



**Government of the Union of Myanmar**  
**Ministry of Forestry**  
**Forest Department**



**Preliminary Studies on the Quality and Yield of Gum  
from Acacia Senegal**

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# Acacia senegal - ဆူးဖြူစေး ထုတ်ယူမှုနှင့် အရည်အသွေးကို ပမာဏလေ့လာခြင်း

ဦးထွန်းအောင်၊ M.Sc. ( Chem. ) ( Rgn. ) သုတေသနမှူး  
ဦးအောင်စိုး၊ B.Sc. ( Chem. ) ( Rgn. )၊ ဓါတ်ခွဲခန်းလက်ထောက်  
နှင့်  
ဒေါ်လဲ့လဲ့အောင်၊ B.Sc. ( Chem. ) ( Rgn. )၊ ဓါတ်ခွဲခန်းလက်ထောက်  
သစ်တောသုတေသနဌာန

## စာတမ်းအကျဉ်းချုပ်

သာစည်မြို့နယ်၊ ရူပါတောင်ရှိ (၃)နှစ်သား နှင့် (၅)နှစ်သား အရွယ် ဆီနီဂေါရှား ( *Acacia senegal* (L.) Willd. ) စမ်းသပ်စိုက်ကွက်များမှ ဆူးဖြူစေး စမ်းသပ်ထုတ်ယူမှုကို၊ ၁၉၈၆-ခုနှစ် ဇွန်လ အတွင်း စတင်ခဲ့ပါသည်။ မိုးရာသီတွင် ထွက်ရှိသော အစေး၏ ရေဓါတ်ပါဝင်နှုန်းမှာ ၂၇% အထိမြင့်မားလျက်ရှိပြီး၊ လွယ်ကူစွာအချဉ်ပေါက် ပျက်စီးနိုင်ကြောင်း တွေ့ရှိရပါသည်။ အဆက်မပြတ် မိုးရွာသွန်းမှုကြောင့် အထွက်နှုန်း ခန့်မှန်းရန်လည်း မလွယ်ကူသဖြင့် မိုးရာသီတွင် ဆူးဖြူစေး မထုတ်ယူသင့်ပါ။ ရောင်းတမ်းဝင် ဆူးဖြူစေးများတွင် သဘာဝအလျောက် ထွက်ရှိသော အစေးများနှင့် ခြစ်ယူရရှိသော အစေးများ စုပေါင်း ပါဝင်လေ့ရှိပါသည်။ ယခု သုတေသနလုပ်ငန်းတွင် ဆောင်းနှင့်နွေရာသီ အစေးထုတ်ယူခြင်း မစတင်နိုင် သေးသော်လည်း ၊ ၎င်းအစေး တို့၏ဖြစ်နိုင်ဖွယ်ရာ ဂုဏ်သတ္တိများကို ခန့်မှန်းတွက်ဆနိုင်ရန်အတွက်၊ ၁၉၈၆-ခုနှစ် မေလအတွင်း အထက်ပါ ရူပါတောင်၊ ဆီနီဂေါရှားစိုက်ခင်းမှ စုယူခဲ့သော သဘာဝအလျောက် ထွက်ရှိသည့် အစေးများ၏ ဂုဏ်သတ္တိများကို ပမာဏစမ်းသပ်လေ့လာခဲ့ပါသည်။ ယင်းသို့လေ့လာရာတွင် သဘာဝအလျောက်၊ ဆီနီဂေါရှားမှ ထွက်သော အစေး၊ သဘာဝအလျောက်ဖြူပင် ( *Acacia Arabica* ) မှထွက်သော အစေးနှင့် နိုင်ငံခြားမှ ဝယ်ယူသော အကေးရှားခေါ် ဆူးဖြူစေးတို့ကို နှိုင်းယှဉ်ခါတ်ခွဲ စမ်းသပ်ခဲ့ရာ ယင်းစမ်းသပ်ချက်မှ ဆီနီဂေါရှား သည် နိုင်ငံခြားမှ သွင်းယူသော ဆူးဖြူစေးနှင့် ဓါတုဂုဏ်သတ္တိ လွန်စွာနီးကပ်ပြီး၊ နိုင်ငံခြားသွင်းကုန်ဖြစ်သော ဆူးဖြူစေးကို အစားထိုး၍ ဆေးဝါးကုန်ကြမ်းအဖြစ် အသုံးပြုနိုင်ရန် လိုအပ်ချက်တစ်ရပ်ဖြစ်သည့် - USP စံညွှန်းများနှင့် ကိုက်ညီကြောင်း တွေ့ရှိရပါသည်။

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## Abstract

Gum tapping on three years old and six years old trial plantations of Senegal sha ( *Acacia senegal* (L.) Willd. ) at Yupataung, Thazi township was commenced in June 1986. The gum exuded in the rainy season was found to contain a large percentage of water ( 27% ) which favoured the fermentation of gum, and as such the yield cannot be estimated as it was affected by the rain. So gum tapping in the rainy season is not recommended.

The commercial gum in the market usually comes from natural exudate and also from tapping. In the present work, although gum obtained in winter and summer are not available, the naturally exudative gum collected from the above plantation in May 1986 analysed to find out the prospective quality of gum from tapping. The analytical results of the natural exudate of Senegal sha and the natural exudate of subyu together with the important Senegal gum (a) *Acacia* show that the quality of gum from Senegal sha extracted in this investigation is very similar to that of the imported senegal gum. The quality of gum obtained in the present work meets the United States Pharmacopeia (USP) Specifications there by indicating that the quality of gum obtained from local plantations is as suitable for pharmaceutical industry as that of the imported gum.

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## 1. Introduction

Gum arabic or acacia in other name is odourless, colourless, tasteless, and nontoxic and is mostly water soluble giving a mucilaginous solution with a comparatively low viscosity. As it can be used without affecting the odour, colour, or taste of the main system in which it involves, it is most widely used in industry among other gums. Due to its particular desirable properties, it has great demand in world market to be used as emulsifier, colloidal stabilizer, adhesive or binder, sensitizer and thickening agents.

Naturally, gum arabic is in the form of tears, granules, irregular-broken pieces or thin flakes in the colour ranging from amber to white. The pure white gums, namely Turkey gum or Kordofan, gum, is the best grade and is mostly used for medicinal purposes.

*Acacia arabica* was the primary source of gum for many years. But the gums in the various commercial grades were later produced from other genus and the trade on the industrial gums such as senegal gum, Kordofan or Turkey gum ( from *A. senegal* ), Barbary or Morocco or Mogador gum ( from *A. arabica* Willd. ), Suakim gum (from *A. seyal* and *A. stenocarpa* ), East Indian gum ( mixed gum from *A. senegal* Willd., *A. stenocarpa* Hochst., *A. fistula* Schweing, and *A. arabica* Willd. ), Australian gum or Wattle gum ( from *A. pycnantha* Benth. and *A. decurrens* Willd. ) were already established in the market. But most of the commercial gum arabic is derived from *A. senegal* Willd. which is a 5-7 m. tall tree with a life span of 25-30 years. The purest and best gum arabic comes from Kordofan, a mountainous province of Sudan, in the name of Kordofan gum.

Acacia gum usually exudes from the wound in the stem of acacia trees, especially from unhealthy ones and the dry gummy exudate can be collected in tear forms. Artificial tappings are also made in a definite season between February and May when the fruit are ripe. Some African countries collect the gum exuded naturally using the dry desert winds which usually fall after the close of the rains in November up till July. A tapping process include the making of an incision on the bark of the stem by means of a small ax or knife and the thin strips of the outer bark from the upper and lower parts of the incision, or from only one part are torn off. Gum slowly exudes as viscous liquid, in drops of tear form and become firm and hard. It may be collected 3-8 weeks later. The physical properties of gum vary from one season to another and from year to year. The age of the parent tree, the amount of rainfall, and the time of exudation affect the property of the exudate. The cause of gum-formation in tree still is not clear, whether it is effected by pathological conditions due to an infection or by an unfavourable environmental condition. But the production of the gum is found to be stimulated by the growth of the parasite *Loranthus senegalensis*.

Acacia gum has been a trading item since AD 100 by the name of Sudan gum and the term ' arabic ' refers to the port of aden, Arabia, which was the major trading outlet of the early times. Most of the gums have their individual trade names referring to the places of production or trading and the names mostly come from Sahelian semiarid Africa. Dutch, Portuguese, and French established the gum trading centres at St. Louis and Portendic in the past. Nowadays, EL obeid in Sudan is the most important market and auction site of gum arabic in the world, while the Kordofan gum is also exported from the region around Cairo and Port Sudan and the senegal gum comes from north of the Senegal River.

The tears of crude gum arabic are classified into two grades in trading as clean amber sorts and handpicked selections. The latter includes white to pale-yellowish

white tears and less adhering fibre or other impurities. Both the grades are processed again into various forms like grains or crystals, spray-dried powder, and milled powder after grading, cleaning, and blending. It is used in industries, such as pharmaceutical, confectionery, food production, textile printing, cosmetics, adhesives, paints, inks, lithography, and others.

Before replacing the imported Acacia with the local gum of Subyu (*A. arabica* Willd. ) in Burma Pharmaceutical Industry, the annual importation of Acacia BP has been reported as about 3,500 kg. ( Thet wai, 1981 ). To avoid the shortage of supply and to replace the imported raw materials with the available local products, gum from Subyu was on an experimental basis in BPI, and plantations were established for further production of gum as it gave a satisfactory result except that it shows a poor suspending property. ( Thet wai, 1981 )

## **2. Materials and Methods**

### **2.1 Experimental I**

#### **2.1.1 Gum Tapping**

A 0.56 acre plot of six years old and a 1.25 acre plot of three-year old trial plantations of Senegal sha (*Acacia senegal* (L.) Willd. ) at Yupataung, Thazi Township ( Ko Ko Gyi and Aung Khin, 1986 ) were randomly chosen for gum tapping in May 1986. Weeding and pruning were carried out to obtain an opening of a working space around the stem. Secateurs were used carefully in pruning to prevent hurting the bifurcations of branches thereby causing the exudation of gum from it. Measurements of stem diameter at ground level and tree height were also done. Trees of 2 in. and above in diameter at ground level were selected for tapping.

In June 1986, a transverse incision ( 1.25 in. wide and 0.125-0.25 in depth ) was made on the surface of the stem at the height of 1.5 ft above the ground using a knife, and a thin strip of bark of 1.25 in. in width was torn off below the incision to get a 1.25 in. X 8 in. debarked surface. The depth of the surface was not more than 0.2 in.

#### **2.1.2 Moisture Content of Gum in Rainy Season.**

The aqueous exudate which is running down from three-year old Senegal sha plantation was carefully collected by means of Pasteur pipette within six hours after tapping. The collection fluid from the drops of rain was stored in air-tight container and kept in the refrigerator within two days after collecting. The cold-stored exudate ( 25 g ) was transferred into a porcelain basin and dried in an oven at the temperature of 105°C until the constant weight was occurred.

## **2.2 Experimental II ( Analysis on the Gum )**

### **2.2.1 Samples**

The randomly collected gum which was naturally exuded from three-year old trial plantation of Senegal Sha, Yupataung, Thazi Township in May 1986 was blended

in the sun for three days, ground and sieved through 115, 170, and 250 mesh. The four classes of gum powder are abbreviated as S-1 ( bigger than 125  $\mu$  ), S-2 ( 90 $\mu$  - 125 $\mu$  ), S-3 ( 63 $\mu$ -90 $\mu$  ), and S-4 ( smaller than 63 $\mu$  ).

The gum collected in the same way as mentioned above, from the urban forest of Subyu ( age-unknown ), Pokokku Township, was also powdered and classified into four according to the particle sizes, and abbreviated as A-1, A-2, A-3, and A-4 in the same manner mentioned above.

The Acacia ( General Purpose Reagent, British Drug House. London ) in granules and tears, which is intended to be used as standard, was also powdered in the same way to get four classes and were abbreviated as BDH-1, BDH-2, BDH-3, and BDH-4.

Acacia ( Gum arabic ) in purified powdered form manufactured from 'Riedel-Dihaen AG Seelze-Hanoover, Germany ' was also used as standard sample and abbreviated as PG.

### 2.2.2 Triplication

All the experiments for quantitative analysis were triplicated except the test for acid insoluble-ash content.

### 2.2.3 Water-Insoluble Matter

The samples of S-1, S-2, S-3, S-4, A-1, A-2, A-3, A-4, and PG were tested for water insoluble matter. The oven-dried gum ( 5.0 g ) was dissolved in 25 ml of dilute hydrochloric acid ( 4.0 mol dm<sup>-3</sup> ) and 25 ml of water mixture. The solution was gently boiled and thoroughly stirred until the into a tared-sintered glass filter ( No-3 ) by suction. The residue was then washed with hot distilled water and dried at 105 $\diamond$ C until a constant weight was obtained.

### 2.2.4 Loss on Drying ( Moisture Content)

All the thirteen samples were used. The powdered gum ( 2.0 g ) was dried in a vacuum oven at the temperature of 75 $\diamond$ C and a vacuum pressure of 400 m bar until a constant weight was obtained.

### 2.2.5 Ash Content

All samples were used. The gum ( 2.0 g ) in a porcelain crucible, which was preheated to a constant weight, was heated in a muffle furnace at the temperature of 400 $\diamond$ C ( raising from room temperature to 400 $\diamond$ C within 30 min. ) for an hour and then the temperature was raised up to 600 $\diamond$ C The heating was continued until a constant weight was obtained.

### 2.2.6 Acid-insoluble Ash

All the samples were used. The resultants from the respective triplicate tests of ash determination were combined to get enough sample-size for acid-insoluble ash experiment. The ash sample was dried in an oven to get a constant weight and it was boiled with 10 ml dilute hydrochloric acid ( 4.0 mol dm<sup>-3</sup> ) for 10 min. The acid-

insoluble residue was transferred into a tared sintered glass filter ( N0-3 ) by means of a Pasteur pipette and washed with hot water. The sintered glass filter with the sample was then dried in an oven at 150°C until the weight became constant.

### 2.2.7 Precipitation with Acetone

The samples of S-1, S-2, S-3, S-4, A-1, A-2, A-3, A-4, and PG were used to be precipitated with acetone. The gum ( 5.0 g ) was dissolved in 15 ml water by warming it at about 60°C and the resultant was centrifuged at 4000 rpm for 15 min. The light-insoluble stuffs floating up on the surface of solution was removed by means of a small spatula. After collecting the solution, the insoluble-matter remained in the bottom of centrifuge tube was washed with 10 ml hot water and centrifuged again for another 15 min. The washing was concentrated by heating and combined with the mother solution. The final solution was acidified with dilute hydrochloric acid until it reached to  $p^H$  2.5 and the acetone was added to it drop by drop with agitation until the precipitation was completed. The gelatinous precipitate was washed and isolated by filtration. It was then dried in the vacuum oven at the temperature of 75°C and pressure of 400 m bar until it gave a constant weight.

### 2.2.8 Alkali Number

The samples of S-4, A-4, and PG were used. The gum ( 0.5 g ) was suspended in 10 ml freshly distilled water by gently swirling and 25 ml standard sodium hydroxide solution ( @ 0.4 mol  $dm^{-3}$  ) was added to it in a constant swirling. Then it was mixed with a 65 ml boiled-distilled water ( nearly 100°C ) by constant agitation and the solution mixture was digested for 60 min. exactly, in the boiling water bath. After that, the mixture was put in an ice-water bath at once and 50 ml of 0°C freshly distilled water was added to it and the final solution was titrated with standard sulphuric acid solution ( @ 0.2 mol  $dm^{-3}$  ) using 1 ml of 0.1% ethanolic solution of thymol blue. The end point was clear yellow.

The blank titration was done for the mixture of 25 ml sodium hydroxide solution ( @ 0.4 mol  $dm^{-3}$  ) and 25 ml freshly distilled water with standard sulphuric acid solution of thymol blue as indicator.

### 2.2.9 Flow Rate ( Viscosity )

The samples of S-4, A-4, and PG were used. The gum solutions in the concentrations of 1%, 2%, 3%,4%,5%,6%, 8%, and 10% (w/v) were prepared and the flow rate of 10 ml each was determined by means of a class-A 10 ml-burette ( 0.05 ml Subdiv. ). The test for the flow rate of distilled water used was also carried out alone.

### 2.2.10 Acid Hydrolysis

The samples of S-4, A-4, and PG were used for hydrolysis. The gum powder ( 1.0 g ) was dissolved in 25 ml sulphuric acid ( @ 0.4 mol  $dm^{-3}$  ). The insoluble matter was removed by filtration and the filtrate was refluxed for 8 hours. After cooling the reaction-mixture, the hydrolyzate was neutralized by dried barium



carbonate powder until it reached to  $p^H$  5-6. The residue was filtered off and the filtrate altogether with the washing was concentrated under reduced pressure. Then the resultant solution was made up to 25 ml with distilled water.

### 2.2.11 Thin Layer Chromatography

The 160  $\mu$ m-thick cellulose-coated Eastman chromatogram sheets were used through out the work. The acid hydrolysed samples of S-4, A-4, and PG ( 8  $\mu$ l each ) and the authentic samples of L-rhamnose, L-arabinose, D-galactose and D-galacturonic acid were spotted on 200 mm x 120 mm cellulose sheet by means of 10  $\mu$ l micropipette and eluted by the solvent of n-butanol-acetic acid-water ( 6:2:2 ). Elution time is 70 min. at room temperature ( 31 $\diamond$ C ) and aniline-diphenylamine reagent ( 2g diphenylamine, 2ml aniline, and 10ml 85% phosphoric acid solution in 100ml acetone ) was applied as spray reagent.

### 2.2.12 Infrared Spectroscopy

The IR spectra of S-4, A-4, and BDH-4 samples were examined by means of PERKIN ELMER 1320 Infrared Spectrophotometer. In preparation of KBr disc, the wet-grinding method on the oven-dried samples was used and the sample of potassium bromide mixture in the die in a concentration of 1 mg/300 mg was pressed at the pressure of 8.0 ton for 5 min. while the vacuum system was applied to the die to a pressure of 600 m bar. The range of the wavenumber was 4,000  $cm^{-1}$  -600  $cm^{-1}$  and the scan time was 12 min.

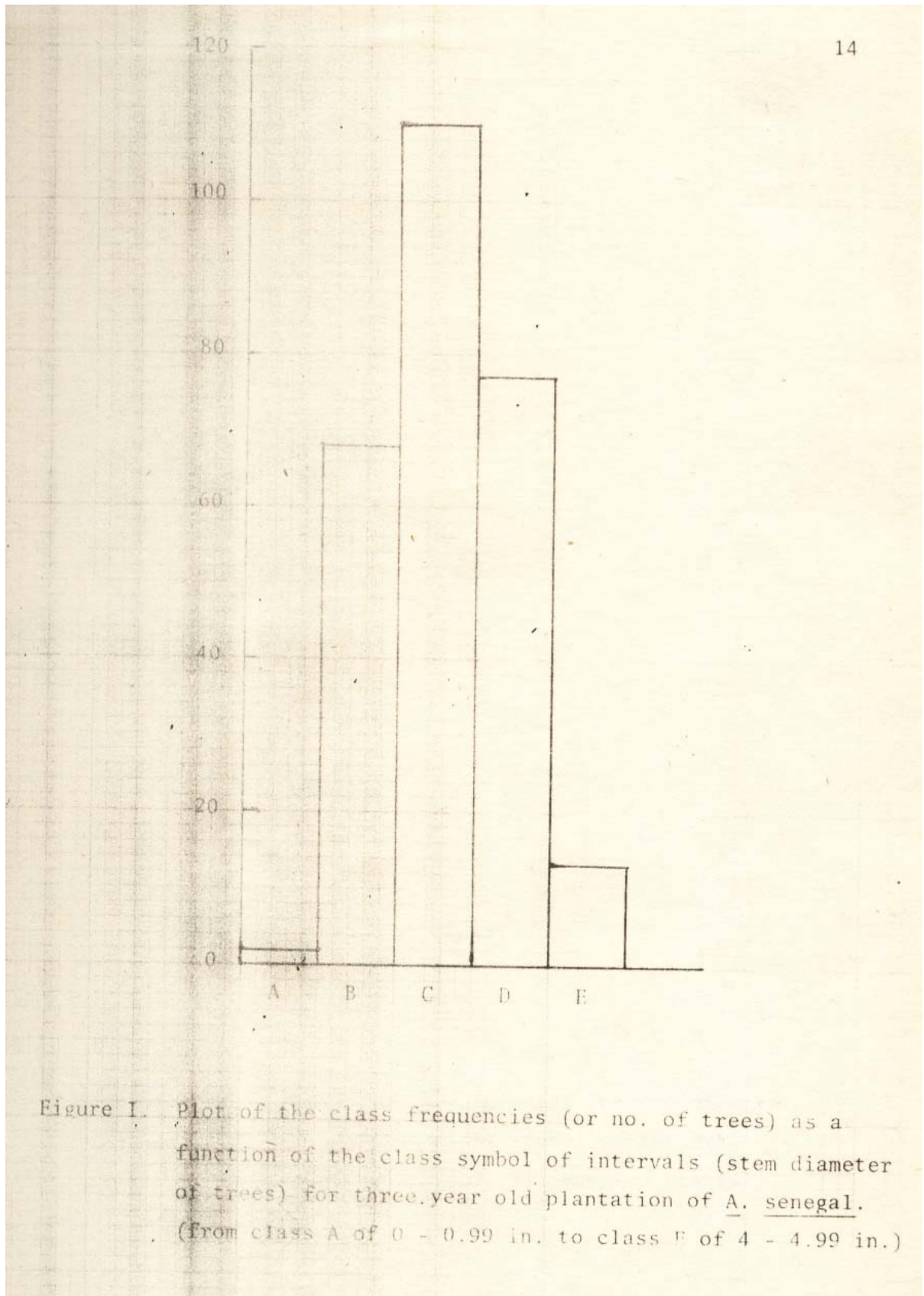
## 3. Results and Discussions

### 3.1 Tapping in Rainy Season

The distribution pattern of the stem-diameters in two different-aged plantations can be seen in respective histogram shown in figure 1 and 2. The predominant class of stem-diameter is found to move to one-step higher from three-year old to six-year old plantation. Both gave a very thin liquid exudate which ran down quickly just after tapping in wet season so that it was impossible to collect it for the application purpose. The collected samples for the purpose of analysis also must be kept in the cold storage as quickly as possible, otherwise, it ferments very easily. The moisture content test on the collected sample shows that almost one third of the sample ( 27% ) is water, and that a large percentage of water content favours the fermentation of gum. So, tapping in the wet season is practically impossible for gum collecting and production of usable quality gum.

### 3.2 Analysis of Gum

The crude acacia gum is generally graded by appearance and the content of impurities such as wood and other foreign materials. The hand-picked tears having the colour of translucent white or shade in pink and pale yellow are selected as the best grade. The natural exudate, collected from the trial plantation of Senegal sha at Yupataung are found lumps as big as small egg having the colour of pale yellow to yellow. The visual impression of the gum appears better than the natural exudate of Subyu which is amber to brown in colour, but is still inferior in appearances to the



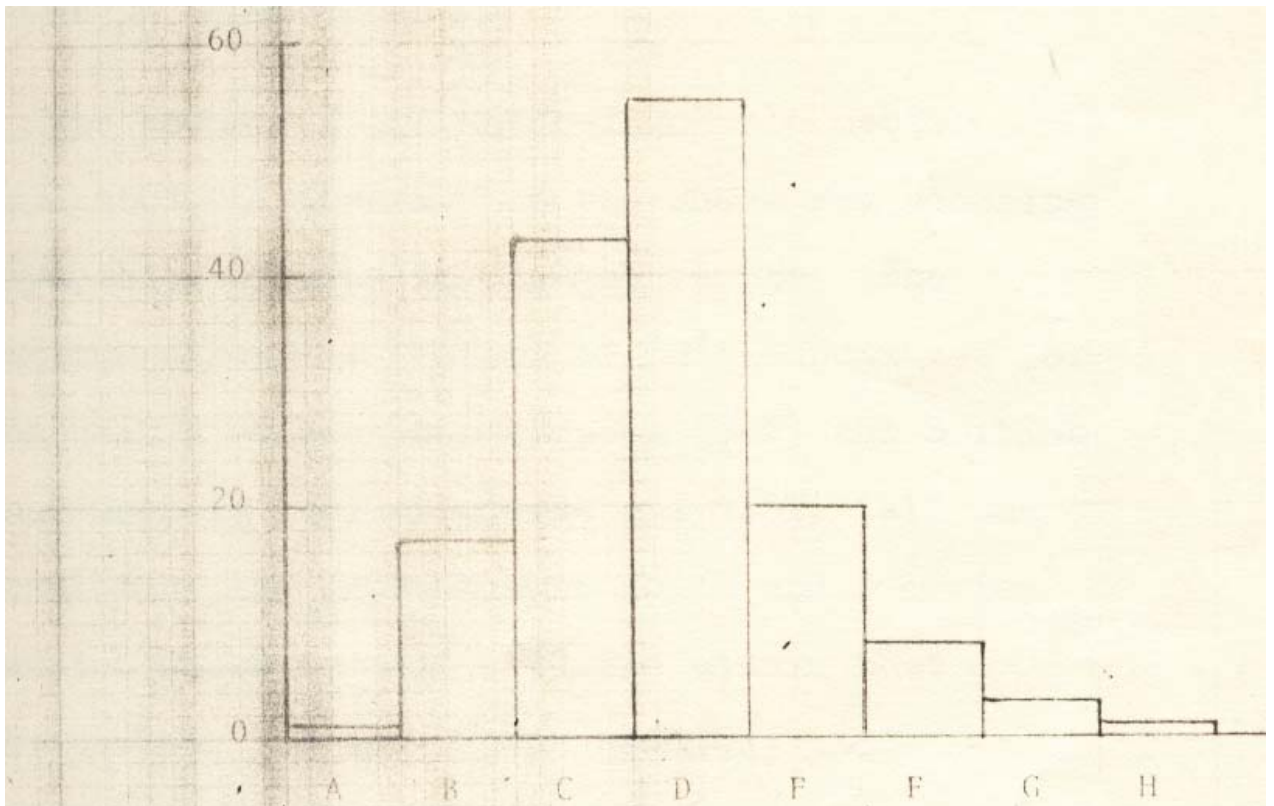


Figure II. Plot of the class frequencies (or no. of trees) as a function of the class symbol of intervals (stem diameter of trees) for six-year old plantation of *A. senegal*. (from class A of 0 - 0.99 in. to class H of 7 - 7.99 in.)

standard acacia gum of BDH, which is a mixture of white, pale yellow and pink. It means that the S Series sample contains a much smaller quantity of tannin material in comparison to the A series sample.

The amount of the water-insoluble matter indicated the quantity of the undesired adhering impurities existed in the gum sample. The maximum allowable content of this impurities for the United States Pharmacopoeia ( USP ) and British Pharmacopoeia ( BP ) standards are 1.0%. All the results of the present work for A and S Series samples shown in table (1) . Lie within that limitation. In the recent studies, the impurities content of crude gum from Subyu collected from different localities of Central Burma were reported as 0.423% ( Khin Myo Nwe, Mi; 1981 ) and as 0.4% ( Thet Wai, 1981 ). Those values are almost the same to those of A-4 and S-4 samples. It shows how a proper care in collecting and hand-picking of crude samples can improve the quality the crude gum and diminish the content of water-insoluble matter.

Table 1. The water-insoluble matter of gum

<u>Sample</u>	<u>w.i.m ( % )</u>	<u>Sample</u>	<u>w.i.m ( % )</u>
A-1	0.96	S-1	0.88
A-2	0.74	S-2	0.75
A-3	0.44	S-3	0.49
A-4	0.47	S-4	0.36
		P-G	0.06

Table 2. The moisture content of gum

<u>Sample</u>	<u>m.c ( % )</u>	<u>Sample</u>	<u>m.c ( % )</u>
A-1	10.92	S-4	7.07
A-2	11.74	BDH-1	6.92
A-3	10.03	BDH-2	8.50
A-4	8.65	BDH-3	8.85
S-1	9.79	BDH-4	7.81
S-2	8.50	P-G	12.17
S-3	9.98		

The moisture content of S series sample in table 2 is comparatively lower than those of the gum from Subyu as reported separately by Mi Khin Myo New and Thet Wai which are 10.98 and 12.40 respectively. As the gum has a hygroscopic property, the particle size of the powder is not the only factor which increase the moisture content in gum. As the absorption property has to be considered in conjunction with the adsorption property to make a correct comprehension of the moisture content of the gum, the knowledge of particle size of the gum above is not sufficient. The results of both A and S series samples still meet the USP specification which does not allow the moisture content to be more than 15%, while the S series sample gives a very similar results as the BDH-series.

The maximum content of ash and acid insoluble ash in acacia gum allowed by the USP are 4.0% and 0.5 % respectively. The arabic acid, which is the major component of acacia gum, is found in nature in a slightly acidic form containing calcium, magnesium, and potassium cations. The existence of these cations as salt and complex formations in the gum may vary due to the various weather conditions and

localities. The results of ash content in the S series sample ( shown in table 3 ) are not much different from those of BDH series while the A series shows more little ash content.

Table 3. Ash and acid-insoluble ash content in gum.

<u>Sample</u>	<u>Ash ( % )</u>	<u>a.i.a. ( % )</u>	<u>Sample</u>	<u>Ash ( % )</u>	<u>a.i.a ( % )</u>
A-1	1.71	0.040	S-4	2.04	0.072
A-2	1.56	0.046	BDH-1	2.74	0.184
A-3	1.84	0.059	BDH-2	2.62	0.045
A-4	1.71	0.050	BDH-3	2.41	0.047
S-1	2.67	0.080	BDH-4	2.58	0.053
S-2	2.65	0.090	PG	2.65	0.049
S-3	2.17	0.068			

These contents in the gum of Subyu from different localities ( Pwintphyu and Kyaukpataung ) were also reported separately by Mi Khin Myo Nwe as 3.06 % and by Thet Wai as 2.20 %. As the gum-collecting season in Pwintphyu was not mentioned, it is assumed that the disagreement of the two results may be due to the difference in localities or by the difference in season of collection or both. Similarly, the acid insoluble ash contents as shown in table 3 fluctuated much between one another even for the same series sample ( different mesh size ). Mi Khin Myo Nwe reported her results as 0.31 % while Thet Wai found his sample to contain 0.68 %. This value indicates the existence of silica in the gum which also can vary by the variation of the surrounding conditions and locality from where the gum is collected.

The arabic acid had been tried to isolate from the acacia gum for many years. The method of Preparation for arabic acid by precipitation had been described by Thomas and Murray since 1982. It can be prepared from gum by various methods such as precipitation with acetone or alcohol, electro dialysis, ion-exchange process etc.. The prepared arabic acid becomes insoluble in water after drying at 105°C. The amount of arabic acid recovered after drying in the present work were tabulated in table 4. The arabic acid obtained became faint in colour in comparison with that of crude gum. Although the loosing of some amount of acids into the filtrate in the collecting process ( filtration ) is normally one of the main reasons for recovering only about 80% in weight of the arabic acid from the crude gum, the amount of arabic acid recovered from sample A-1, A-2, S-1, and S-2, are much lower than expected that there appears to be some other causes for the low return. To know ( constants ) of arabic acid, the chemical structure, the advantages of using the different solvents for precipitation and the compounds remained in the filtrate have to be considered. To understand the above, a further detailed study of the matter including the knowledge of some of the basic-chemistry have to be made.

Table 4. Precipitation of arabic acid from gum

<u>Sample</u>	<u>Precipitate %</u>	<u>Sample</u>	<u>Precipitate %</u>
A-1	46.85	S-2	52.89
A-2	52.94	S-3	76.82
A-3	72.01	S-4	77.65
A-4	75.09	PG	83.37
S-1	64.63		

Table 5. Alkali number and pH of gum solution

<u>Sample</u>	<u>Alkali Number</u>	<u>pH ( 10% solution )</u>
A-4	3.61	5.3
S-4	5.88	4.9
PG	5.99	4.7

As previously mentioned, arabic acid is usually found in the gum in the form of salt of calcium, magnesium, and potassium cations. But most of the natural acid compounds also tend to be formed into ester form together with the salts and free acids. So, when the gum powder was digested with sodium hydroxide solution in the present work, the alkali reacted not only to the free acid but also to the acid ester with saponification. So, the alkali number of the gum cannot wholly represent the pH of gum ( solution ) although it can be estimated roughly from their pH values as shown in table 5. The dissimilarity of the alkali number of A-4 sample to those of S-4 and PG confirmed that the type of the uronic acid ( arabic acid ) in the gum of *A. arabica* is different from that of *A. senegal*. ( It also agreed with the finding of TLC result which will be discussed later that uronic acid in gums of *A. senegal* is more abundant than that of *A. arabica* ). It means, in other words, that the number of polymerization or molecular weight is in the decreasing order sample A-4, to S-4 and PG, although the last two may have the same unit of acidic groups.

As a proper viscosimeter was not available, the viscosity of gum solutions were guessed by comparison from their rate of flow. The three different flow-rates obtained for the three different samples are very close to each other in the low concentration level as illustrated in figure 3. The trend of the flow rate lines are similar and the differences in the region of high concentration ( up to 10% ) are not so big that the solution viscosities cannot be much different from one another. The order of the flow rate lines in the high-concentration region can be correlated directly to the molecular weight which also agree with the conclusion ( alkali number ) made earlier.

The different flow rates also may be caused by another factor viz. the influence of electrolyte contents on the viscosity of gum solution ( R.L. Davidson, 1980 ). The electrolytes can lower the viscosity of gum ( William A. Meer 1980 and M. Jefferies et. al., 1977 ). AS viscosity is an important character for which the acacia gum is in demand by the industry, the contents of electrolytic-metal ions in the gum of Senegal sha and the influence it has on the viscosity of the gum will have to be investigated in the further investigation.

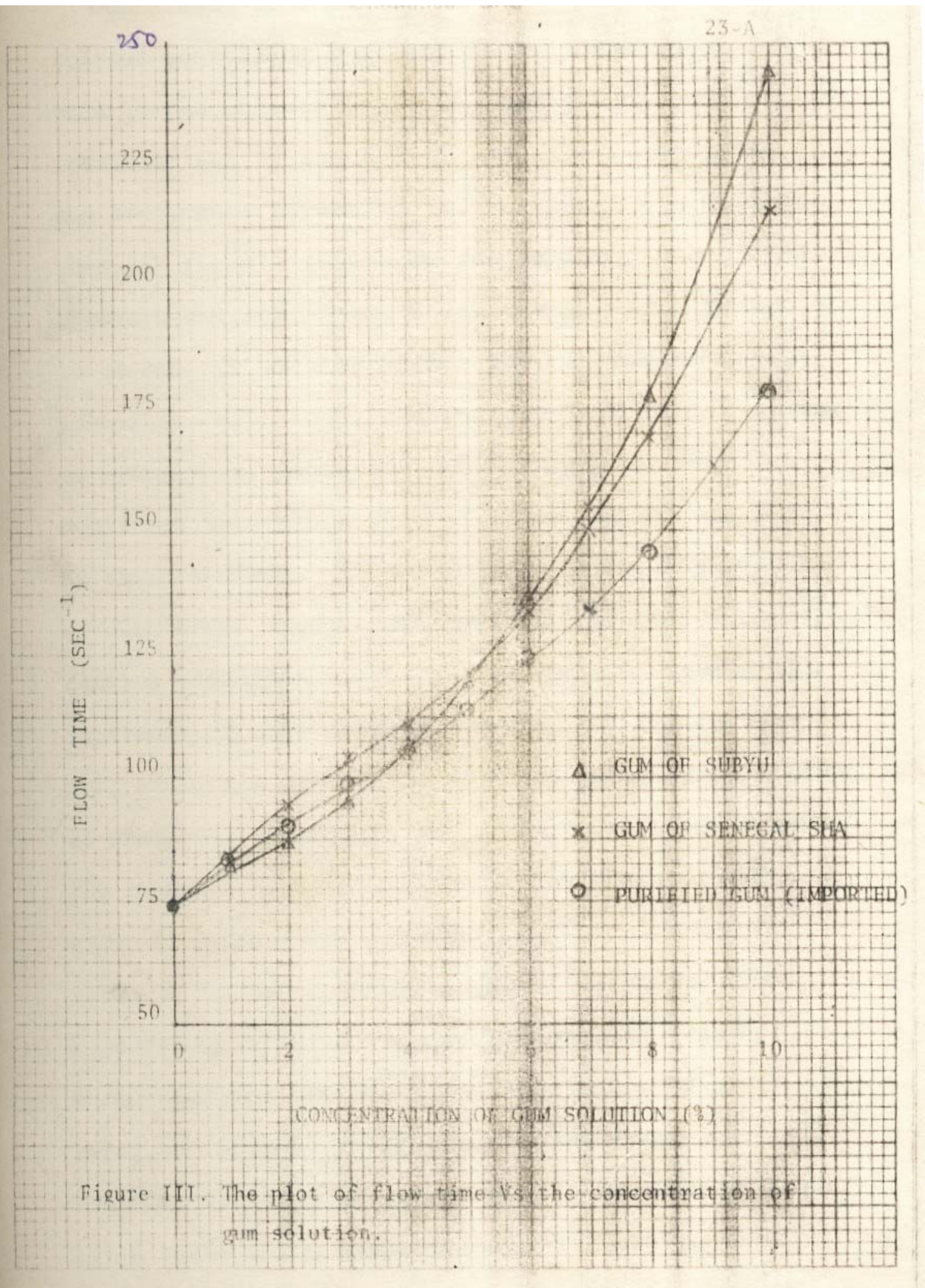


Table 6. Flow Rate of Gum Solution

Concentration ( % )	Flow Rates ( sec. )		
	A-4	S-4	PG
0.0	74.4	74.4	74.4
1.0	80.8	84.3	83.8
2.0	86.7	94.9	90.7
3.0	95.1	103.5	98.4
4.0	106.3	111.5	106.0
5.0	119.0	121.1	114.2
6.0	136.9	133.3	124.1
8.0	177.6	168.9	145.9
10.0	244.4	215.4	178.3

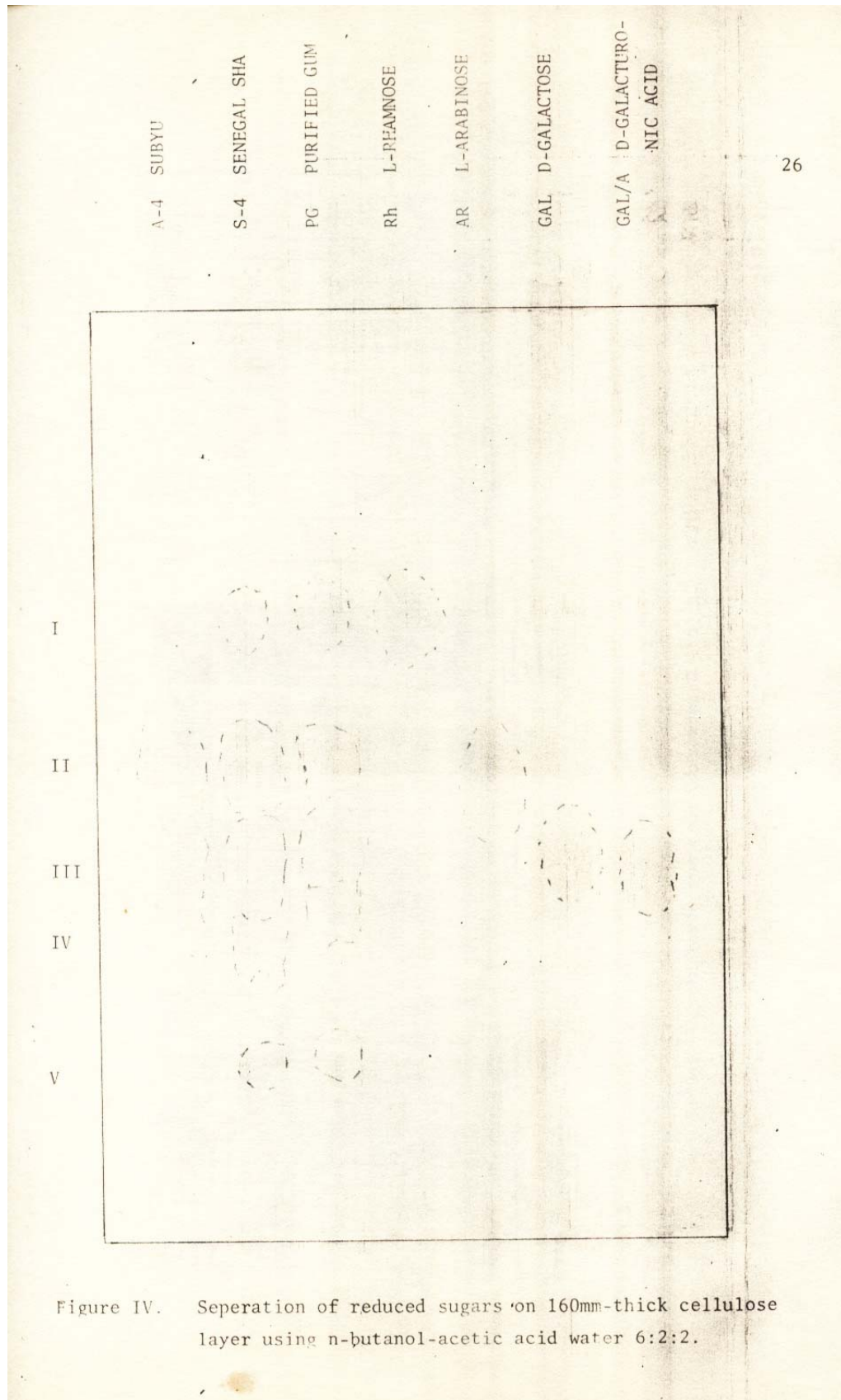
Gum arabic is a highly branched carbohydrate polymer containing D-galactose and D-glucuronic acid in the nucleus ( calcium, magnesium, and potassium salts ) and the sugars like L-arabinose and L-rhamnose attach to it. Although the definite chemical formula cannot be assessed because of the unstable quality of gum which changes from season to season, it usually yields reduced sugars i.e., arabinose, galactose, and rhamnose and uronic acids on hydrolysis. Adherson and Karamalla ( 1966 ) confirmed the composition of those sugars and acids in their studies. In the present work, the results of Thin Layer Chromatography ( TLC ) of hydrolysed gum samples coincides with their statement showing the existence of some reduced sugars ( see figure 4 ). But, while the S-4 and PG show the same constituents of rhamnose, arabinose, and galactose on TLC plates, the rhamnose is not present in the reduced sugar group of hydrolysed A-4 sample. The absence of rhamnose in the hydrolysed gum of Subyu was also reported by Mi Khin Myo Nwe ( descending paper chromatography with n-butanol-pyridine-water 6:4:3 as solvent ) although Thet Wai found spot of rhamnose from his Subyu gum sample on 250u silica gel G plate using n-butanol-glacial acetic acid-water 4:1:5 as solvent. So, rhamnose is assumed that the presence of rhamnose in the gum of Subyu ( *A. arabica* ) is not always certain, while it is present in the gum of Senegal sha ( *A. senega* ). To get a better separation around the spots of galactose and galacturonic acid, other various kinds of solvent were used and a better separation on spot No. 4 was obtained when solvent pyridine-ethyl acetate-acetic acid-water 36:36:7:21, was used and it gives a different hRf value from the authentic galacturonic acid\* showing that it is not that acid. As we did not have the right kind of authentic compounds, it is not possible to make a definite verification of No. 4 and 5. But, by referring to the hRf values, given in the literature, the two unknowns were likely to be glucuronic acid and galacturonic acid respectively. A further investigation on such as the preparative TLC and IR spectroscopy of individual compounds will have to be made for a complete identification of all spots appeared on the TLC plate.

The IR spectra of BDH-4 and S-4 are shown in figure 5 and 6 and the comparative spectra of BDH-4 and A-4 can be seen in figure 7. Except for the band distortions seen in the spectrum of S -4 caused by poor grinding in the KBr-disc

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\*The authentic galacturonic acid obtained from other laboratory was later doubted of being the genuineness due to its irregular order of TLC separation, the given hRf value and the given colour of spot after developing.





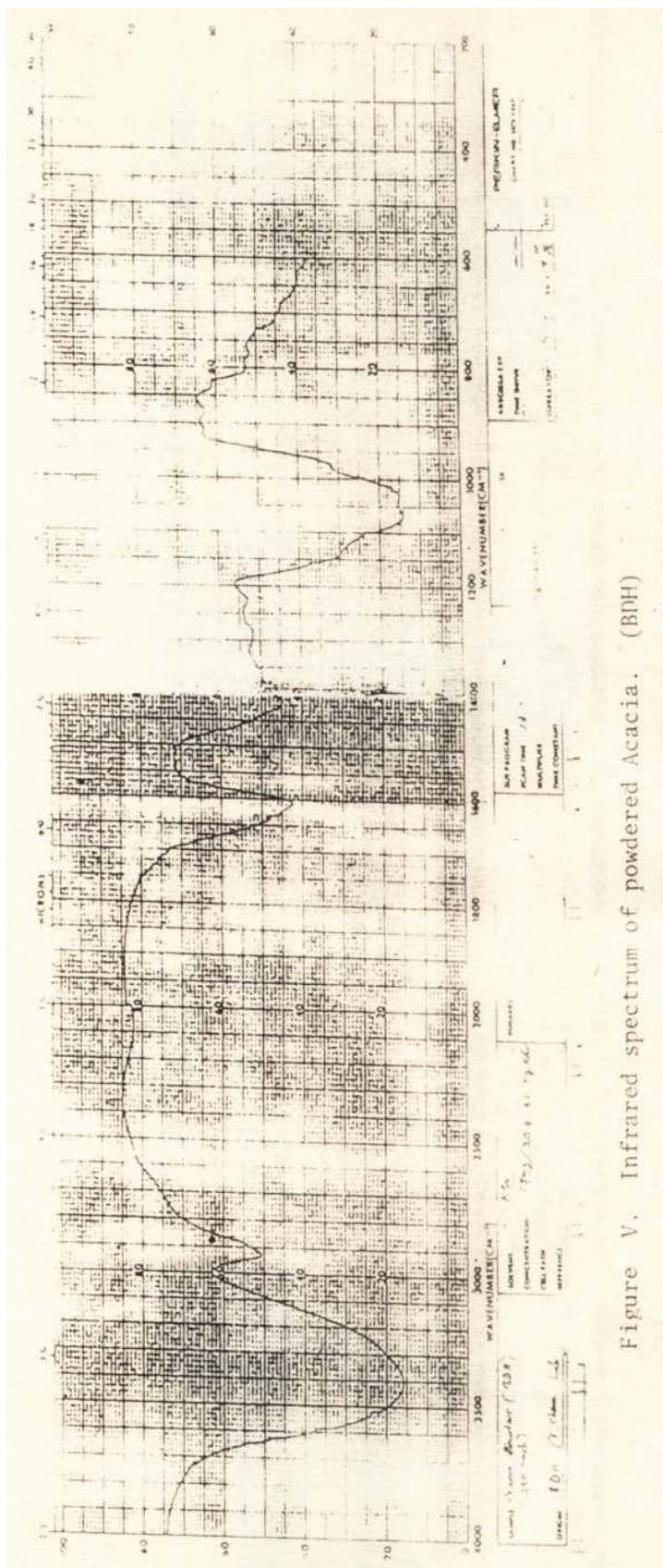


Figure V. Infrared spectrum of powdered Acacia. (BDH)

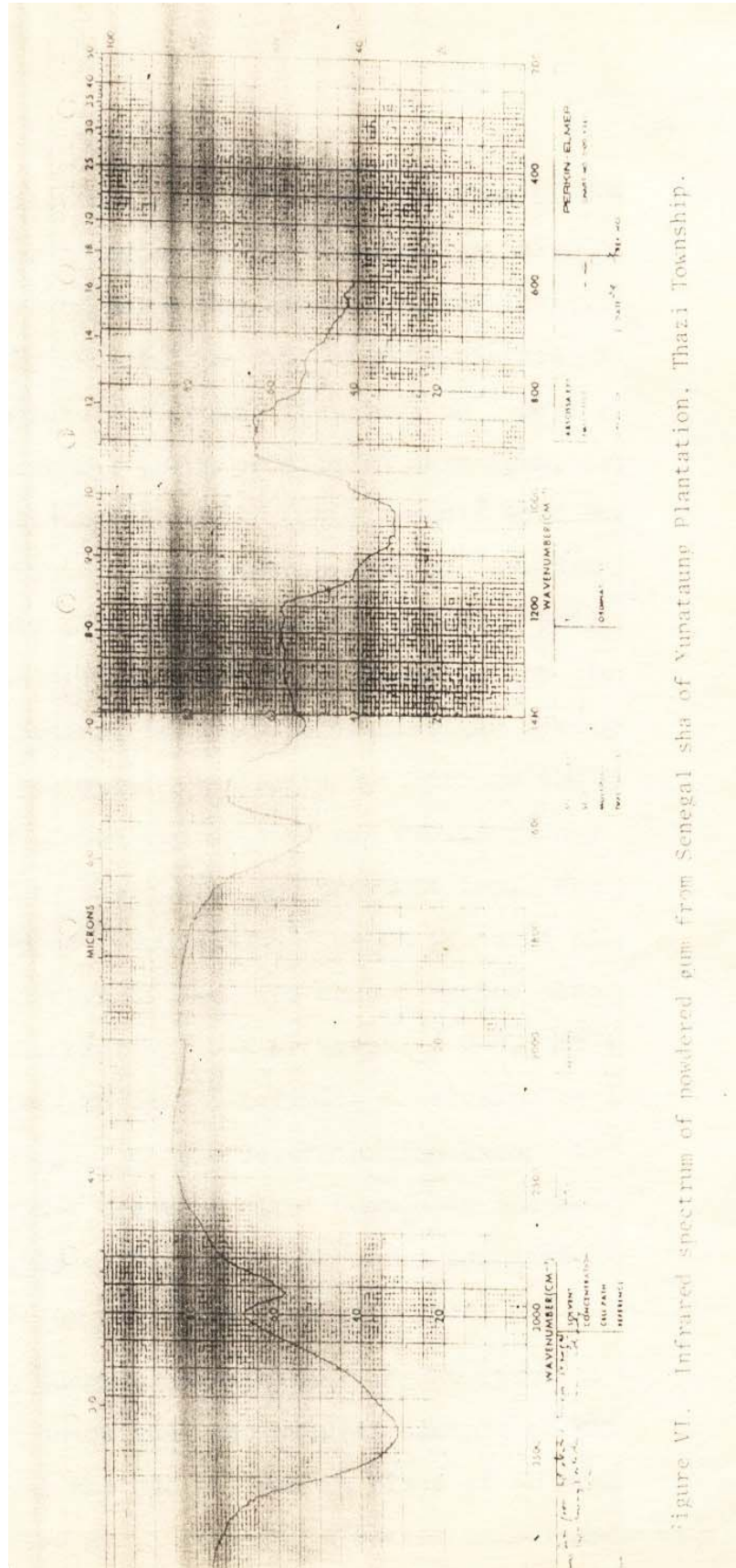


Figure VI. Infrared spectrum of powdered gum from Senegal sha of Yupatauny Plantation, Thazi Township.



preparation, the spectra of BDH-4 and S-4 are almost identical, thereby showing the true characteristics of a polymerized compound. The  $1605\text{ cm}^{-1}$  peak represents the carbonyl group of acid in salt form, especially, the glucuronic acid. ( D-glucuronic acid sodium salt shows strong peak at  $1600\text{ cm}^{-1}$ , Aldrich Library of Infrared Spectra Ed. III, 1981 ). The characterized peaks of galactose is not clearly seen because it is in polymerization mixing with acid polymers. In figure 7, although the general trend of the two spectra are similar, they are not very close like the previous two. The peaks of  $775\text{ cm}^{-1}$  and  $835\text{ cm}^{-1}$  which appeared only in the spectra of A-4 were caused by the absorption of free olefinic C-H or aromatic C-H. It is not possible to make a definite conclusion by IR spectrophotometric determination except the S-4 and BDH-4 are very close compounds and A-4 may slightly differ from them as it contains different number or different kind of branchy groups.

In accordance with the present results, there id no doubt that the natural exudate of planted Senegal sha can be used in place of BP graded imported gum. It gives a better performance than the gum of Subyu. To established a mass production of senegal gum, a complete study on the gum-tapping procedure should be carried out and the industrial requirement of gum, such as, suspension and emulsion properties, viscosity variations, etc., should be clearly determined.

## **APPENDIX I**

### Calculation of Alkali Number

$$\begin{aligned} \text{Weight of gum sample} &= a \text{ g} \\ \text{blank titre} &= b \text{ ml} \\ \text{gum sample titre} &= c \text{ ml} \\ \text{alkali number} &= \frac{(b-c) \times \text{Acid Normality} \times 100}{a} \end{aligned}$$

## References

1. Davidson, R.L. 1980. Handbook of Water -Soluble Gums and Resins. McGraw-Hill book Company, N.Y.
2. Jefferies, M., G. Pass, and G.O. Phillips. 1978. The Effect of Metal Ion Content on the Viscosity of Gum Ghatti. Journal of Science and Agriculture, 29 pp. 193-200.
3. Khin Myo Nwe, Mi 1981. Studies of Gum Arabic ( *Acacia Arabica* ) from Subyu Tree. Chemistry Department, Rangoon University.
4. Meer, W.A. 1977. Plant Hydrocollodis - Food Colloids. Chapter 14, The AVI Publication Company, Inc., Westport, Conn..
5. Thet Wai, 1981. Utilization of *Acacia Arabica* Willed., For the Preparation of Industrial Gum. Botany Department, Rangoon University.
6. Thomas, A.W. and H.A. Murray 1928. J. Phys. Chem., 32, 676.