွက်နှင့်သူလိုက်ဖက်အောင်ခြယ်သနိုင်ခဲ့ကြောင်း တွေ့မြင်ရပါသည်။

အလှဘွဲ့စွမ်းရည်

ကမ္ဘာ့စာပေ၊မြန်မာ့စာပေတို့တွင် မိန်းကလေးတို့၏ အလှကိုစာဆိုတို့ကအမျိုးမျိုး၊ အဖုံဖုံ အလေးပေးဖွဲ့ဆိုခဲ့ကြသည်။ ထိုအထဲတွင် စာဆိုရွှေတောင်နန္ဒသူသည်လည်း တစ်ဦးအပါအဝင် ဖြစ်သည့်နည်းတူ မိန်းကလေးတို့၏အလှဘွဲ့များကို လှပသောစိတ်ကူး၊ ပေါ်လွင်သော သရုပ်ဖော်အဖွဲ့ များဖြင့်ရေးဖွဲ့ခဲ့သည်။ ရွှေတောင်နန္ဒသူသည် သူ၏ငွေတောင်ရကန်အတွင်းမှ နန်းတွင်းသူမိန်းမပျိုလေးတို့၏ပင်ကိုသဘာဝအလှကို အသေးစိတ်ခြယ်မှုန်းပြခဲ့သည်။ နန်းတွင်းသူလေးများ၏နုပုံ၊ နွဲ့ပုံ၊ ယဉ်ပုံကို–

"နေမပူလေမသုတ်၊ ရွှလုပ်အိအဲ့၊ စိမ်းလဲ့ပြာဖြူ၊ နန်းတွင်းသူ" (စာ–၄၇) ဟူ၍လည်းကောင်း

"မိန်းမညက် မိန်းမပျော့ ကြော့လည်းကြော့ ကျိုင်းလည်းကျိုင်း ပိုင်းတောင့်ကိုလုံးသည့်နယ်" (စာ–၅၀)ဟူ၍ လည်းကောင်းမြင်သာအောင်ဥပမာပြခဲ့သည်။

အချို့သော မိန်းကလေးတို့သည် မပြင်မဆင်သဘာဝ အတိုင်းပြုမူနေ ထိုင်လှုပ်ရှားဟန်ကပင် နှစ်သက်ဖွယ်အဆင်း ရှိကြပေသည်။ ဤသည်ကိုမြင်တတ်၊ တွေ့တတ်၊ ခံစားတတ်သောစာဆိုသည် သူ၏ဇာတ်ဆောင် နန်းတွင်းသူတို့၏ သဘာဝအလှကို–

"အပျိုသွယ်သွယ်၊ ရင်ဆီမှာကားကားနှင့်၊ ခါးဆီမှာကျင်တဲ့လို့၊ ဘင်းပင်းငဲ့နှယ်။ လည်းဘင်းနယ် ပါးနယ်နားနယ်သုံးရပ်မှာ ဆံစပ်ကရောက်လို့ ဝဲပေါက်အောင်ဖွေ လယ် ကုသိုလ်ပြုဘူးသည် မွေးနေနယ်ကို မကွယ်ပါစေနှင့်" (စာ–၁၀၃)

ဟူ၍ သဘာဝအတိုင်းပေါက်နေသောမွေးညင်းနုလေးများ၏ အလှအထိဖွဲ့နိုင်ခဲ့သည်။

ထိုမျှသာမကသေး ရွှေတောင်နန္ဒသူကအတိမ်း၊ အယိမ်း၊ အတွဲ၊ အနွဲ့နှင့်အမူအရာပိုကြသော နန်းသူများ၏အလှကို–

"မျက်တောင်အကြွကိုတစ်လလောက်နီးခန်းတစ်လှမ်းသယ်မည်ကိုဘဲ့နယ်မျှမချီနိုင် ထဘီနားပင်လယ်ဝေ နောက်နေကဖြာစီး ဒေါင်းမြီးနယ်ကိုမသယ်နိုင်၊ မပို့နိုင်၊ ယိုင်လိုက်သည့်အယိမ်းနှင့် တိမ်းလိုက်သည့်အနွဲ့ နယ်ကြီးချဲ့သည့်နယ်၊ နွဲ့လည်းနွဲ့၊ ကော့လည်းကော့၊ လျော့လည်းလျော့၍ ကြော့အထားမှာ အတွင်းသားသစ်သစ် အူအရစ်ရစ်ကလေး၊ သေးသေးပေါ်အောင်" (စာ–၅၂)

ဟူ၍ အတွင်းသားအလှထိ ပေါ်အောင်ဖွဲ့သကဲ့သို့ ဦးတိုးကလည်း ရာမရကန်၌သီတာ မင်းသမီးကလေး၏ အလှကို–

"ရွှေထဘီအကျမှာ၊ မြဒေါင်းမြီးအပွနယ်၊ လှိုင်းဆယ်လိန့်ထရော၊ ယဉ်လှသည့် ပြန်လှန်၊ နောက်ယံကအနေ၊ ဝေဝေသီသီ၊ ရှေ့ဆီကနယ်ပိုင်း၊ ချောလှသည့် အကျိုးမှာ၊ ဗိုင်းအတောင်လှပမာဏ၊ ရွှသည်အူသည်၊ ဖြူသည်နုသည်၊ ထွတ်ထွတ်လဲ့" (စာ–၂၄) ဟူ၍ ဆင်တူသောအဖွဲ့ပုံစံမျိုးဖြင့် ဖွဲ့ခဲ့ပြန်သည်။

ရွှေတောင်နန္ဒသူ၏စွမ်းရည်ကြောင့် ငွေတောင်ရကန်တွင်ပါသော သရုပ်ဖော်အဖွဲ့များအနက် အလှဘွဲ့များသည် ရကန်တစ်စောင်လုံးတွင် အပေါ်လွင်ဆုံးဖြစ်နေပါတော့သည်။

ဟာသရသမြောက်အဖွဲ့စွမ်းရည်

ရွှင်ရွှင်မြူးမြူးဖြစ်စေသောဟာသရသမြောက်အဖွဲ့များသည်ရကန်စာပေ၏အရေးပါသောအခန်းကဏ္ဍ ကပါဝင်ခဲ့သည်။ ရကန်စာဆိုတို့သည် အလေးပေးရေးဖွဲ့မည့်အခန်းကိုရွေးချယ်ရာ၌ ဟာသရသပါ အောင်ထည့်သွင်းရေးဖွဲ့နိုင်မည့်အခန်းကို ရွေးချယ်လေ့ရှိကြသည်။ ထို့နည်းတူစွာ ရွှေတောင်နန္ဒသူသည်လည်းသူ၏ငွေတောင်ရကန်တွင် ဟာသရသမြောက်သောအဖွဲ့များကို ဇာတ်လမ်း၏ သက်ဆိုင်ရာ နေရာများတွင် ထည့်သွင်းထားသည်ကိုတွေ့မြင်ရပါသည်။

စာဆိုရွှေတောင်နန္ဒသူသည် မိန်းကလေးတို့၏ရင်တွင်းဆန္ဒ၊ အတွင်းစိတ်ကိုထိုးဖောက်မြင် တတ်သူဖြစ်ပေသည်။ ငွေတောင်ရကန်တွင် ချောမောလှပသော သုခနုမင်းသားအားမြင်၍ နန်းတွင်းသူ ကလေးများ၏ စိတ်ကစားကြပုံကို–

"မျက်နှာပြကိုယ်လှုပ် နှုတ်ပလီမာယာဆင် ဆံထုံးပြင်ရင်သိမ်းမှု ပြုချင်ကြသည်လည်း ပယောဂစိတ်ဝင်၍ မထခင်မကြွခင်စပ်ကြား စိတ်ကစား၍ သူ့ကိုလားငဲ့ကိုလားလို့ ထင်စားကြသည်လည်း ဆိုင်ရာရာ" (စာ–၇၈)

ဟူ၍ မထိန်းနိုင်၊ မသိမ်းနိုင်ကန္ခြေမရဖြစ်ကြပုံကိုလည်းကောင်း

"အတို့ငွေတောင်တွင်မိုးမှောင်ကြီးစွာကျတည့်လာ၍ငါမှန်းသူမှန်း ကြောင်းလမ်းမမြင် ဆွဲငင်မိရာ သူနှင့်ပါလျှင် နက်ဖန်ခါလောက်မှ လင်းပါလေသော် တော်လေပ" (စာ–၇၈)

ဟူ၍လည်းကောင်းမိန်းကလေးများစိတ်အတွင်းမှ အမျိုးမျိုးဖောက်ပြန်ကြပုံကိုပြုံးရယ်ချင်စရာဖြစ်အောင်ရေးဖွဲ့ခဲ့သည်။

တစ်ဖန်ငွေတောင်ရကန်ဇာတ်လမ်းပါသုခနုမင်းသား၏အစွမ်းကိုယောက်ခမတော် ဒုမရာဇာမင်းကြီးကစမ်းသပ်ခန်းတွင် ပထမဦးစွာမြင်းဆိုးစီးခိုင်းပြီး၊ ဒုတိယအကြိမ် ဆင်ဆိုးစီးခိုင်းပြန်သော အခါတွင် တိုင်းသူပြည်သားများက မင်းကြီးအပေါ် မကျေမနပ်ပြောဆိုကြပုံကို –

> **"လုပြည်ကသုသမက် တယောက်တွက်တာ ငြိမ်သက်လှစွာ နတ်ပေါင်းနေသည့် တောင်ကေလာကို ပွတ်စာတတ်အောင်.... သည်သမီးသည်သမက် သည်မြင်းနက် သည်ဆင် ပြုချင်သမျှ သည်ယောက်ခမ အကပ်တကော့ပင်လယ်ဝေ သမီးကျန်ခြောက်ပါးကို သည့်နှယ်သားဘက် ပေးစားချေလျှင် ကေလာတောင်မှာ တကောင်မျှမကျန် ကုန်ရမည်အမှန်"(စာ–၁၁၈)**

ဟူ၍ လူ့စရိုက်အား ရယ်စရာအဖြစ် သရုပ်ဖော်ပြခဲ့သည်။ ဆက်လက်၍ သုခနုမင်းသား လေးစွမ်းပြ၍ နတ်ပရိတ်သတ် အထိတ်ထိတ်အလန့်လန့် ဖြစ်ကြပုံကို –

> **"နတ်တကာအပေါင်း ဦးခေါင်းနထင် ကွဲချင်လုလု ငုံ့သူနောက်ကို မှောက်သူက တထပ် ဝပ်သူကတဆင့် သေသင့်ပြီလည်းသိ အယူရှိကြ၍ မိဘဘိုးဘွားကယ်ပါလား ယူပါလား ဖန်များတဆို ငိုသူဟစ်သူ အော်သူကျော်သူ ဟူတို့ရကား ပြေးလွှားလဲပြို နတ်အိုရွယ်ကြီး နတ်သမီးရွယ်လွန် ဘေးကိုရှဲ၍ သီသံဗုဒ္ဓေါ နမောတဿ တိသျှတ္တ သြောင်းမောမောထွေထွေရာရာ မေတ္တာပို့ရွတ်အံ့ ပြေးလည်းပြေး၍"(စာ–၁၃၁)**

ဟူ၍ ကြောက်လန့်တကြား ပြေးလွှားလဲပြိုကျသူ၊ ဘိုးဘွားမိဘတသူ၊ ဘုရားစာကို အယောင်ယောင် အမှားမှားရွတ်ဆိုသူများဖြင့် ရုန်းရင်းဆန်ခတ်ဖြစ်နေပုံကို ပြုံးရုံမက ရယ်ရွှင်ဖွယ်ဖြစ်အောင် ဖွဲ့ခဲ့သည်။

အထက်ပါ ရွှေတောင်နန္ဒသူ၏ ငွေတောင်ရကန်ပါ သုခနုမင်းသား လေးစွမ်းပြ၍ အထိတ်ထိတ် အလန့်လန့်ဖြစ်ကြပုံကို ဦးတိုးကလည်း ရာမရကန်၊ ရာမမင်းသား လေးတင်ခန်းတွင် –

> **"ငုံ့သူအထပ်ထပ် ဝပ်သူမင်းအများ အလျားမှောက်သည့်ဇကရာဇ၏ အပြစ်တင်ဝန်လေး သည်နောက်ဘေးစုမှာ လမ်းပြေးပေါက်ရှာ မင်းတချို့မှာလည်း သည်တခါပွဲတွေ့ သေနေ့စေ့တော့သည် အောင့်၍သာခံ သေမည်သာကြံ ကံကံကံကံ သီသံဗုဒ္ဓေါကို သမိန္ဒောသမိန္ဒော ဣတိပိသောကို ဣသောသောဆိုနေ သဗ္ဗဒွေများကို ထေထေသာဆိုနိုင် သွက္ခာတောအချ ဓဇဂ္ဂပရိတ္တံ မာမံဟိ်သိ မာတရေကိ်ဖို့ သိရသို့မိမိမိမိ နှင့် အကြိမ်ကြိမ်နှုတ်ယောင်လို့"(စာ–၁၂၁)**

ဟူ၍ ရေးဖွဲ့ခဲ့ကြောင်း တွေ့မြင်ရသည်။

ငွေတောင်ရကန်တွင် စာဆို ရွှေတောင်နန္ဒသူသည် ရွှေနေပိဿီ တရားလည်းတတ်၊ ဗဟုသုတ လည်းများ၊ စကားလည်းကြွယ်ကာ အာဝဇ္ဇန်းရွှင်ရွှင်ဖြင့် သူ၏ ဇာတ်ကောင်များကို အသက်လည်းဝင်၊ သရုပ်လည်းပေါ်၊ ဟာသရသလည်းမြောက်အောင် ရေးဖွဲ့နိုင်သည်ကို တွေ့မြင်ခဲ့ရပါသည်။

ခြုံငုံသုံးသပ်ချက်

ရွှေတောင်နန္ဒသူသည် ငွေတောင်ရကန်၌ ကိုယ်ရည်သွေးရာတွင်လည်းကောင်း၊ ကန်ကျောက်ရာတွင်လည်းကောင်း သူ၏ပညာဉာဏ်စွမ်းကို ပေါ်လွင်အောင် ဥပမာပေးကာ ဖွဲ့ခဲ့သည်။ လူ့သဘာဝကို ဖွဲ့ရာတွင်လည်း ဇာတ်ဆောင်များ၏ ပြုမူပြောဆိုပုံများ၊ လှုပ်ရှားဟန်များသည် လူ့သဘာဝ သရုပ်ပေါ်လွင်လှသည်။ အလှကို ဖွဲ့ရာတွင်လည်း မိန်းကလေးများ၏ အလှကို ဦးခေါင်းမှစ ခြေများအဆုံး မွေးညင်းလေးများပါ မကျန် အသေးစိတ်ဖွဲ့ခဲ့သည်။ ထိုမျှမက ရကန်စာပေ၏ အသက်ဟုဆိုရလောက်သော ဟာသရသအဖွဲ့များတွင်လည်း ပြီးရုံမက ရယ်မောရလောက်အောင် ဖွဲ့ဆိုခဲ့သည်။ အချုပ်အားဖြင့်ဆိုသော်စာဆိုရွှေတောင်နန္ဒသူသည် ငွေတောင်ရကန်တွင် သူ၏ စာပေဂုဏ် အရည်အသွေးကို ပြနိုင်ခဲ့၍ နောက်နှောင်းစာဆိုတို့အတွက် နည်းယူဖွယ်ဖြစ်ခဲ့ပေသည်။

နိဂုံး

စာဆိုရွှေတောင်နန္ဒသူ၏ အရေးအဖွဲ့စွမ်းရည်ကို စာဆိုဦးတိုး၏ ရာမရကန်၊ စာဆိုဦးယန်၏ တေမိ ရကန်မှ အရေးအဖွဲ့အချို့နှင့် နှိုင်းယှဉ်ပြခဲ့ပါသည်။ စာဆို၏ အရေးအဖွဲ့စွမ်းရည်ကြောင့် ငွေတောင် ရကန်ဟူ၍ ယနေ့တိုင် ထင်ရှားနေဆဲဖြစ်ပါသည်။

ကျေးဇူးတင်လွှာ

ဤစာတမ်းဖြစ်မြောက်ရေးအတွက် ကူညီပေးပါသော တောင်ကုတ်တက္ကသိုလ် ဒုတိယပါမောက္ခချုပ် ဒေါက်တာသန်းထွဋ်လွင်၊ မြန်မာစာဌာနမှ ပါမောက္ခ(ဌာနမှူး) ဒေါက်တာသန်းထိုက် နှင့် တောင်ကုတ်တက္ကသိုလ်သုတေသနဂျာနယ်ဖြစ်မြောက်ရေးအဖွဲ့တို့ကို ကျေးဇူးတင်ရှိပါသည်။

ကျမ်းကိုးစာရင်း

ကြီးခင်၊ ဦး၊ မြင့်ဆွေ၊ ဦး။ (၁၉၆၁)။ *ဇင်းမယ်ပဏ္ဏာသနိပါတ်တော်ကြီးနှင့် ဇင်းမယ် ပဏ္ဏာသစစ်တမ်း*၊ ပထမတွဲ။ ရန်ကုန်၊ မြင့်ဆွေစာအုပ်တိုက်။

ခင်မင်၊ မောင် (ဓနုဖြူ)။ (၂၀၁၄)။ *မြန်မာစာပေခရီး*။ ရန်ကုန်၊ ရာပြည့်စာပေ။

စိန်သီးဦး၊ မောင်။ *အသစ်တွေ့တေမိရကန် လေ့လာချက်သုတေသနကျမ်း*။

တိုး၊ ဦး။ (၁၂၉၅)။ *ရာမရကန်* ။ ပထမအကြိမ်၊ ရန်ကုန်၊ ပြည်ကြီးမဏ္ဍိုင်။

မြန်မာအဘိဓာန်။ (၁၉၉၁)။ ရန်ကုန်၊ ပညာရေးဝန်ကြီးဌာန၊ မြန်မာစာအဖွဲ့ဦးစီးဌာန။

ရွှေတောင်နန္ဒသူ။ (၁၉၇၅)။ *ငွေတောင်ရကန်* ။ ရန်ကုန်၊ မြန်မာနိုင်ငံသုတေသနအသင်း။

Preparation and Characterization of Biochar from Pan-mezali *Peltophorum pterocarpum* (Dc.) Backer. ex K. Heyne)

Maung Maung Khin [1] , Khin Hnin Mon[2], Saw Hla Myint[3]

Abstract

It is concerned with the preparation and characterization of biochar from Pan-mezali (*Peltophorum pterocarpum* (Dc.) Backer. ex K. Heyne). The amount of biochar 19.4 % from Pan-mezali was obtained by using TLUD (Top-Lit Up Draft) furnace. Determination of the effectiveness of chimney height of TLUD furnace, the comparison of the biochar preparation at various chimney height and the characterization of the prepared biochar by EDXRF, SEM, UV and FT IR have been performed. In the biochar preparation process, the effectiveness of chimney height of TLUD furnace was also studied. The highest approximately yield % of biochar was acquired with the chimney height at 2′ 6″. Furthermore, ash content 0.18 %, moisture content 1.89 % and bulk density 82.21 g/100 mL were also determined. The plant nutrients such as nitrogen and phosphorous were determined by chemical methods and that of potassium by spectroscopic techniques such as AAS. It was obtained the nitrogen content 3.0 %, potassium content 0.8457 % and phosphorous content 0.026 % in biochar, which can be used as soil amendment and they support on plant growth. The characterization of the prepared biochar by EDXRF, SEM, UV and FT IR have been performed. By EDXRF analysis, Si, K, S, Ca, Fe, Mn, Ti, Cu, Cr and Zn were detected in wood chips of Pan-mezali but Si, K, S, Ca, Fe, Mn, Zn, Ti, Cu and Rb were detected in its biochar. In the determination of the porous structures of wood chips of Pan-mezali and its biochar by SEM spectroscopic techniques, the prepared biochar possessed greater surface area by comparing to the original wood chips used. Some organic functional groups such as aromatic, C=C, C–H, C–O, $–CH_2–$, $–CH_3$ were studied by UV and FT IR spectrosopic techniques.

Keywords: Biochar, wood chips, plant nutrient (N, P,K) contents, spectroscopic techniques

Introduction

Biochar is a form of charcoal produced from super-heating biomass. It is found naturally in soils around the world as a result of vegetation fires. Biochar has also been created and used by humans in traditional agricul-tural practices in the Amazon Basin of South America for more than 2,500 years. Dark, charcoal-rich soil (known as terra preta or black earth) supported productive farms in areas that previously had poor, and in some places toxic, soils. Biochar can be manufactured via slow pyrolysis, fast pyrolysis, and intermediate pyrolysis. The primary difference among the methods is the temperature used. The varying temperatures will affect the final biochar-syngas-bio-oil proportions, but will not substantially alter the amount of carbon converted into biochar. While charcoal is mostly used as a fuel (e.g. heating), biochar is meant for application to soils and thus, caution needs to be taken for preventing any deleterious impact on the quality of soil and ground and surface waters (Verheijen et al., 2010).

The chemical composition of biochar provides the principal explanation for its generally high level of stability and is reflected in broad terms by its structure and elemental composition: i.e. its strong aromaticity and high carbon content (Sohi et al 2009).

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Materials and Methods

Collection and Preparation of Sample

The sample, Pan-mezali, was collected from an area of 20-Quarter, Shwepyithar Township, Yangon Region. It was cut into many pieces of nearly equal size, which was 1.5 cm in length and 0.4 cm in width. And then, they were kept in air to dry at room temperature for a few weeks and dried in an oven at 99 ºC for 4 h because of its moisture content.

Determination of some Parameters of Pant Materials

Determination of bulk density of sample

A clean dry 10 mL graduated cylinder was weighed. It was then filled with the dry sample to the 10 mL mark and reweighed. The graduated cylinder was placed in a tapping box and the cylinder was gently tapped until there was no more reduction in volume. The minimum volume was recorded and the bulk density was calculated (Antal and Gronli, 2003). The result was illustrated in Table 1.

Determination of moisture content (Oven Drying Method)

Into a flat–bottom metallic dish, finely divided asbestos were spread in a thin layer. It was firstly dried at 110 ºC for 1 h and the dish was covered, cooled and weighed. 20 g of sample was uniformly spread over the asbestos layer. It was weighed as quickly as possible to avoid loss of moisture. The cover was removed and dried in a hot air oven at atmospheric pressure. A temperature of 100 ºC was maintained in the case of plant tissue. The duration of heating will vary with the type of tissues; 16 – 18 h is sufficient for most tissues. After drying, the lid was replaced, the sample was cooled in a desiccator, and it was reweighed. The sample was reheated, if necessary, until the consecutive weighing do not vary by more than 3 – 5 mg. Tissues which contain volatile organic constituents or high percentage of sugars cannot be brought to a constant weight. In such cases, a compromise procedure must be adopted. A standard technique should be employed. Drying at 55 ºC for four days is generally suitable. The sample after determination of moisture content–could be used for ashing and estimation of minerals. The result was shown in Table 1.

Determination of ash contents of plant material

Accurately weighed about 10 g of some plant material, Pan-mezali, was placed in porcelain crucible and the organic matter was dried and burnt off without flaming and finally heated in a muffle furnace at 823 K (550 ºC). Heating was continued until the resultant ash was turned into white in color and free from particles of unburnt carbon and fused. Then, the crucible containing the residue was cooled to room temperature in a desiccator and weighed. Heating, cooling and weighing were repeated until a constant weight was obtained. The ash content was then calculated. The result was shown in Table 1.

Preparation of Biochar from Pan-mezali

Accurately weighed 600 g wood chips of sample, Pan-mezali, was put into TLUD can. Three nails, which were triangle in position, were placed under a TLUD can. One–third of sample was mixed with fuel such as absolute ethyl alcohol (25 mL) and it was put into a TLUD can as a top-layer. Then, they were started to burn with a candle flame. As burning continued, the crown was set up at the top of TLUD can and then chimney, two

feet height, was kept over the crown. After complete burning, a blue colored smoke come out, it was stopped to prevent ventilation, because air entered from bottom to top during burning which raise temperature to 252 ºC within 26 min by using two feet chimney height and it was allowed for cooling. And then, the weight of biochar was determined. The result was shown in Table 2. Furthermore, biochars were prepared from 600 g wood chips of Pan-mezali by varying chimney heights. With one feet chimney height which caused rise in temperature of 248 °C within 29 min, with one and half feet chimney height which caused rise in temperature of 250 °C within 30 min, with two and half feet chimney height which caused rise of in temperature of 275 °C within 28 min, and with two and half feet chimney height which caused rise in temperature of 275 °C within 28 min, as above procedure. The results were shown in Table 2. (Antal and Gronli, 2003)

Determination of Plant Nutrients in Biochar

Determination of nitrogen content in biochar (Micro Kjeldahl Method)

(a) Digestion

0.1 g of finely ground biochar was transferred to a Kjeldahl flask. 1 mL of a mixture of salicylic acid and sulphuric acid was added and thoroughly mixed with biochar. After 20 min, approximately 0.3 g sodium thiosulphate was added and gently heated until fumes were evolved. The mixture was cooled and 0.06 g of catalyst and 0.75 mL nitrogen free H_2SO_4 were added. The mixture was heated on a digestion rack (electric) over a small flame for about an hour until the solution became apple green in colour. The digested sample was cooled and diluted with about 10 – 15 mL of distilled water to dissolve the sample.

(b) Distillation

The digest was transferred to the flask of the distillation unit through the side tube. The digestion flask was repeatedly washed with 2 – 3 mL of distilled water so that no digest was left in the flask. Excess of 40 % NaOH was added to the flask and the distillation process was continued. A conical flask was placed below the condenser containing 5 mL of 2 % boric acid solution. The distillation process was continued until 20 mL of distillate collects in the receiving flask.

(c) Titration

Two drops of Conway's indicator was added to the conical flask containing boric acid and it was titrated against 0.01 N HCl until a faint pink colour is obtained. Blank determination (without sample) using all the reagents as in the case of sample (Burzarbarua, 2000). The result was shown in Table 3.

Determination of phosphorus content in biochar (Colorimetric Method)

2 mL of digested sample extract was transferred into 25 mL volumetric flask. A few drops of 2,4-dinitrophenol indicator was added and the contents was neutralized with 4 N ammonia solution. Any excess of ammonia was neutralized with 2 N H_2SO_4 and the volume to about two third of the flask was made with water. 1 mL of sulphomolybdate solution was dispensed into it. The neck of the volumetric flask was washed with distilled water, and 0.5 mL of freshly prepared stannous chloride solution was added. The contents were thoroughly mixed and the volume was made to 25 mL. Then, within 4 to 20 mins the absorbance was recorded at 660 nm using a spectrophotometer. Following the above procedure a standard curve containing 0.2 – 1.0 ppm phosphorus was prepared. The amount of phosphorus in the sample was found out from the standard curve and the results

were expressed as mg /100 g dry weight of the sample after taking into account the dilution factors. The result was shown in Table 3.

Determination of potassium content in biochar (Atomic Absorption Spectroscopic Method)

The atomic absorption spectrophotometer was switched 'ON' and the instrument was allowed to warm up as per the instruction in the user's manual. The appropriate combination of flame gases were used for a specific mineral to be assayed using appropriate gas pressure so as to get an optimum height of a non-luminous flame. The recommended hollow cathode tube was checked that pertaining to the mineral to be analyzed was fitted into the instrument. One by one different volumes of the standard solutions were introduced for preparation of a reference curve using the standard conditions for the mineral to be analyzed after compensation for the blanks. The sample mineral extract to be analysed was aspirated into the instrument and the observation was recorded after compensation for the blanks. Readings of the standard solutions were periodically taken in between the samples to ensure proper functioning and reproducibility of the instrument response. The result was shown in Table 3. (Birzarbarua, 2000)

Characterization of Biochars by Modern Spectroscopic Techniques

FT IR analysis

Biochar samples (using KBr) were first inserted separately in the sample holder (cassette). Then using air as reference, IR spectra of the pellets were also recorded. IR recorded chart of the sample was shown in Figure 1 which shows the characteristic feature of FT IR spectrum of biochar sample. (Birzarbarua, 2000)

UV analysis

Biochar samples which dissolved in methanol were first inserted separately in the sample holder (cassette). Then using air as reference, UV- spectra of the pellets were also recorded. UV recorded chart of the sample was described in Table 4 which shows the spectral assignment for biochar sample. (Birzarbarua, 2000)

SEM analysis

The prepared biochar samples were recorded by Scanning Electron Microscopy. The photographs were shown in Figures 2(a) and 2(b).

EDXRF analysis

Material used for the analysis was prepared biochar samples. EDXRF model is Regaku X-ray Diffractometer, RINT 2000 / PC software, Cat. No. 9240 J101, Japan. Copper tube with nickel filter was used for the analysis. The EDXRF spectra of samples are shown in Figures 3(a) and 3(b).

Results and Dicussion

Collection and Preparation of Samples

Myanmar, our country, was covered with many forest areas where different types of trees are growing naturally. Some of them were also cultivated for uses. So, the plant materials, namely baw-za-gaing was collected to prepare biochar. The material is abundantly found in our environment. Biochar could come from just about any thermochemical processing of a carbonaceous material. Feedstocks could include agricultural wastes potential biochars could come from just about any thermochemical, forestry residues, used tires, old building materials, municipal solid wastes, *etc*. Those

feedstocks and processes suitable for the production of biochar are, in reality, limited by feedstock material safety and availability, market conditions for biochar and its process co-products, local soil properties, and the combined environmental impacts. After collection of samples, it was firstly cut into small pieces of sample, dried to get moisture content less than 10 %, and then it was stored for the preparation of biochar.

Some Parameters of Plant Materials

Bulk density of a plant sample was determined by measuring sample weight and its volumes. The result of bulk density of Pan-mezali was shown in Table 1.

Moisture content may be determined by drying in an oven. This method consists in measuring the weight lost by plant materials due to the evaporation of water. An oven whose temperature can be controlled accurately was used. Since the temperature tends to be different on different shelves, a drying oven fitted with an internal fan for circulation of air is to be preferred. The sample, after determination of moisture, could be used for the determination of ash. The result of moisture content in Pan-mezali was shown in Table 1.

Ash content of plant materials represents inorganic residues remaining after destruction of organic matter. It may not necessarily be exactly equivalent to the mineral matter as some changes may occur due to volatilization or some interaction between constituents. High ash content and / or a low alkalinity of the ash may in some cases be suggestive of the presence of adulterants. The acid insoluble ash is a measure of sand and other silicious matter present. Difficulty of effecting complete combustion in some sample, and the possible loss by volatilization on ignition may be overcome by moistening the substance to be ignited or the carbonaceous residue therefrom with concentrated sulphuric acid. The result of ash content in Pan-mezali was also shown in Table 1.

Table 1. Bulk Density, Moisture, Ash Contents of Plant Sample

Parameters	Results
Bulk density (g/100 mL)	82.21
Moisture content (%)	1.89
Ash content (%)	0.18

Biochar was prepared from some plant materials at different chimney heights and temperatures (200 – 400 ºC). The different plant materials from old trees were collected from secondary forest growth area of the Shwe Pyi Thar Township. Woody material was chosen so that similar diameter samples were placed in the pyrolysis chamber, in place of selecting material from similar locations on the trees. In these samples, the branches were used and biochars were made from fresh material in the pyrolysis TLUD furnace at the chemistry laboratory. Slow pyrolysis was accomplished in a TLUD furnace of one gallon can capacity, with samples brought to temperature over 2 hours. When the pyrolysis was complete, three things were observed: blue flame at the upper part, yellow flame at the bottom, and change of smoke colour to blue. The furnace was then turned off by closing the bottom and upper parts of the TLUD furnace and allowed to cool. After combustion, the products, biochars, were crushed to get similar sized pieces.

Biochar was prepared from Pan-mezali by using two feet chimney height and the arising of temperature was recorded. Furthermore, biochar was prepared by changing different chimney heights and the arising temperature was recorded. In the preparation of biochar by changing the chimney height, the yield percent gave the highest at two feet and six inches. The results were shown in Table 2.

Table 2. Yield Percent of Biochar from Pan-mezali at Different Chimney Heights

Sample No.	Chimney height	Sample wt (g)	Time taken (min)	Temperature (ºC)	Product wt (g)	Yield (%)
I	1′ 0″	600	29	248	60	10.0
II	1′ 6″	600	30	250	60	10.0
III	2′ 0″	600	26	252	60	10.0
IV	2′ 6″	600	28	275	100	16.7
V	3′ 0″	600	22	272	60	10.0

Plant Nutrients in Biochar

Nitrogen content is estimated by the Kjeldahl method which is based on the determination of the amount of reduced nitrogen (NH_2 and NH) present in the sample. The various nitrogen compounds are converted into ammonium sulphate by boiling with concentrated H_2SO_4. The ammonium sulphate formed is decomposed with an alkali (NaOH), and the ammonium liberated is absorbed in excess of neutral boric acid solution and then titrated with standard acid. The result of nitrogen content in biochar was shown in Table 3.

For the determination of total phosphorous, the sample in which organic matter has been destroyed by tri-acid mixture is used. The phosphate containing solution is treated with sulphomolybdic acid to produce phosphomolybdic acid. This is then reduced by stannous chloride giving a blue coloured complex whose colour intensity is proportional to the amount of phosphate in the preparation. The result of phosphorous content was shown in Table 3.

The atomic absorption spectrophotometry may be used for the determination of potassium content. The plant tissue must first be properly processed before its introduction into the atomic absorption spectrophotometer (AAS). Dry ashing can effectively be used for determination of potassium in plant tissue. The result of potassium content was shown in Table 3.

Table 3. Nitrogen, Phosphorus, Potassium Contents in Biochar

Parameters	Results
Nitrogen content (%)	3.0
Phosphorous content (%)	0.026
Potassium content (%)	0.8457

Characterization of Biochar by Modern Spectroscopic Techniques

FT IR analysis of biochar

Fourier transform infrared spectroscopy (FT IR) is frequently used to identify and qualitatively track changes in functional groups in biochar and soil samples. Since, biochars are opaque solids, an FT IR analysis requires special sample preparation and / or detection method. Some common methods include conventional transmission FT IR using potassium bromide (KBr) pressed pellets. Important peaks in the biochar spectra are the O-H stretch (3400 cm^{-1}), the aliphatic C-H stretch (3000-2860 cm^{-1}), the aromatic C-H stretch (3060 cm^{-1}), the carboxyl (C=O) stretch (1700 cm^{-1}) and the various aromatic ring modes at 1590 and 1515 cm^{-1}. As the pyrolysis reaction progresses, certain peaks (O-H stretch and carboxyl C=O stretch) disappear, the CH peaks shift from being more aliphatic to more aromatic (and eventually disappear altogether), and peaks representing aromatic carbon compounds begin to appear. FT IR Images indicates peak changes and helps identification of functional groups. Observed prominent peaks and its associated functional groups are shown in Figure 1.

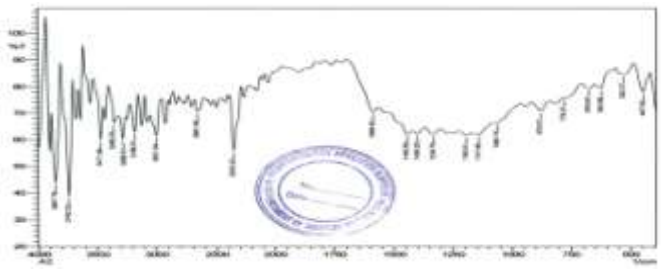


Figure 1. FT IR spectrum of biochar

UV analysis of biochar

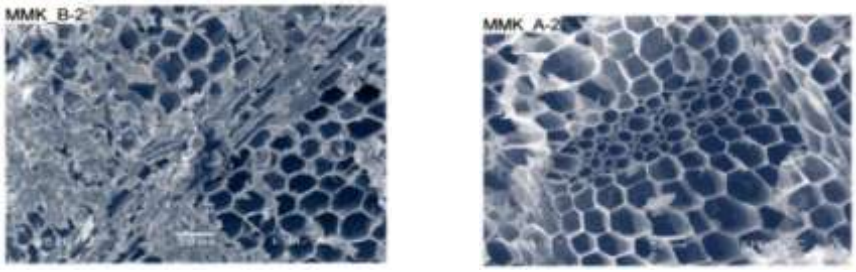
In analysis of UV for biochars prepared from Pan-mezali, the interaction of UV and visible radiation with matter could provide qualitative identification of molecules and polyatomic species, including ions and complexes. The shape and intensity of UV/VIS absorption bands are related to the electronic structure of the absorbing species. This would focus of the relationship of the absorption to the structure of simple organic molecules. Table 4 showed the approximate absorption maxima of common organic chromophores, functional groups that absorb UV and / or visible light. Strong bands around 215 and 245 nm suggest a phenolic structure.

Table 4. UV Spectral Data of Biochar

λ_{max} (nm)/EtOH	Assigment
217.28	$\pi \rightarrow \pi^*$ (E_2 band, enone)
246.14	$\pi \rightarrow \pi^*$ (K band, aromatic ring conjugated with C=C or C=O)
266.35	$n \rightarrow \pi^*$ (R band, C=O)

SEM analysis of biochar

SEM images indicate structural changes between raw plant samples and biochars. Surface area increase was observed in biochar. Fragmentation of structure favoured increased adsorptive properties for biochar with increased porosity due to slow pyrolysis. SEM study of Pan-mezali clearly showed the microporous and microtubular structures for the cross-sectional and longitudinal sections of the prepared biochar. SEM Images of raw sample of plant material and biochar produced were shown in Figure 2(a) and Figure 2(b).



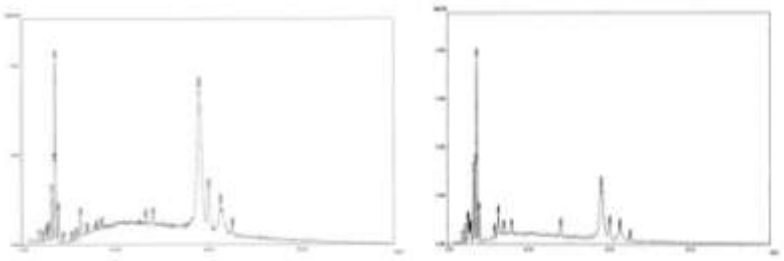
(a) **(b)**

Figure 2. (a) SEM microphotograph of wood chip
(b) SEM microphotograph of biochar

EDXRF analysis of biochar

The elemental analysis and the ash composition of samples and biochars prepared were determined by ED-XRF. Due to the nature of the samples and the calibration method, the relative concentrations of the elements are accurate, but the overall mineral content in the char is overestimated.

In EDXRF analysis of biochar and woodchips from Pan-mezali, the EDXRF spectra as shown in Figure 3 (a) and Figure 3(b) showed the relative abundant elements such as Si, K, S, Ca, Fe, Mn, Ti, Cu and Zn. But, it showed Cr in wood chips and Rb in its biochar. The content of element, Ca, was found to be the most in both woodchips and biochar but Zn was the least in wood chips and Rb was in its biochar.



(a) **(b)**

Figure 3. (a) EDXRF spectrum of wood chip
(b)EDXRF spectrum of biochar

Conclusion

For the preparation of biochar from Pan-mezali, it could be concluded that biochar was prepared 19.04 % as yield. In the biochar preparation process, the effectiveness of chimney height in TLUD furnance was studied by using various chimney height (1′-3′). The highest yield % of biochar was acquired in 2′ 6″ chimney height. But at 2′ chimney height of TLUD furnance, the preparation of biochar was also studied. Bulk density of plant sample such as Pan-mezali 82.21 g/100 mL was determined. Moisture content was found out to be 1.89 %. Ash content was also found to be 0.18 %. The plant nutrients such as nitrogen, phosphorus, and potassium contents in biochar were also determined. The nitrogen content of biochar was given to be 3.0 %. The phosphorus content was to be 0.026 %. The potassium content was also given to be 0.8457 %. By EDXRF analysis, Si, K, S, Ca, Fe, Mn, Ti, Cu, Cr and Zn were detected in wood chips of Pan-mezali but Si, K, S, Ca, Fe, Mn, Ti, Cu and Rb were detected in its biochar. SEM study of Pan-mezali clearly shows the microporous and microtubuler structures for the cross sectional and longitudinal sections of the prepared biochar. Some characteristics of organic functional groups such as aromatic, C=C, C–H, C–O, $–CH_2–$, $–CH_3$ in biochar was studied by UV and FT IR spectrosopic techniques. As a suggestion, biochar can be used as a soil amendment to improve crop yield and fertilizer requirements because it contains some elements, organic compounds, porous structures to culture microorganisms which can produce plant nutrients, and plant nutrients which can support for plant growth.

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Assessment of Domestic Water Quality in Taunggoke University Campus, Taunggoke Township, Rakhine State

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Abstract

In this project, the water sample was collected from two sites located in Taunggoke University Campus, Taunggoke Township, Rakhine State on October 2020. Sampling sites were recorded with GPS detector. These water samples are commonly used for bathing, cleaning, washing and cooking purposes. So, it is denoted domestic water. These water samples were measured at Small Scale Industries Department, Yangon. Water quality parameters were detected according to standard analytical procedures and modern instrumental techniques. Some physicochemical properties such as pH, temperature, dissolved oxygen **(**DO), conductivity, turbidity, total hardness, total alkalinity, total dissolved solid (TDS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), chloride, sulphate and trace metals (Fe, Pb, As) were determined. The observed data were compared with World Health Organization (WHO) standard values to identify the existence of contaminants above the acceptable levels. All the parameters were found to be in the prescribed permissible limit but it was occurred a little polluted. These water samples were complied with WHO water standard and then it would be safely used as domestic water for human health in Taunggoke University Campus.

Keywords: water quality parameters, WHO, domestic water, Taunggoke University Campus

Introduction

Water, one of the most precious commodities of life has numerous uses and it is impossible to exhaust all the water supplies of the world, as water is continuously recycled through the hydrological cycle (Gorde,S.P. *et al*., 2013). Water which is essential to all forms of life and makes about 50 - 97 percent the weight of all pants and animals, is the most poorly managed resource in the world.

Water plays the important roles of our life. Without water, there is no life on our planet. (Fakayode, S.O., 2005). Water is called the universal solvent because it dissolves more substances than any other liquid. Water has a number of unique properties that are essential to life. Some of the special characteristics of water include its polar character, tendency to form hydrogen bonds and ability to hydrate metal ions. These properties are excellent solvent, highest dielectric constant, high surface tension, transparent, maximum density at 4 °C, high heat of evaporation, high latent heat of fusion and high heat capacity. The physicochemical properties of water consist of both physical and chemical and biological characteristics of water.

The important sources of nature waters are rain water stream, river waters, spring, well water, lake, pound and sea water (Abida, B. *et al*., 2008). Water can be divided into various well-marked classes such as atmosphere water, surface water, ground water etc. Water is a basic nutrient of the human body and is critical to human life. It supports the digestion of food, adsorption, transportation and use of nutrients and the elimination of

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toxins and wastes from the body (Kleiner, 1999). Water is also essential for the preparation of foodstuffs and requirements for food preparation are included in the discussion of consumption requirements. The quantity of water delivered and used for households is an important aspect of domestic water supplies, which influences hygiene and therefore public health. Domestic water supplies are one of the fundamental requirements for human life. Without water, life cannot be sustained beyond a few days and the lack of access to adequate water supplies leads to the spread of disease. According to the World Health Organization (WHO), between 50 and 100 liters of water per person per day are needed to ensure that most basic needs are met, and few health concerns arise. At any one time, close to half of all people in developing countries are suffering from health problems caused by poor water and sanitation. Together, unclean water and poor sanitation is the world's second biggest killer of children. It has been calculated that 443 million school days are lost each year to water-related illness (WHO, UNICEF, - Progress on sanitation and drinking water).

Materials and Methods

Description of Research Area and Sample Collection

The research area is confined to the Taunggoke University Campus in October 2020. Taunggoke University situates on Ann main road in Taunggoke Township, Thandwe District, and Rakhine State. The width is about 212.20 acres and is situated from front longitude 94º 13′ 19.8" to 94º 14′ 25.5" and from north latitude 18º 52′ 25.7″ to 18º 54′ 54.94″. There are hostels, chummeries, residential quarters and house in it. Water for domestic use is being supplied through PVC pipes from University dam. Figure 1 shows the map of water sample collection sites in Taunggoke University Campus.

Water samples were collected from two sites of Taunggoke University Campus. Site I was taken from 8 feet deep above the bottom of the University dam and site II was collected 3 feet deep above the bottom of the University dam. Site I distributed 5 chummeries, two stories student hostels, four units housing, six units housing, one unit and eight-unit one story housing in the Taunggoke University Campus. And then, site II also spread rector housing, purification water machine, two stories and three stories class buildings, library, canteens, four unit four stories housings, professor housings, eight unit two stories building. Water samples were collected with cleaned one litter polythene bottles and brought to the Water Quality laboratory in Small Scale Industries Department, Yangon, Myanmar. Table 1 shows parameters and test methods of the water samples in Taunggoke University Campus.

Figure 1. Location map of water sampling sites in Taunggoke University Campus, Taunggoke Township, Rakhine State

Table1. Parameters and Test Methods of the Water Samples Collected from Taunggoke University Campus

No	Parameters	Units	Equipment and Methods Used
1	pH	-	Model HI 98130 HANNA pH meter
2	Temperature	(°C)	Model HI 98130 HANNA pH meter
3	Electrical Conductivity	µS/cm	Lovibond Senso Direct 150 multimeter
4	Total Dissolve Solids (TDS)	ppm	Filtration, Evaporation and Gravimetric Method
5	Turbidity	NTU	Model 2100P Turbidimeter
6	Dissolved Oxygen (DO)	ppm	DO meter (Model HI- 9145, Italy)
7	Biochemical Oxygen Demand (BOD)	ppm	Incubation method
8	Chemical Oxygen Demand (COD)	ppm	Permanganate Titrimetric method
9	Total Hardness	ppm	Complexometric titration method
10	Total Alkalinity	ppm	Titrimetric method
11	Sulphate	ppm	SufalVar Turbidimetric method
12	Chloride	ppm	Mohr's Titration Method
13	Iron (Fe)	ppm	FerroVer method
14	Lead (Pb)	ppm	Atomic Absorption Spectrophotometer
15	Arsenic (As)	ppm	Atomic Absorption Spectrophotometer

Part per million (ppm),
Nephelometric Turbidity Unit (NTU)
Microsiemens per centimeter (µS/cm)

Results and Discussion

Physiochemical Properties of Collected Water Samples

The pH scale runs from 0 to 14 (i.e. very acidic to very alkaline), with pH 7 representing a neutral condition. The observed pH value of water samples were site I (6.61) and site II (6.58). On comparing, the result against water quality standards laid by WHO (6.8-8.5). This pH value of water samples were nearly complied with WHO standard. Temperature of collected samples site I and site II were found to be 32 °C. The variation is mainly related with the temperature of atmospheric and weather condition.

Electrical conductivity, in particular specific conductance, is one of the most useful and commonly measured water quality parameters. Electrical conductivity usually used for indicating the total concentration of ionized constituents of water. Conductivity, or specific conductance, is a measure of the ability of water to conduct an electric current. Conductivity is expressed as microsiemens per centimetre (µS cm^{-1}). According to WHO

standards, Electrical conductivity value should not exceed 400 μS cm^{-1}. The results showed that the measured conductivity of the site I and site II water samples were 5.5 μS cm^{-1} and 6.8 μS cm^{-1} respectively. These results clearly indicated that water in the study area was not considerably ionized and had the lower level of ionic concentration activity due to small dissolve solids.

The presence of total dissolved solids (TDS) in water may affect its taste. The palatability of drinking water has been rated by panels of tasters in relation to its TDS level as follows, excellent level is less than 300 ppm, good level is between 300 and 600 ppm, fair level is between 600 and 900 ppm, poor level is between 900 and 1200 ppm and unacceptable level is greater than 1200 ppm. Water with extremely low concentrations of TDS may also be unacceptable because of its flat, insipid taste. The results were shown 143 ppm and 186 ppm in site I and site II respectively. Therefore, the water samples of dissolved solids level are excellent condition compared with WHO standard.

The dissolved oxygen content is one of the most important factors in stream health. Dissolved oxygen is essential to all forms of aquatic life, including those organisms responsible for the self-purification processes in natural waters. The oxygen content of natural waters varies with temperature, salinity, turbulence, the photosynthetic activity of algae and plants, and atmospheric pressure. Concentrations below 5 ppm may adversely affect the functioning and survival of biological communities and below 2 ppm may lead to the death of most fish. The results of DO contents were found to be about 2.5 ppm and 3.1 ppm in site I and site II. The critical oxygen concentration for fish is achieved at 4 ppm in water

Biochemical Oxygen Demand (BOD) is the amount of dissolved oxygen required for stabilization the biodegradable organic matter by microorganisms of the sample under aerobic conditions in a specific time. Due to WHO standards, the BOD value is 5ppm. The BOD of the water sample was found to be 5 ppm and 6 ppm in site I and site II respectively. Therefore, the result of site II water sample was a little more than WHO standard. Chemical oxygen demand (COD) is a measure of the oxygen equivalent of the organic matter in a water sample. The COD value of WHO standard is 10 ppm. According to the results, the values of COD (1.84 ppm, site I) and (2.13 ppm, site II) were found. Hence, the observed values were lesser than allowed the limit WHO.

Hardness may vary over a wide range. Total hardness of water sample was found to be in the range of 37 ppm in site I and 46 ppm in site II. According to WHO standard, the value of water samples less than 150 ppm is considered soft water while values greater than 200 ppm are considered hard water. Alkalinity can be used as a measure of the buffer capacity of water. Data from this work showed that alkalinity of water samples site I and site II were found to be 19 and 22 ppm. According to the WHO the value of alkalinity, less than 50 ppm is low alkalinity, 50 - 250 ppm is medium alkalinity and greater than 250 ppm is high alkalinity. So, the results data showed low alkalinity. Turbidity is the cloudiness of water caused by a variety of particles and is another key parameter in drinking water analysis. It is also related to the content of diseases causing organisms in water, which may come from soil runoff. The standard recommended maximum turbidity limit, set by WHO, for drinking water is 5nephelometric turbidity units (NTU). The turbidity values of water samples in site I (10.5 NTU) and the value of water samples in site II (13 NTU) were found respectively. The results indicate that the turbidity of two samples was studied over the maximum standard limit of 5 NTU. Sulphate content is naturally present in surface waters as SO_4^{2-}. The WHO has established 250 ppm as the highest desirable limit of sulphate in drinking water. The sulphate contents of site I was

22 ppm and site II were 34 ppm. The results exhibit that concentration of sulphate in the domestic water at Taunggoke University Campus was lower than the standard limit and it may not be harmful for human health. Moreover, chloride occurs naturally in all types of waters. High concentration of chlorides is considered to be the indicators of pollution due to organic wastes of animal or industrial origin. The obtained results were 8 ppm and 11 ppm for the site I and site II, respectively. According to WHO standards, concentration of chloride should not exceed 250 ppm. By comparison with the WHO standard, the chloride contents levels more than 250 ppm may cause a salty taste or corrosion of some metals. Table 2 shows physicochemical value of the water samples collected from Taunggoke University Campus.

Table 2. Physicochemical Value of the Water Samples Collected from Taunggoke University Campus

No	Parameter	Samples		WHO Limits*
		Site I	Site II	
1	pH	6.6	6.1	6.8 -8.5
2	Temperature (°C)	32	32	-
3	Electrical Conductivity (µS/cm)	5.5	6.7	≤ 1500
4	Dissolved Oxygen (ppm)	2.5	3.1	≥5 (low) 2-5 (medium) 0-2 (high)
5	Total Dissolve Solids (ppm)	143	186	500
6	Biochemical Oxygen Demand BOD (ppm)	5	6	5
7	Chemical Oxygen Demand COD (ppm)	1.84	2.13	10
8	Total Hardness(ppm)	37	46	Soft 0-75 Moderately Hard 150-300 Very Hard Max over 300
9	Alkalinity(ppm)	19	22	Low alkalinity < 50 ppm Medium alkalinity 50 - 250 ppm High alkalinity > 250 ppm
10	Tubidity (NTU)	10.5	13	5
11	Sulphate(ppm)	15	27	250
12	Chloride (ppm)	8	11	250

*World Health Organization (WHO), (2011).

The presence of heavy metals in drinking water higher than a certain concentration can cause detrimental impacts on human health. Therefore, the analysis of heavy metals in drinking water is an important parameter, and most of the studies on drinking water quality involve investigation of heavy metals. Table 3 shows toxic elements content of the water samples collected from Taunggoke University Campus.

Iron in water has many effects on aquatic life situation. In this result iron contents of the water samples collected from the site I and site II were 0.2 ppm and 0.3 ppm, respectively. Concentrations of iron in drinking-water are normally less than 0.3 ppm. Iron is nuisance chemicals that cause troublesome stains and deposits on light-colored clothes and plumbing fixtures. Iron causes yellow, red or reddish-brown stains and deposits. Lead

concentrations exceeding the permissible WHO limits have been found 15 ppm. Lead concentrations of the water sample site I and site II were not detected. And then according to the experiment results, the arsenic concentrations of the water samples from site I and site II were also not detected. The permissible limit of WHO standard of arsenic concentration is 0.1 ppm. Therefore, the analyzed water samples were not contaminated with toxic arsenic and lead due to natural and anthropogenic activities. In the present study, the results of heavy metals such as iron (Fe), lead (Pb) and arsenic (As) were compared with the safe limits set by WHO.

Table 3. Toxic Elements Content of the Water Samples Collected from Taunggoke University Campus

No	Parameters	Samples		WHO Limits *
		Site I	Site II	
1	Iron (ppm)	0.2	0.3	0.3
2	Lead (ppm)	ND	ND	15
3	Arsenic (ppm)	ND	ND	0.1

*World Health Organization (WHO), (2011).
not detected (ND)
part per million (ppm)

Conclusion

The present research work is carried out to give the environmental awareness to the residents. The values of water quality parameters such as pH, temperature, electrical conductivity, dissolved oxygen, total dissolve solids, the chemical oxygen demand (COD), total hardness, alkalinity, sulphate and chloride from all domestic water samples collected from the two sites in the Taunggoke University Campus were found to be within the recommended limits of WHO except Biochemical Oxygen Demand (BOD) and turbidity. The concentration of the almost parameters studied in all samples in this work are rather low compared to the maximum permissible international levels provided by the World Health Organization (WHO). But Biochemical Oxygen Demand (BOD) value is moderately polluted the water samples vary between 2 to 8 ppm. High turbidity can be caused by silt, mud, algae, and plant pieces, melting glaciers, sawdust, wood ashes or chemicals in the water. Therefore, the water treatment will be needed to describe those processes used to make water acceptable for a desired end- use. The goal of all water treatment process is to remove existing contaminants in water. The results of water samples indicate that water parameter values are nearly safe for the use of domestic water. Hence, this preliminary work supports the better control of water quality from Taunggoke University Campus by determining the physiochemical parameters.

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