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Analytical Studies on the Gum Exudates from *Anogeissus leiocarpus*

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Abstract: *Anogeissus leiocarpus* gum samples were collected randomly as natural exudates from 3 different locations in Sudan, namely Abojebiha (season 1994-1995), Elfula and Rosaries (season 1996-1997). Physicochemical properties of gum samples (moisture, ash, nitrogen, protein, specific rotation, relative viscosity, refractive index, equivalent weight, pH, uranic acid, reducing sugar and tannin content). Results showed significant differences within each location in most parameters studied except in the refractive index values which was found to be constant in all samples (1.334). The effect of location on the properties of gum samples was also studied and the analysis of variance showed insignificant differences ($p \leq 0.05$) in all properties studied except in ash content and this may be due to the differences in the type of clay soil which found in the three different locations. The general characteristics of *Anogeissus leiocarpus* gum might be described as the mean value of all properties studied of all gum samples of the three different location as follows: 9.2% moisture, 3.4% ash, 0.72% nitrogen, 4.74% protein%, -35.5° specific rotation, 1.68 relative viscosity, 4.2 pH, 1.334 refractive index, 14.3% uranic acid, 0.44% reducing sugar 1336.0% equivalent weight and 0.68% tannin content. UV absorption spectra of gum samples were determined and the maximum absorption points were found the same ranging between wave length 243 and 285. Cationic composition of gum samples was also determined and the results showed that magnesium (Mg) has the highest value in all samples followed by iron (Fe), sodium (Na), potassium (K), calcium (Ca), zinc (Zn) and trace amount of manganese (Mn), copper (Cu), nickel (Ni), cadmium (Cd) and lead (Pb). Functionality (water holding capacity and emulsifying stability of *Anogeissus leiocarpus* gum were studied. The water holding capacity value was found to be 65.5% and emulsifying stability value was found to be 1.008 insignificant differences were observed between *Anogeissus leiocarpus* gum and *Acacia senegal* gum for the 2 parameters studied.

Key words: *Anogeissus leiocarpus*, gum, exudates, analytical parameters

INTRODUCTION

Plant gums are organic substances obtained as an exudation from fruit, trunk or branches of the trees spontaneously or after mechanical injury of the plant by incision of the bark, or after the removal of the branch, or after invasion by bacteria or fungi. The exudates becomes hard nodules or ribbons on dehydration to form a protective sheath against microorganism. They form clear glassy masses, which are usually colored from dark brown to pale yellow.

These gums are classes of high molecular weight polymeric compounds composed mainly of C, H, O and N are capable of possessing colloidal properties in an appropriate solvent, or swelling agent at low dry weight. They occur naturally as salts (especially of calcium and magnesium) and in some cases proportion of the hydroxyl group are esterified most frequently as acetates. In practical term gums are either hydrophobic or hydrophilic. Hydrophobic gums are insoluble in water and include resins, rubber, etc where as hydrophilic gums are soluble in water and can be subdivided into natural, semi-synthetic and synthetic gums.

Testes used to characteristic of plant gums: In order to identify a particular gum from a series of different gum exudates an extensive number of analytical tests have to be performed (Anderson, 1986). This approach enable a finger print of each gum to be determined. the analytical test currently used include determination of the total ash, nitrogen (hence protein) methoxyl contents, measurements of optical rotation, intrinsic viscosity, equivalent weight, analysis of the ratio of neutral sugars (galactose, arabinose and rhamnose) and glucuronic acid content after hydrolysis and measurement of molecular mass.

Properties and application of plant gum: The most fundamental property of a gum which makes it unique amongst polysaccharide generally is its solubility and viscosity. The majority of gums dissolve in water at different concentration (e.g., Gum Arabic can form solutions of up to 60% forming viscous solutions). These properties of gums are exploited in many applications. The major application of gum is in food industry where emulsifying and stabilizing properties are utilized. The gum is also used in the pharmaceutical and

medical fields, in addition to other industries (cosmetic, adhesive, paints and inks).

Gum from *Anogeissus leiocarpus* (*Anogeissus schimperi*)

Definition of the family: *Combertaceae* is a family of 20 genera and 600 species tropical and subtropical trees and shrubs. Generally *combertaceae* was known as rich sources of tannin. Genera include Terminals, Combertum, Quisqualis, Myrobolansand Anogeissus (Hans, 1990) some gums from combertaceae are being increasingly utilized commercially for example ghatti gum and *leiocarpus* gum.

Nomenclature: *Anogeissus leiocarpus* (DC) Guill, Perr. *A. schimperi* Hochst ex and Dalz. Arabic: Sahab (Elamin, 1990)

General distribution: *Anogeissus leiocarpus* tree is widely distributed in Africa between isoheight of about 200 mm and the rain forest, from Senegal to Sudan and Ethiopia, in the south to Zaire (Hans, 1990).

In Sudan *Anogeissus leiocarpus* tree is widespread in Kassala Province, Darfur province, Bahr El Gazal province and Upper Nile province. It is absent from the east bank of the Nile except for small area within 20 km of Juba. In yambio distinct it occurs in gallery forest. Specimen from dried areas tend to have smaller leaves and more hairy flowers (Elamin, 1990).

Uses of *Anogeissus leiocarpus*: The wood is used mainly in the round for transmission and building poles, fences posts, forked poles and as beam of local building construction. It s also used for firewood and charcoal. The leaves and barks contain tannin materials recognized by Sudan tanning industry (Elamin, 1990). In northern Nigeria and Burkina Faso the ashes are used for preparation of goatskin. Hans (1990) reported that in Mali all parts of *Anogeissus leiocarpus* tree are used as medicine mixed with other plants in traditional system. Also *Anogeissus leiocarpus* gum was used as food additives mixed with gum Arabic or as a substitute for it.

MATERIALS AND METHODS

Eighteen nodules of *Anogeissus leiocarpus* (12 nodules from Abojebiha and 6 nodules from Elfula) were collected randomly from the natural exudates nodules of different trees.

The gum nodules were dried at room temperature (about 30°C) then cleaned by hand, ground, sieved through sieve No. 16 and kept in labeled plastic containers for analysis.

Analytical methods: Moisture%, ash%, pH, viscosity and specific rotation were determined according to FAO (1990a,b) papers No. 44 and 49. Nitrogen was determined by a semi-micro khjeldal methods (AOAC, 1984) and the protein content was determined by multiplying nitrogen percent by the factor 6.6 (Anderson, 1986). Equivalent weight was determined according to methods reported in the Encyclopedia of Chemical Technology (1966). qualitative estimation of tannin was carried out using the modified methods of Price *et al.* (1978). Reducing sugars were determined according to method reported by Robert and White (1987) and maximum absorption spectra of 1 % gum solution were determined by using a Perkin-Eimer Lambda 2 UV/VIS Sdpecrrometer.

Statistical analysis: Each sample was analyzed in triplicate and data was assessed by Analysis of Variance (ANOVA) (Snedecor and Cochran, 1987) and by Duncan (1955) multiple rang test with probability $p \leq 0.05$.

RESULTS AND DISCUSSION

Table 1, 2 and 3 present the results of analytical studies carried out on the gum natural exudates from Abojebiha, Elfula and Rosares respectively. Table 4 shows the effect of location on the physicochemical properties of *Anogeissus leiocarpus* gum.

The moisture content of Abojebiha samples was found to be in the rang of 8.2-10.1% (Table 1), while Elfula samples ranged from 7.7% to 9.8% (Table 2), Rosares samples (Table 3) ranged between 9.2 and 9.9%.

Analysis of variance showed that within one location there is a significant difference ($p \leq 0.05$) in each of Abojebiha and Rosares samples, whereas insignificant differences ($p \leq 0.05$) were observed in Elfula samples. Table 4 showed insignificant effect of location on moisture content. However the mean value of moisture content of all samples in the tree location is 9.26%.

It is observed that the mean value of moisture content was laws than the range of Gatti gum (Meer, 1980) and within the range of Senegal gum (8.1-14.05%) as reported by Siddig (1996). Ash content of Abojebiha samples ranged between 4.5 and 5.5% (Table 1), Elfula samples ranged from 1.8-2.3% and Rosares samples ranged from 3.3-3.6%. Analysis of variance within location showed significant differences ($p \leq 0.05$) in each of Elfula samples and Rosares samples whereas insignificant differences ($p \leq 0.05$) were observed in Abojebiha samples.

Location significantly affected the ash content (Table 4) the mean value of ash content of samples from the 3 different locations was 3.45%. The range of ash content was closer to the results obtained by Siddig (1996) for Senegal gum (2.15-5.3%).

Nitrogen content of Abojebiha samples ranged from 0.45-0.92% and hence the protein content ranged from 3.0-5.5% (Table 1). Table 2 shows the that nitrogen content of Elfula samples ranged between 0.79 and 0.88% and protein content ranged between 5.21 and 5.8%, Rosares samples have the same values of nitrogen content and also protein content which were

Table 1: Analytical data of 3 different *Anogeissus leiocarpus* gum samples from Abojebiha

Sample	Moisture (%)	Ash (%)	Nitrogen (%)	Protein (%)	Specific rotation $(\alpha)_D$	Relative viscosity $(T\text{-}T_o/T_o)$	pH	Refractive Index (RI)	Uranic acid (%)	Reducing Sugar (%)	Equivalent weight	Tannin (%)
As1	9.3^{ab}	4.5^{a}	0.92^{a}	4.50^{a}	-21.8^{oa}	1.48^{a}	4.1^{a}	1.334^{a}	13.1^{b}	0.49^{a}	1477.7^{a}	0.55^{a}
As2	10.1^{a}	4.7^{a}	0.80^{a}	4.73^{a}	-16.2^{ob}	2.25^{a}	4.0^{a}	1.334^{a}	13.7^{ab}	0.36^{a}	1298.6^{b}	0.150^{b}
As3	8.2^{b}	5.5^{a}	0.45^{a}	3.00^{a}	-38.3^{oa}	1.68^{a}	4.1^{a}	1.334^{a}	14.9^{a}	0.42^{a}	1289.0^{b}	0.152^{b}
Mean	9.2	4.9	0.72	4.41	25.4	1.80	4.06	1.334^{a}	13.9	0.423	1417.8	0.467
S.E±	0.474	0.361	0.124	0.716	1.454	1.414	0.201	0.000	0.422	0.044	23.656	0.149

As = Abojebiha sample, Each value in table is a mean of three replicates. No significant difference for value sharing the same letter ($p \geq 0.05$)

Table 2: Analytical data of 3 different *Anogeissus leiocarpus* gum samples from Elfula

Sample	Moisture (%)	Ash (%)	Nitrogen (%)	Protein (%)	Specific rotation $(\alpha)_D$	Relative Viscosity $(T\text{-}T_o/T_o)$	pH	Refractive Index (RI)	Uronic acid (%)	Reducing sugar (%)	Equivalent weight	Tannin (%)
Es1	7.7^{a}	2.2^{a}	0.88^{a}	5.80^{a}	-37.4^{ob}	1.58^{a}	4.2^{a}	1.334^{a}	14.1^{a}	0.46^{a}	1289.3^{a}	1.33^{a}
Es2	8.6^{a}	2.3^{a}	0.83^{a}	5.47^{a}	-38.6^{ob}	1.82^{a}	4.2^{a}	1.334^{a}	13.4^{a}	0.44^{a}	1292.7^{a}	1.31^{a}
Es3	9.8^{a}	1.8^{b}	0.79^{a}	5.21^{a}	-45.1^{oa}	1.71^{a}	4.0^{a}	1.334^{a}	14.2^{a}	0.54^{a}	1296.7^{a}	0.07^{a}
Mean	8.7	2.1	0.83	5.47	-40.36	1.70	4.13	1.334	13.9	0.486	1292.9	0.898
S.E±	1.414	0.093	0.102	0.789	0.704	0.191	0.083	0.00	1.250	0.054	13.189	0.736

Es = Elfula sample, Each value in table is a mean of three replicates. No significant difference for value sharing the same letter ($p \geq 0.05$)

Table 3: Analytical data of 3 different *Anogeissus leiocarpus* gum samples from Rosares

Sample	Moisture (%)	Ash (%)	Nitrogen (%)	Protein (%)	Specific rotation $(\alpha)_D$	Relative Viscosity $(T\text{-}T_o/T_o)$	pH	Refractive Index (RI)	Uronic acid (%)	Reducing sugar (%)	Equivalent weight	Tannin (%)
Rs1	9.2^{b}	3.3^{b}	0.61^{a}	4.03^{a}	-41.3^{oa}	1.54^{a}	4.5^{a}	1.334^{a}	15.3^{a}	0.41^{a}	1288^{b}	0.49^{a}
Rs2	9.8^{a}	3.6^{a}	0.61^{a}	4.03^{a}	-40.0^{oa}	1.55^{a}	4.4^{a}	1.334^{a}	14.9^{a}	0.43^{a}	1316.3^{ab}	0.81^{a}
Rs3	9.9^{a}	3.3^{b}	0.61^{a}	4.03^{a}	-41.4^{oa}	1.58^{a}	4.5^{a}	1.334^{a}	14.7^{a}	0.41^{a}	1343^{a}	0.65^{a}
Mean	9.63	3.4	0.61	4.03	-40.9°	1.55	4.46	1.334	14.96	0.416	1315.7	0.65
S.E±	0.116	0.064	0.00	0.00	0.781	0.031	0.052	0.000	0.253	0.012	13.09	0.523

Rs = Rosares sample, Each value in table is a mean of three replicates. No significant difference for value sharing the same letter ($p \geq 0.05$)

0.61 and 4.03% respectively (Table 3). Insignificant differences were observed in the analyzed data of each of nitrogen and protein contents of Abojebiha, Elfula and Rosares samples. Also the effect of location on nitrogen and protein contents showed insignificant differences (Table 4). Nitrogen and protein contents of *Anogeissus leiocarpus* gum samples are in agreement with that reported for Senegal gum nitrogen 0.19-0.62%, protein 1.25-4.09%) (Siddig, 1996).

The aqueous solutions of all samples were found to be optically active (leavo rotatory). Table 1 showed that the specific rotation of Abojebiha samples ranged from -16.2° to -38.3°, while specific rotation of Elfulea samples ranged from -37.4° to -45.1° (Table 2), Rosares samples ranged from -40.0° to -41.3° (Table 3). Within one location analysis of variance showed significant differences ($p \leq 0.05$) between the samples of each of Abojebiha and Elfula, whereas Rosares samples showed insignificant differences ($p \leq 0.05$). Table 4 showed that there was no affect of location in specific rotation and the mean value of specific rotation of all samples was -35.5°.

Aqueous solution of all samples of *anogeissus leiocarpus* gum is viscous. Table 1 showed that the relative viscosity of Abojebiha samples ranged from 1.48-2.25 and Elfula samples ranged from 1.58-1.82 (Table 2). Rosares samples were in the range of 1.54-414.58 (Table 3).

Analysis of variance within location showed insignificant differences ($p \leq 0.05$) in each one, also location was found to be insignificantly affecting the relative viscosity (Table 4). The mean value of the relative viscosity of all samples was 1.69 which was in agreement with that reported by Awad El Karium (1994) for Senegal gum (1.1-2.74).

The pH aqueous solution of all samples indicated the acidity of *Anogeissus leiocarpus* gum which may be due to the presences of acidic sugars (glucuronic acids). Table 1 showed that pH of Abjebiha samples were in the range of 4.0-4.1, Elfula samples were in the range of 4.0-4.2 (Table 2) and Rosares samples were in the range of 4.4-4.5 (Table 3).

Analysis of variance indicated that within one location there is insignificant differences ($p \leq 0.05$) in the pH values and so location did not affect the pH of the gum (insignificant differences) (Table 4). The mean value of pH of the gum samples in the three locations was found to be 4.2, which was in agreement with that value of Senegal gum (3.19-5.61) (Siddig, 1996).

Refractive index of all samples from the three different locations was found to be constant having the value 1.334 (Table 1-3) and so there is no affect of location in the value of the refractive index (Table 4). This may prove to be a qualifying index for this gum. Awad El Karium (1994) reported that refractive index for Senegal gum was 1.338 and *Seyal* gum was 1.337.

Presence of uranic acids in all samples of *Anogeissus leiocarpus* gum indicated that all samples have acidic

Table 4: Effect of location on physic-chemical properties of *Anogeissus leiocarpus* gum

Sample	Moisture (%)	Ash (%)	Nitrogen (%)	Protein (%)	Specific rotation $(\alpha)_D$	Relative Viscosity (T- T_o/T_o)	pH	Refractive Index (RI)	Uranic acid (%)	Reducing sugar (%)	Equivalent weight	Tannin (%)
Abojebiha	9.2[a]	4.8[a]	0.72[a]	4.75[a]	-25.4[o a]	1.80[a]	4.1[a]	1.334[a]	13.9[a]	0.42[a]	1399.5[a]	0.50[a]
Elfula	8.7[a]	2.1[b]	0.83[a]	5.47[a]	-40.5[o a]	1.70[a]	4.1[a]	1.334[a]	14.1[a]	0.49[a]	1292.8[a]	0.89[a]
Rosares	9.6[a]	3.4[ab]	0.61[a]	4.02[a]	-40.6[o a]	1.55[a]	4.4[a]	1.334[a]	14.9[a]	0.42[a]	1315.7[a]	0.654[a]
Mean	9.2		0.72	4.74	-35.5o	1.68	4.2	1.334	14.3	0.44	1336.0	0.68
S.E±	0.595		0.101	0.560	5.002	0.170	0.062	0.000	0.486	0.037	39.267	0.33

Each value in table is a mean of three samples, No significant difference for value sharing the same letter ($p \geq 0.05$)

Table 5: Minerals content of *Anogeissus leiocarpus* gum

Sample	Mg	Ca	Na	K	Fe	Zn	Cu	Mn	Pb	Cd	Ni
As	1398.7[a]	1764.2[a]	6499.6[a]	7691.1[a]	12500[a]	1428.3[a]	28.4[a]	3.6[b]	25.7[a]	11.1[a]	33.3[a]
Es	12287.4[b]	1764.6[a]	5999.7[b]	4614.1[b]	12500[a]	857.2[b]	14.2[b]	3.9[b]	34.3[a]	11.1[a]	33.3[a]
Rs	12288.7[b]	1764.2[a]	6503.6	4615[b]	12500[a]	857.3[b]	14.1[b]	4.4[a]	34.5[a]	11.1[a]	33.3[a]
Mean	12852.9	1764.3	6334.3	5640.6	12500	1047.6	18.9	4.06	31.5	11.1	33.3
S.E±	7.483	0.527	8.49	1.027	0.000	3.09	0.088	0.033	0.392	0.00	0.00

As = Abojebiha sample, Es = Elfula sample, Rs = Rosares sample, Each value in table is a mean of three replicates. No significant difference for value sharing the same letter ($p \geq 0.05$)

sugar (glucuronic acids) and this was confirmed qualitatively and quantitatively by using chromatographic method (paper, thin layer) (Plate, 3).

Uranic acid content of Abojebiha samples ranged from 13.1-14.9% (Table 1) Elfula samples ranged from 13.4-14.2% (Table 2) and Rosares samples ranged from 14.9% ton 15.3% (Table 3).

Analysis of variance indicated that insignificant differences ($p \leq 0.05$) in each of Elfula and Rosares samples, where as Abjebiha samples showed significant differences. Table 4 showed that location insignificantly affected the uranic acid content and the mean value of the three location samples was 14.3%, which was in the rang of Senegal gum (10.34-23.32%) (Siddig, 1996).

Reducing sugars of *Anogeissus leiocarpus* gum was calculated as arabinose and the presence of reducing sugar gives evidence to the reducing power (free reducing groups) of this type of gum. Reducing sugar content of Abojebiha samples was in the range of 0.36-0.49% (Table 1) Elfula samples was in the range of 0.44-0.56% (Table 2) and that of Rosares samples ranged from 0.41-0.43% (Table 3).

Analysis of variance showed insignificant differences ($p \leq 0.05$) within location, and also location was found to be insignificantly affected the reducing sugar content (Table 4). The mean value of reducing sugar of all samples was 0.44% which was in agreement with the that reported by Anderson and Karamalla (1966) for Senegal gum (0.16-0.44%).

Table 1 showed that equivalent weight of Abojebiha samples ranged between 1298 and 1477.7 and Elfula samples ranged from 1289.3-1296.7 (Table 2) and that of Rosares samples ranged from 1288 and 1343 (Table 3).

Analysis of variance showed significant differences ($p \leq 0.05$) in each of Abojebiha and Rosares samples, while Elfula samples showed insignificant differences. However the effect of location on equivalent weight showed insignificant differences (Table 4) and the value of equivalent weight of samples in the 3 locations was 1336.0. This value in agreement with that obtained by Siddig (1996) for Senegal gum (1136-1875).

Anogeissus leiocarpus tree is known as one of the most important sources of tannin in the world (2%) (Hans, 1990) and this may explain the presence of tannin in the gum exudates from this tree. Tannin content was calculated as D (+) catechin. Tannin content of Abojebiha samples ranged between 0.15 and 0.55% (Table 1). Elfula samples ranged between 0.07 and 14.33% (Table 2) and that of Rosares samples ranged between 0.49 and 0.81% (Table 3).

Analysis of variance showed significant differences ($p \leq 0.05$) in Abojebiha samples while insignificant differences were observed in Elfula and Rosares samples. Location insignificantly affected the tannin content (Table 4) the mean value of tannin content for the three locations was 0.68%.

Cationic composition of *Anogeissus leiocarpus* gum from the three different locations was determined by atomic absorption spectrophotometer and results are represented in Table 5. Abojebiha gum showed decreasing trend in metal ions for Mg >Fe >K >Na >Ca >Zn >Ni >Cu >Pb >Cd >Mn and in Elfula for Mg >Fe >Na >K >Ca >Zn >Pb >Ni >Cu >Cd >Mn. While Rosares gum ions represent a decreasing trend as Mg >Fe >Na >K >Ca >Zn >Pb >Ni >Cu >Cd >Mn.

It could be observed that Magnesium (Mg) has the higher value in the three different locations and also *Anogeissus leiocarpus* gum may be a source of iron and indicates the nutritive values of this gum.

Analysis of variance showed significant differences ($p \leq 0.05$) in each of Mg, Na, K, Zn and Mn where as Ca, Fe, Cd and Ni showed insignificant differences.

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