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Study on the Quality of Gum from Acacia Senegal

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အကေးရှား စင်နီဂေါ သစ်ပင်မှ ရရှိသည့် အစေး၏ အရည်အသွေးကို လေ့လာခြင်း

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အကေးရှား စင်နီဂေါ သစ်ပင်မှ စုဆောင်းရရှိသည့် အစေးများ၏ အရည်အသွေးကို သိရှိရန် စေးပျစ်ခြင်း၊ ဓာတုပစ္စည်းဖွဲ့စည်းခြင်း၊ ပြာဓါတ်ပါဝင်မှု၊ ချဉ်ငံဓါတ်ပါဝင်မှု စသည်တို့ကို ဓါတ်ခွဲခန်းအတွင်း စမ်းသပ်ခဲ့ပါသည်။ ၎င်းအစေးများကို ၁၉၈၇-ခုနှစ်မှ ၁၉၈၉-ခုနှစ်များအတွင်း အစေးထွက်သော ရာသီဖြစ်သည့် နိုဝင်ဘာလမှ မေလအတွင်း စုဆောင်းရယူခဲ့ခြင်း ဖြစ်ပါသည်။ တွေ့ရှိချက်များအရ၊ ယခုတင်ပြသည့် အစေးမှာ နိုင်ငံခြားမှ မှာယူတင်သွင်းသော အကေးရှားခေါ် ဆူးဖြူစေးနှင့်လည်းကောင်း၊ ယခင်တင်ပြခဲ့သော စာတမ်းမှ အကေးရှားအစေးနှင့် လည်းကောင်း အရည်အသွေး တူညီကြောင်း တွေ့ရှိရပါသည်။ ၎င်းပြင် ယခု၏ရှိသော အစေးများသည် ဆေးဝါးကုန်ကြမ်းအတွက် အရည်အသွေး ပြည့်မှီကြောင်း တွေ့ရှိရပါသည်။

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Abstract

Gum samples, collected monthly during gumming season between November and May of 1987-1989 were analysed for its solution viscosity, chemical composition, loss of weight on drying, ash content, trace element content and solution pH. The results of tested samples were in agreement with those of authentic gum samples and earlier reports. The influence of weather of the gumming season on the quality (solution viscosity) of produced gum was also investigated. The results indicated that the tested gums are true acacia gums with acceptable quality for pharmaceutical and industrial use.

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1. Introduction

Plant gums are one kind of plant exudates or extractives, but differs from resins and other exudates, being insoluable in drying oils and organic solvents and decomposing completely by heating, without melting.

Gum arabic, the best known one among the plant gums, was so named because of ancient Arabian traders and it can be produced from various acacia species. But the true gum arabic of great distinction is the exudates of Acacia Senegal only. It is generally traded in two grades which are (i) clean amber and (ii) selected sorts. Grading is based upon colour and better appearance of raw gum and the latter is traded as superior quality with the colour of pale yellow and with less adhering of wood and other foreign matters, To satisfy the requirement of the consumer, the gum of both grades is usually processed into one of several forms, ie. grains or crystals, milled powder and spray-dried powder.

The plant gums are generally composed of neutral salts of uronic acids and complex polysaccharides which consists of sugar units including hexose, pentose and methyl pentose. In the gum arabic, the components of the characterized sugar units were reported by Butler and Cretcher as D-galactose, L-arabinose, L-rhamnose and D-glucuronic acid in composition of 36.8%, 30.3%, 11.4% and 13.8% respectively. E LHirst, F. Smith and J. Jackson also reported in their study of structural composition that degraded arabic acid obtained from autohydrolysis of gum arabic, was found to contain three aldobiouronic acid side chain and one major chain of six D-galacto-pyranose units to which L-arabofuranose, L-rhamnopranose, and 3-0-D-galactopyranosyl, L-arabofuranose were joined.

Current works emphasize assessment of gum arabic produced from plantation of exotic Acacia senegal by studying some of its physical and chemical properties essentially required for industrial use. There is no doubt that the present study of quality variation with respect to the various seasonally exuded gum arabic is being carried out for the first time in Myanmar.

2. Experimental

2.1 Sample

Gum samples were collected from mechanical injuries of stems of planted *Acacia senegal* Willd. from the plantations of Yupataung, Thazi Township and Yeposa, Chaung Oo Township. They were collected every month during the gum bearing season which falls between November and May. The collected samples were air-dried, cleaned by removing wooded tissues and other impurities and powdered to pass through 60 mesh sieve. The powdered samples were kept in air-tight glass containers.

Acacia of General Purpose Reagent grade from British Drug House (BDH) in the forms of granules and tears and Acacia (Gum arabic) in purified powdered from manufactured from Kiedel-Dihaen AG Seelze-Hanoover were used as authentic samples throughout the experiment. The Acacia of BDH was powdered following the same procedure as that of the local gum.

2.2 Viscosity

To measure the viscosity of each of the local gum and BDH gum, Ostwald Viscometer, size No. 2, from Technio, England, was used. For every batch of investigations, the viscometer was washed with chromic acid and afterwards with volatile solvents. It was calibrated with redistilled water and then with 60% (W/W) sucrose solution separately before test for sample. During the experiment, the viscometer was vertically fastened in thermostatic-controlled water bath at temperature of 30^{o} C.

The gum-water solutions in concentrations of 2,4,6,8,12, and 16 % (W/V) were prepared and densities of the respective solutions were determined by means of a pyknometer at the same experimental temperature. Then, 10 ml aliquate of respective gum solution was pipetted into the viscometer and time interval taken to flow mark to mark by the solution was noted. The viscosities obtained were tabulated in Table (1).

2.3 Calculation

n1	=	0.895 centipoise (Viscosity of redistilled water)
p1	=	density of redistilled water
t1	=	time of redistilled water (Viscometer)
n2	=	Viscosity of gum solution
p2	=	density of gum solution
t2	=	time of gum solution

$$\frac{t1}{t2} = \frac{n1 / p1}{n2 / p2} = \frac{n1\ p2}{n2\ p1}$$

2.4 **Qualitative Analysis**

Paper Chromatography

About 1.0g of powdered gum was weighed first and dissolved in 25 ml of 0.5 M sulphuric acid by stirring and insoluble matters were separated out. The resultant solution was refluxed for 8 hrs. (The optimum refluxing time had been previously investigated). After cooling the refluxtant , it was neutrallized by adding dried barium carbonate powder (A.R) slowly and stirring until the pH of the solution reached 5.5. The neutral solution was isolated by means of Buchner filtration. The filtrate including the washings was concentrated to about 5 ml and it was stored in a refrigerator.

Whatman No. 4 chromatography paper was used for separation of reduced sugars. The solvents used were n-butanol- pyridine-water in four different ratios of 6:4:3, 10:4:4, 3:1:1 and 5:1:4. Among these alternatives, That which was mixed with the first ratio was mostly used. Seperation times were within 3-4 hours with subject to size of tank and room temperature. Resultant chromatograms were viewed under short wave UV light (254 nm) before and after color developing. One of the two color developing methods, ie. spraying with aniline-xoalate* reagent and dipping in silver nitrate solution was ocassionally used. But the former alternative was widely used throughout the investigation due to its easy handling and effective color seperation between hexoses and pentoses although those colors become faint by and by (Analine dyes hexoses yellow and pentoses red).

2.5 Quantitative Analysis

Preparative Paper Chromatography

About 1.0 g of the gum powder was exactly weighed and acid-hydrolysed, the procedure being the same as the procedure of qualitative analysis so as to get about 5.0 ml of neutrallized reduced sugar solution. The solution was made up made to 10 ml.

Whatman No. 4 chromatograph paper were used. left and right ends of paper were used only for measuring standard sugar mixture containing 0.01 ml each of 2% solutions of galactose, arabinose, xylose and rhamnose. The middle portion which is sufficient for four kinds of spotting was to drop the reduced sugar solution in total volume of 0.04 ml was equally divided into four spots on the chromatography paper. Solvent system was n-butanol-pyridine-water (6:4:3) and chromogenic spray for the first and last section after elution and after cutting them from mother paper with aniline-oxalate solution. By reference-guide strips on which the specific colored spots reveal respective sugars, the middle part of the mother paper was horizontally cut off into stripes (four strips) covering the specific reduced sugars. Then the sugar from each paper stripe was completely eluted out by distilled water separately. Resultant solutions of each reduced sugar were made up to 10 ml.

2.6 Somogyi Titration

An aliquate of Somogyi solution (5 ml) was mixed with distilled water (5 ml) and another 5 ml aliquate of Somogyi solution was mixed with a mixture of 0.5 ml standard galactose solution (0.5 mg/ ml) and 4.5 ml distilled water. Tubes containing the above solutions respectively were heated in water bath for fifteen minute and then cooled down immediately in ice bath. Each tube was added with 0.5 ml of 2.5% potassium iodide solution very slowly and the resultant solutions were acidified rapidly with 1.5 ml each of 1 M sulphuric acid. (Color changes from blue to yellow). Then the solutions were titrated separately with standard sodium thiosulphurate solution using starch as an indicator.

More Somohyi titrations were consequently done using 1.0, 1.5,2.0 and 2.5 ml standard galactose solutions (0.5 mg/ml) in the same procedure as above to get results for a diagram plot of Weight of Standard Galactose Vs Volume of Titre. The same producre was also used to construct similar reference diagrams for standard arabinose, xylose and rhamnose solutions.

Somogyi titrations for 10 ml each of respective reduced sugar solutions and also for the blanks were done, following the same procedure. Amount of reduced sugar dissolved in the solution was determined by means of resultant titres and the reference diagram of respective sugar.

2.7 Loss of Weight on Drying

Weight-known gum sample (2.0 g) (powder or grain) was dried by means of an electric oven at the temperature of 105^{o} C for 5 hrs. Then difference in weights was converted to percent value.

2.8 Ash Content

Oven-dried gum sample (2.0 g) was weight exactly and heated in a muffle furnace at the temperature of 400^o C for one hour and then the temperature was raised up to 600^o C. The heating was repeated until a constant weight was obtained.

2.9 Trace Elements

The ash of gum was dissolved in a hydrochloric acid solution and amounts of calcium, magnesium and potassium ions in the solution were determined by means of Perkin Elmer Atomic Absorption Spectrophotometer.

2.10 P^H of gum solution

KENT EIL 7055 p^H meter was used to determine the p^H of 10 % gum water solutions.

3. Results and Discussion

3.1 Viscosity

The structure and the size of polymerization in plant exudates govern the viscosity of the solution or the muscilage of it in water. The solution viscosity is one of the most important measures to judge whether the quality of a gum is satisfactor or not Among the plant exudates, gum arabic is wellknown as it can produce concentrated solutions up to 50% concentration at 25^o C with comparatively low viscosity (G.E Osborne and C.O Lee, 1951). The values of solution viscosity, a significant physical property of gum arabic, obtained in this experiment are summarized in Table 1. The concentration trend on the solution viscosity of gum is presented) in Figure 1,2 and 3. Figure 4 shows variation of the solution viscosity of the gums collected in different months of gumming season.

Table 1. **Solution viscosity of gum.**

Gum Samples	Solution Viscosity (Centipoise)					
	2 %	4 %	6 %	8 %	12 %	16 %
Yeposa						
12/87-1/88	1.72	2.52	3.62	4.73	7.63	11.28
2/88	1.67	2.38	3.11	4.02	6.45	10.18
3/88	1.55	2.10	2.89	3.76	6.02	8.55
5/88	1.75	2.56	3.52	4.97	7.46	11.20
2/89	1.81	2.78	4.58	5.03	8.70	12.94
3/89	2.26	3.64	5.43	7.22	13.30	19.40
4/89	1.95	2.90	4.29	5.41	9.45	13.86
5/89	1.75	2.44	3.52	4.49	7.19	9.40
Yupataung						
3/89	1.95	2.95	4.21	5.73	10.52	16.36
4/89	1.78	2.67	3.94	4.95	8.03	13.12
5/89	1.74	2.44	3.51	4.60	7.42	11.33
PG	1.69	2.41	3.29	4.20	7.06	10.65
BDH	1.67	2.44	3.03	4.20	7.07	10.90

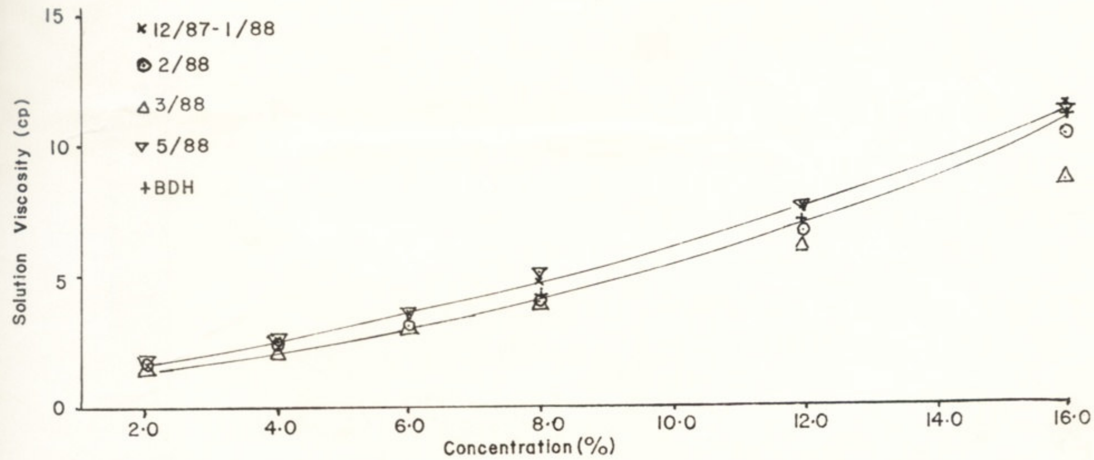

Figure 1. Viscosity as a function of concentration for gum arabic solutions prepared by the gums of Yeposa plantation collected between Dec. 1987 to May 1988 and those of BDH gum sample.

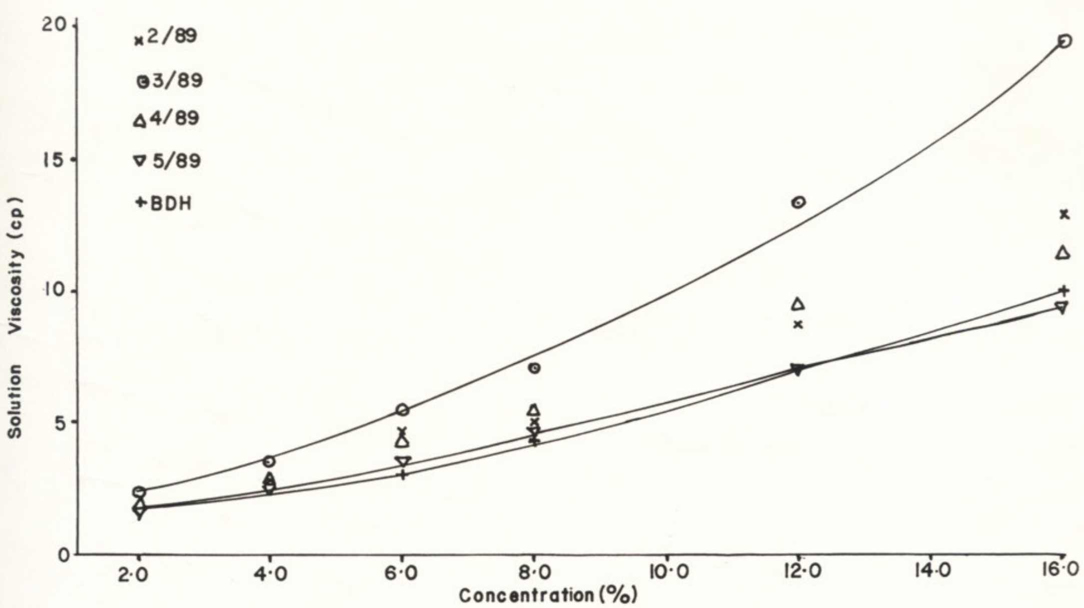

Figure 2. Viscosity as a function of concentration for gum arabic solutions prepared by the gums of Yeposa plantation collected between Feb. to May 1989 and those of BDH gum sample.

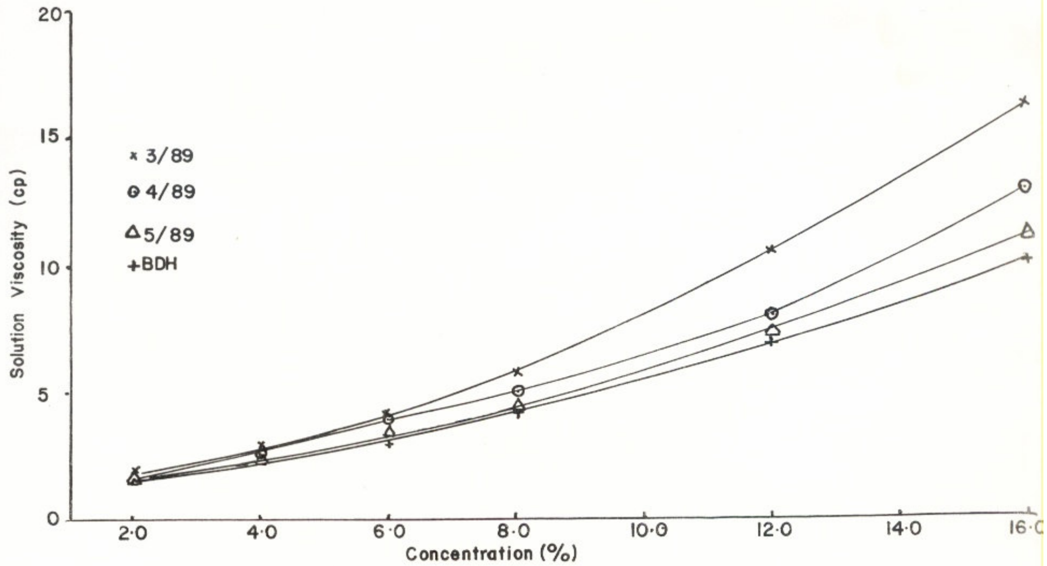

Figure 3. Viscosity as a function of concentration for gum arabic solutions prepared by the gums of Rupatong plantation collected between Mar. to May 1989 and those of BDH gum sample.

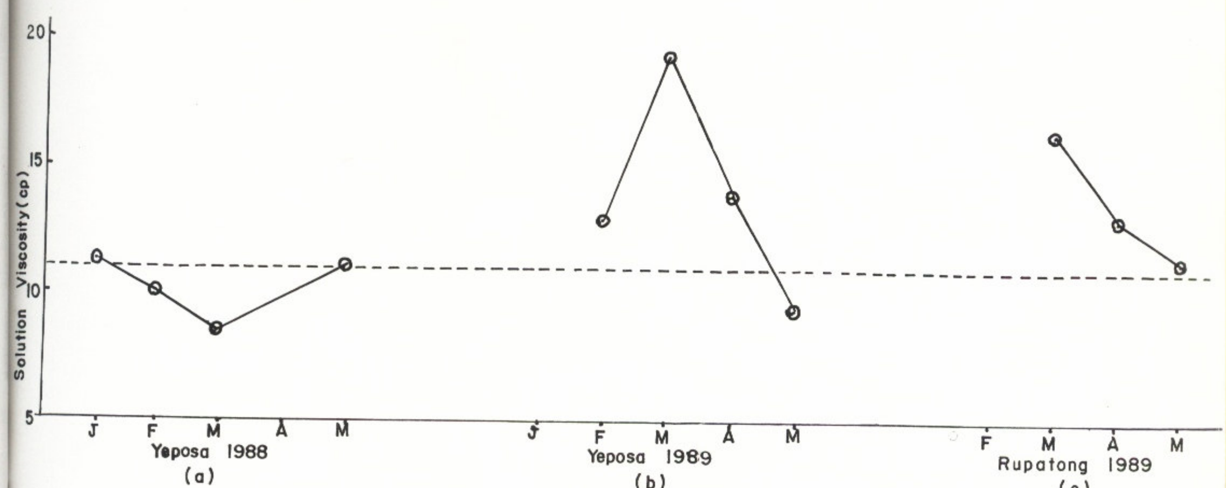

Figure 4. Effect of gum-forming month on the viscosity of 16% gum arabic solutions prepared by the gums collected from (a) Yeposa plantation in 1988 (b) Yeposa plantation in 1989 and (c) Rupatong plantation in 1989 (dotted line is for the viscosity of 16% BDH gum arabic solution).

Although gum-tapping and yield-study was observed for the whole years, the gumming season was found to lie between November and the start of the monsoon in May the following year. The regular-gum-picking was done monthly. However no exudation occurred in some months during unfavorable environmental conditions. Comparing the two sites studied, Yeoposa was found to have a longer gumming season of about 4 to 5 months whilst Yupatong shows a shorter period of 1 to 3 months only.

Figure 1 to 3 show similar trends of viscosity for the range of 2 % to 6 % gum-water solutions. Up to 8 % concentration, a plot of solution viscosity against the concentration shows a straight line correlation similar to the study of Mi Khin Myo Nwe (1981) who presented the solution viscosities of an imported gum arabic within the range of 1 % to 10 % concentration. But beyound that region, the solution viscosity increased up to about 19 cp. for 16 % concentration in deviation from the initial straight-line correlation. Oswalt Viscometer, the only available instrument in this study is not fit for the higher viscous region in which the most workable range of viscosity generally lies. But in comparison with the values of standard gums. ie. BDH and PG the results obtained mostly agree with those of standard samples showing that the tested gums possess usable quality for industry. In the same correlation trend to this present finding. G.E Osborne and C.O. Lee (1951) observed a viscosity concentration correlation for various solution-concentration up to 50 % which gave the maximum viscosity of 7000-10,000 cp.

Figure 4. a, b and c are presented to show the effect of weather on the solution viscosity of gum. Those diagrams were constructed with the viscosity values of 16% gum-water solutions. The figures apparently show the gradual decline of viscosity month by month in the gumming season as a normal time trend except in some outstanding values. As the number of polymerization tends to become varied due to varied due to various factors such as temperature, light, moisture and relative humidity, raining condition, etc., the exudates with the exceptional viscosity which lies out of the trend are considered to be formed in the irregular weather conditions. Meteorological data of relative humidity for Myinmu. The nearest place 12 miles away from Yeposa where a township- meteorological station is located and Yupatong between 1984-1988 shows that March was generally found to be the least humid season and the moisture content of top soil as well as the plant-parts seemed to be the least in that month. Coincidentally, the viscosity of exudate occurred in that season is generally the highest and the viscosity falls down in the later months with increasing relative humidity. But the trend of the monthly viscosity for 1988 did not show the highest for the gum extracted in March although that month had the lowest relative humidity. An unusual occurrence of few shower reported by the Myinmu meteorological station in February 1988 may be one of the possible causes for the irregular variation in viscosity of exudate although the period between January and March was the rain-free season according to the meteorological reports for that region between 1984 and 1986. After that small shower, the gum-viscosity was gradually falling down till it rose again in May as a result of missing the usual introductory-monsoon precipitation in April. So the dry weather and the high temperature of April possibly made the gum exdudate increase in the solution viscosity. The possibility of variation up to 50% for the solution viscosity of the gum arabic was previously recorded and age of parent tree, amount of rainfall, time of exudation, and type of storage were considered as the influential factors for the properties of that exudate. (Willion Meer, 1980) William Meer, Gum Arabic in Handbook of Water Soluble Gums and Resins edited by R.L Davison , McGraw-Hill Book Co., N.Y, 1980.

Although all the exudates harvested throughout the gumming season are blended and sorted by appearance for usual trading in average quality, the effect of the weather condition on the viscosity of gum may be helpful for some specific cases on application.

3.2 Reduced Sugars

Chemical structures of natural exudates, especially the gums, are very complicated. Most gums are composed of a neutral or slightly acidic salt of a complex polysaccharide. Main skeleton or nucleus of the gum-arabic structure was already investigated showing that D-galactose and D-glucuronic acid units are mainly present in it joined by glycosidic bondings. The highly branched functional groups composed of monosaccharides are attaches to those nucleus and degrees and forms of those branchings are not definite. So the properties of gum may vary from time to time due to its indefinite state of composition and polymerization. In certain gums, methyl pentoses may be present showing the existance of L-rhamnose in gum arabic. E.L. Hirdt (1942) and others seperately described D-galactose, L-arabinose, and L-rhamnose as the composed monosaccharides of gum arabic. But record for the existance of D-xylose in gum arabic was very exceptional.

In this study, the formal monosaccharides of gum arabic was investigated quantitatively and quantitatively in comparison with those of the standard gums to prove the being of genuine gum. But identification for uronic acid of the gum was not emphasized as some essential facilities were not readily available. The reduced sugars obtained from the acid hydrolysis of gums were principally identified by paper chromatography. Analine-oxalate was a quite effective reagent rather than aniline-diphenylamine and silver nitrate as it can give different colours between pentoses and hexoses. A chromatogram of the reduced sugars of gum together with the authentic samples is shown in Figure 5. The amount of the components shown in Table 2 were estimated from sopt size, intensity of fluorescence under short and long wave UV light (254/366 nm) and colour on the chromatogram of figures 5 after spraying with the aniline-oxalate reagent. The major components found on the chromatogram were uronic acid (acids) (predicting by means of literature R_f values) with some unknown compounds (shown by fluoresces [4] spots under UV), D-galactose, L-arabinose, and L-rhamnose. A faint spot corresponding to R_f value of L-xylose on chromatogram was also found in some batches of the experiment but in some cases it was not detectable. R_f values of the respective reduced sugars matching with those of authentic sugar samples were tabulated in Table 3, identifying the component sugars of hydrolysed gum.

The quantitative distribution of composed sugars in gum were summarized in Table 4 with values of percent content and rounded figures of number of molecules. Most of the gum studied showed the unit composition of 3 moles. of D-galactose, 2 moles. of L-arabinose, and to 1 mole. of L-rhamnose t o give totally 6 moles. Generally, the results do not vary much from that ratio of 3:2:1, but few exceptional cases were also found to occur as 1.5:4:0.5 and 2:3:0.5 (:0.5) which are quite different from the above. Apart from this deviation, the ratio of (3:2:1) completely agreed with the finding of E.L. Hirst (1941). A different composition of gum arabic as 36.8% D-galactose, 30.3% L-arabinose, 11.4% L-rhamnose and 13.8% glucuronic acid (approx. 4:4:1.5 of gal.-rham.) also had been reported by C.L. Butter and L.H Cretcher (1929). In This study, the standard gums gave the same results to those of the tested gums and the result confirmed that the existence of D-xylose in gum arabic is unsusal. Even if found, the xylose content may be less than half a molecule in the above ratios.

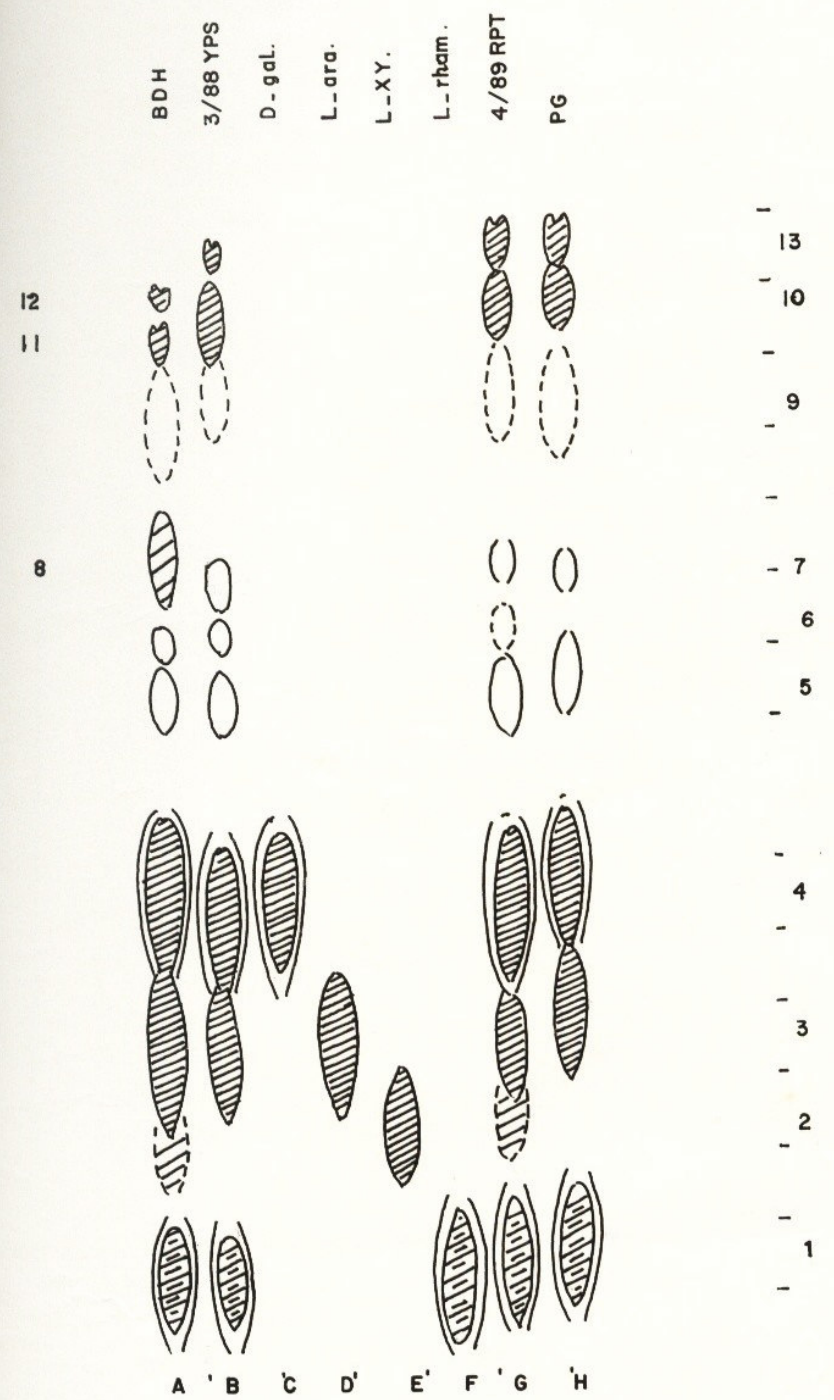

Figure 5. Paper Chromatogram of reduced sugars with reference to authentic samples; (A) BDH gum, (B) Yeposa gum smaple of March 1988, (C) D-galactose, (D) L-arabinose, (E) L-xylose, (F) L-rhamnose, (G) Rupatong gum sample of April 1989, and (H) PG gum; Solvent: n-butanol-pyridine-water, 6:4:3 and viewed by aniline-oxalate reagent and then under UV light (336 nm).

Table 2. Components obtained after acid hydrolysis of gum arabic with reference to Figure 5.

Component	Identity	Response to UV light (366 nm)	Response to Aniline-oxalate	Amounts* in			
				3/88 XPS	4/89 RPT	BDH	PG
1	L-rhamnose	Opaque, white Blue rimmed	Yellow	+ +	+ +	+ +	+ +
2.	L-xylose	OP.	Red	-	t	+	-
3.	L-arabinose	Op.	Red	+ + +	+ + +	+ + +	+ + +
4.	D-galactose	Op. W.B rimmed	Yel. Br .	+ + +	+ + +	+ + +	+ + +
5.	Unknown 1	White Blue	-	+	+	+	+
6.	Unknown 2	White	-	t	t	t	-
7	Unknown 3	White Blue	-	+	+	-	+
8	Unknown 4	Pink	Pink	-	-	+	-
9	Unknown 5	Op. & Blue	Pink	t	t	t	t
10	Unknown 6	Op.	Pink	+	+	-	+
11	Unknown 7	Op	Yel.Br	-	-	+	-
12	Unknown 8	Yel.	Yel.	-	-	t	-
13	Unknown 9	Op	Yel. Br.	+	+	-	+

* + + +, Large amount; + +, medium; +, small; t, trace; -, not detected (amounts estimated from spots size and intensity of colour)

Table 3. R_f values of reduced sugars obtained by acid hydrolysis of gum arabic together with those of authentic sugars.

Solvent : n-butanol-pyridine-water, 6:4:3/ Reagent : aniline-oxalate

Sample	1(L-rham.)	2.(L-xy.)	3.(L-ara.)	4(D-gal)	room temp.
<u>Yeposa</u>					
12/87-1/88	0.63	-	0.45	0.35	26^o C
2/88	0.65	-	0.49	0.37	
3/88	0.64	-	0.49	0.36	
5/88	0.66	-	0.48	0.37	
Authentic samples	0.66	-	0.46	0.37	
<u>Yeposa</u>					
2/89	0.56	-	0.36	0.25	35^o C
3/89	0.58	-	0.36	0.25	
4/89	0.55	0.44	0.33	0.22	
5/89	0.54	0.43	0.33	0.24	
Authentic samples	0.52	0.44	0.35	0.25	
<u>Yupatong</u>					
3/89	0.62	0.53	0.40	0.28	35^o C
4/89	0.64	0.52	0.40	0.28	
5/89	0.64	-	0.42	0.30	
Authentic samples	0.66	0.51	0.42	0.31	

Table 4. Unit content of component sugars (in percent and number of mole) and mole ratio.

Sample	Component Sugars Content									
	% content				mole content / unit					
	gal	ara	rh	xy	gal	ara	rh	xy	mole ratio	Total
<u>Yeposa</u>										
12/87-1/88	19.8	13.5	2.0		0.31	0.25	0.03		3: : 2.5 : 0.5	6
2/88	16.0		4.4		0.31	0.19	0.09		3 : 2 : 1	6
3/88	28.0	14.4	10.7		0.29	0.18	0.12		3 : 2 : 1	6
5/88	22.5	15.5	7.0		0.28	0.23	0.09		3 : 2.5 : 1	6.5
2/89	5.4	10.8	2.0		0.16	0.4	0.07		1.5 : 4 : 0.5	6
3/89	26.3	15.7	5.4		0.31	0.22	0.07		3 : 2 : 0.5	5.5
4/89	23.0	26.0	5.4	4.4	0.22	0.29	0.06	0.05	2 : 3 : 0.5 : 0.5	6
5/89	19.7	18.7	17.7	1.2	0.19	0.22	0.19	0.01	2 : 2 : 2	6
<u>Yupatong</u>										
3/89	19.7	16.2	2.3	1.0	0.28	0.28	0.04	0.02	3 : 3 : 0.5	6.5
4/89	20.7	15.5	7.6	1.3	0.25	0.23	0.1	0.02	2.5 : 2.5 : 1	6
5/89	4.5	3.8	2.6		0.23	0.23	0.15		2.5 : 2.5 : 1.5	6.5
BDH	32.6	16.8	2.6	2.7	0.33	0.2	0.03	0.03	3.5 : 2 : 0.5 : 0.5	6
P.G	54.4	34.1	8.9	2.4	0.30	0.23	0.05	0.02	3 : 2.5 : 0.5	

The present finding of the gum composition is very similar to the results of gum from *Acacia sundra* reported by S.Mukherjee and A. N. Shrivastava (1958) who found 3:2:1 mole. ratio of D-galactose, L-arabinose, and L-rhamnose with some trace amount of xylose in it. But Mi Khin Myo Nwe (1981) reported the existence of 1:3 mole. ratio of D-galactose, and L-arabinose, in gum arabic from BDH company (20%

and 44% respectively obtained by means of Somogyi's method) in her study of indigenous gum from *A. arabica.* She did qualitative study only on L-rhamnose by paper chromatography to compare the true gum arabic with the above gum which did not show the existence of that sugar.

3.3 Tests for the British Pharmacopeia Specifications

Some of the tests and results for the B.P. specifications on gum arabic samples exuded naturally from a plantation of Senegal Sha (*A. senegal* (L) Willd.) in Yupatong, Thazi Township were presented in a previous paper (Tun Aung, Aung Soe and Li Li Aung , 1987). In the current study, three gum samples obtained from test-tapping of *A. senegal,* Yeposa plantation in December 1987, March 1989, and May 1989 respectively were sent to the Methods Research , and Quality Control Dept., Development Centre for Pharmaceutical Techniques (D.C.P.T) Yangon for analysis and the results sent back were presented in Table 5.

Table 5. Results for tests of BP specifications on the gum samples of test-tapping.

Tests \ Sample	12/1987	2/1989	5/1989
(I and M No, DCPT)	5884	6595	6595
Description	*	**	***
Identification	S	S	S
Solubility	-	S	S
Sol. in alcohol	S	-	-
Sol. in water	S	-	-
Optical rotation	N.S	N.S +	N.S +
Starch and Dextrin	S	S	S
Tannin	S	S	S
Insoluble matter	0.15% S	0.44 % S	0.18 % S
Ash	3.61 % S	3.92 % S	3.33 % S
Acid-insoluble ash	0.06 % S	0.29 % S	0.29 % S
Loss on drying	14.10 % S	17.7 % S	16.8 % S

* Pale Amber, opaque and irregular shaped masses of varying size, about 1.0 to 3.5 cm in diameter, having slight odour.

** Amber, opaque and irregular-shaped masses of varying sizes, about 1.5 to 5.5 cm in diameter, having a slight odour.

*** Pale amber, opaque and irregular shaped masses of varying sizes, about 1.4 to 5.5 cm in diameter, having a slight odour.S and N.S denote satisfactory and not satisfactory, respectively, according to the British Pharmacopoeia (1968) specifications. + A 10% w/v solutions is apaque and does not permit to measure its optical rotation.

Except for the results for optical rotation and Loss on Drying, the gum passed the tests of B.P. specifications. The unsatifactory results for the optical rotation of gum solutions is considered to be due to the affect of age of mother-tree. Although that unsound reason cannot be solved at the moment, more attempt for the loss of Weight on Drying was dome again in own FRI laboratory and it was found that the results obtained for both powdered gum and crude-gum grains lie within limit of 15 % of B.P specification.

Table 6. Loss of Weight on Drying

Sample	Loss %	
	Powder	Crude
88 YPS	4.83	9.15
89 YPS	3.70	7.35
89RPT	3.69	6.59
BDH	5.74	9.60

The ash content was also determined as an intermediate step for the study of Trace Element Content in gum. Among the trace elements present in the gum, calcium, magnesium and potassium were only detected as they are the correct cations forming in the salt of a complex polysaccharide of gum arabic. Table 7 presents the contents of ash and trace elements in gum and trace element content of ash in comparison with the results of the authentic samples. The ash contents obtained are acceptable according to the B.P specification. Although the trace elements are found to exist in different proportions in differently collected gums, those results do not differ greatly from those of the authentic gums, But a previous work by Mi Khin Myo New (1981) expressed a very low content of potassium, 0.003 %, in her authentic gum-arabic sample in comparison with the amounts of calcium and magnesium of 0.81% and 0.205 % respectively. So, the results demonstrate that the gum contains calcium, magnesium, and potassium cations in different proportions due to the different sources and seasons of collection, similar to the amounts of other composed monosaccharides.

Table 7. Contents of ash & some trace elements in gum arabic.

Sample	Ash (%)	Trace Elements (%)						
		Ash			Gum			
		Ca^{++}	Mg^{++}	K^{+}	Ca^{++}	Mg^{++}	K^{++}	Total
YPS								
2/89	3.48	13.46	5.19	16.42	0.47	0.18	0.57	1.22
3/89	2.19	13.61	4.63	14.78	0.30	0.10	0.32	0.72
4/89	2.54	11.28	6.43	21.19	0.29	0.16	0.54	0.99
5/89	3.36	12.32	5.64	14.75	0.41	0.19	0.50	1.1
BDG	3.03	22.15	7.10	15.16	0.67	0.22	0.46	1.35
P.G	2.93	18.01	6.09	14.85	0.53	0.18	0.44	1.15

3.4 Other Tests

E. Smith (1939) and F.W Tieback prepared arabic acid from gum arabic and it was reported to be a moderately strong acid with a p^H range of 2.2 to 2.7 for aqueous solution and with a Ka value of 2.0 x 10^{-4} (22^o C). The pH values of 10 % gum solution were determined in this present study and those for the tested gum are found to be almost the same to that of the authentic sample, (see Table 8) showing that the present gums are slightly acidic complex polysaccharide.

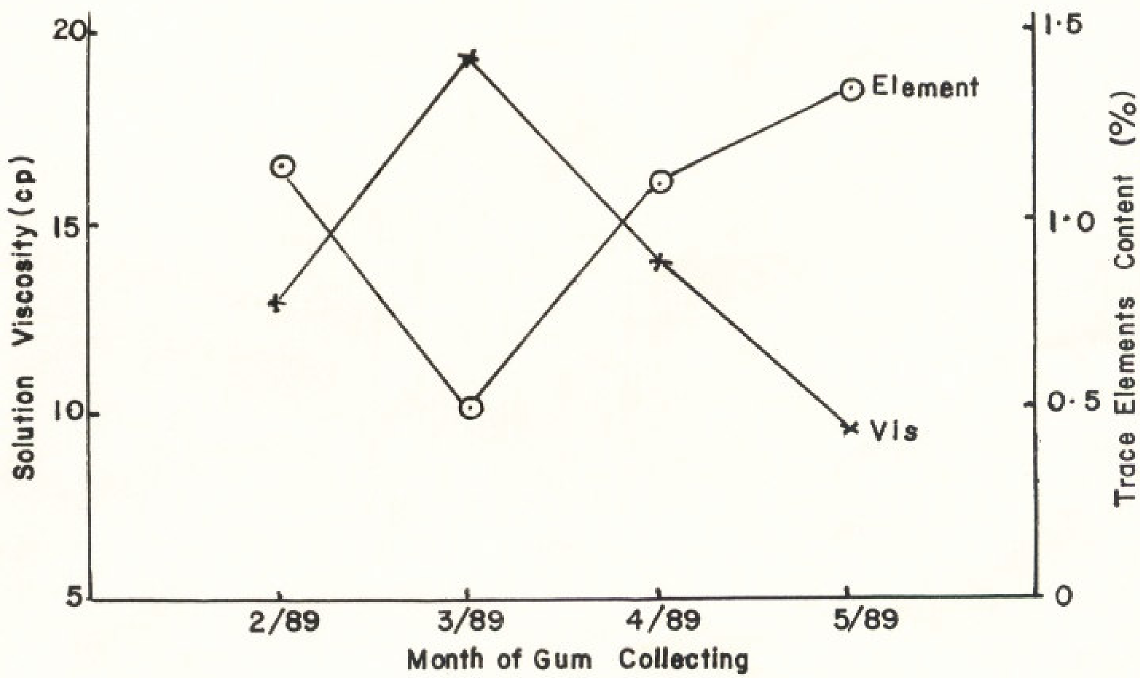

Figure 6. Comparison of the total amount of trace-element cations (calcium, magnesium, and potassium) and the viscosity of 16% gum solutions of 1989 Yeposa gums.

Table 8. p^H values of 10% gum solution

Sample	P^H
3/88 YPS	4.60
4/89 YPS	4.73
4/89 RPT	4.40
BDH	4.40

Due to the work of F. Smith mentioned above, the present p^H values tabulated in Table 8 may be governed not only by the pH of the salts of arabic acid but also by that of small amount of free acid. They also reported that the arabic acid alone produces a higher solution viscosity than does its salts. In agreement to that report, a reverse correlation between the total content of calcium, magnesium and potassium cations and the solution viscosity of gum (16 % solution) (see Table 7 and 1) makes it very interesting as shown in Figure 6. The low content of major cations in gum means the presence of more free arabic acid hence makes the solution viscosity high.

The finding assists to conclude that the gum arabic contains a mixture of the salt of complex polysaccharide and the free acid in indefinite proportions so that it can vary the solution pH from about 4.0 to neutral.

4. Conclusion

(1) The solution viscosity and the chemical composition of the gum extracted from planted *A. senegal* Willd. is almost identical to those of the authentic samples proving the genuineness of gum arabic.

(2) Furthermore, drought in the region of the acacia plantations makes the solution viscosity of produced gum high.

(3) Except for the optical rotation, the results for the other physical and chemical properties of the tested gums are satisfactory according to the British pharmacopoeia Specifications so that gum arabic with the distinctive properties suitable for both pharmaceutical and industrial uses can be produced from our planted *A. senegal* (Willd).

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