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Research Article

Characterization of Gum from *Anogeissus Leiocarpus* (DC.) Guill. & Perr. (Combretaceae)

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Abstract

Anogeissus leiocarpus gum samples were collected as natural exudates from different locations of gum belt in Sudan, the physicochemical properties of the gum were studied, the solubility of this gum was 14.5% w/v dissolves in water at 25^o C to form a clear solution, moisture content range between (6.987% to 8.649% w/w), ash content between (2.00% to 2.05% w/w), pH between (4.39 to 4.65), refractive index between (1.58 to 1.60) , nitrogen between (0.125% to 0.155%), protein between (0.81% to 1.00%), specific optical rotation between (-33.8 to -35.2). The cationic composition was in the order: (Ca^{++}) 4533 ppm has the highest value in all samples followed by (K^+) 3520 ppm, (Mg^{++}) 1047 ppm, (Na^+) 600 ppm, (Fe^{++}) 562 ppm , (Pb^{++}) 258 ppm, (Zn^{++}) 197 ppm and trace amount of (Mn^{++}) 74.5 ppm, (Cr^{++}) 4.5 ppm. Intrinsic viscosity was 0.115 in NaCl and 0.914 in H_2O, reducing sugar as follows; Rhamnose was 9.288%, Aribanose was 34.00%, and Galactose was 27.50%, estimation of equivalent weight was 1384.33 and uronic acid 14.02. The analysis of variance showed insignificant differences ($p<0.05$) in all properties studied.

Keywords: *Anogeissus leiocarpus* gum, intrinsic viscosity, physicochemical, refractive index, specific rotation.

1. Introduction

Gums are complex mixtures of polysaccharides and glycoproteins. It was historically the source of the sugars arabinose, galactose and uronic acid, which are isolated from it, and are named after it [1].

Gums are used primarily in the food industry as a stabilizer. There are edible and gum arabic has an E number. Gum is a key ingredient in traditional lithography and is used in printing, paint production, glue, cosmetics and various industrial applications, including viscosity control in inks and in textile industries, although less expensive materials compete with it for many of these roles [1].

Plant gums are harvested from wild trees throughout the Sahel from Senegal to Somalia, although it has been historically cultivated in Arabia and West Asia.

While gum is now produced mostly throughout the African Sahel, it is still harvested and used to make a chilled, sweetened, and flavored gelato-like dessert. [1].

Anogeissus leiocarpus is a tall evergreen tree native to savannas of Tropical Africa [2]. It is sole West African species of the genus *Anogeissus*, a genus otherwise distributed from tropical central and east Africa through tropical Southeast Asia, [3] in Sudan it is found in southern Kordofan (Nuba mountain) and southern Darfour [4].

Anogeissus leiocarpa germinates in the new soils produced by seasonal wetlands and grows at the edges of the rainforest, in the savanna, and along riverbanks forming gallery forests. The tree flowers in the rainy season, from June to October. The seeds are dispersed by ants [3].

2. Experimental and Materials

Anogeissus leiocarpus gum were obtained from different location in Sudan, the gum samples were collected from gum belt namely from Abojebiha and Elfula, the gum samples were cleaned by hands to remove foreign particles. The samples were then ground using mortar and piston, sieved through sieve 250 µm and kept in plastic container for further analysis.

2.1 Methods

Solubility of the gum was examined in water according to procedure described in [5,6]. Moisture content were Calculated by placed mg of gum powder in an oven (RADWAG, Model: MAX 50/NH) at temperature 105°C ± 2°C [7]. Then, the moisture content was determined a percentage of the lost weight to the total weight. Ash content was determined according to AOAC (1984) method. The pH-meter (Sartorius, Model: Professional meter PP-20) was calibrated, and directly in a homogenate prepared with 10% (w/v) gum powder in distilled water. Density and specific gravity of the gum were determined following the procedure described in Skoog and West [8] using standardized pycnometer. The refractive index was measured using instrument: (Krus Model; A. Kruss Optrionic). Nitrogen and protein% were determined Kjeldal method [9]. Protein calculated by follows equation:

%protein = % Nitrogen content X 6.25 (Eq.1)

Optical rotation and specific optical rotation were determined by polarimeter (Uni pol L Model: SCHMIDT+HAENSCH) using procedure described by FAO [6,7].

The sugar composition was determinate by HPLC; samples were hydrolyzed to liberate the sugar residues according to methods described in [10]. Cationic composition determinated by using an atomic emission spectrometer Shimadzu model AA-6800 in accordance with the manufacturer's instructions at the prescribed wavelength. The intrinsic viscosity was evaluated using a Cannon-Ubbelohde (MI30) semi micro-dilution viscometer size 75.

The spectrophotometer (Shimadzu, Model IR Affinity-1) FTIR was used to determine infrared spectrum, a 2 mg of the *Anogeissus leiocarpus* gum powder triturated with 300-400 mg, of finely powdered and dried potassium bromide R is used. [6]

(U.V Spectrophotometer Shimadzu U.V 1800s) was used for measuring the ultraviolet range of the spectrum consist of an optical system capable of producing monochromatic radiation in the range of 190 - 400 nm and measuring the absorbance. A 0.5 gram of gum powder dissolved in 100ml purified water, the absorbance at the prescribed wavelength were measured [11].

3. Results and discussions

Table 1 show the "characteristic properties of *Anogeissus leiocarpus* powder gum", which indicates that solubility, is commonly used to describe the gum powder, to indicate a gum powder's polarity, to help to distinguish it from other gums, and as a guide to applications of the gum. A 1.0 gram of *Anogeissus leiocarpus* gum powder was dissolved completely in 7.0 ml of purified water that means the *Anogeissus leiocarpus* gum is freely soluble in purified water. The gum of *Anogeissus leiocarpus* was found to have a moisture content of 6.987 to 8.649% (w/w), while the total ash content obtained after subjecting the gum to furnace treatment was 1.990 to 2.048% (w/w). The pH value was 4.39 to 4.65. Since specific gravity is a constant that varies slightly for any given kind of carbohydrates, it is a little value in determining the purity of the sample and it can only be used in the characterization of a given sample. Specific gravity of the solution is nearly equal to 1.0 which is the density of water that controls the distribution of particles in the solution [12]. Thus, addition of other substances to the gum solution can be accommodated and may alter the characteristic by improving the texture of added material. The refractive index was 1.5815 to 1.5975, which is a fundamental physical property can be used to identify the substance, determination purity and to measure its concentration. The nitrogen content value was found 0.1250 to 0.1550%w/w and protein 0.140±00% w/w respectively. The optical rotation was -33.833 to -35.193, equivalent weight approximately about 1384.33 and uronic acid about 14.02%.

Table 1: Physicochemical properties of *Anogeissus leiocarpus* gum.

Test	Results
Moisture content % w/w	6.99 to 8.649
Ash content % w/w	1.99 to 2.05
ρH	4.39 to 4.65
Specific gravity w/w	0.96 to 1.04
Refractive index	1.58 to 1.60
Nitrogen % w/w	0.13 to 0.16
Protein % w/w	0.81 to 1.00
Specific optical rotation	-33.83 to -35.19
Equivalent weight	1384.33
Uronic acid%	14.02
Rhamnose%	9.288
Aribanose%	34.00
Galactose%	27.50

Total sugars data for the fractions as follows: Rhamnose was 9.288%, Aribanose was 34.00%, and Galactose was 27.50%.

Table 2 shows that calcium; magnesium, potassium, sodium, iron, and copper are the most abundant elements in all gum samples. The mean values in the table show that the major elements in *Anogeissus leiocarpus* samples are, in the decreasing order Ca^{++} was 4532.5 ppm, K^{+} was 3520.0 ppm, Mg^{++} was 1046.5 ppm, Na^{+} was 600.0 ppm, Fe^{++} was 562.5 ppm, Pb^{++} was 258.0 ppm, Zn^{++} was 197.25 ppm, Mn^{++} was 74.5 ppm, Cr^{++} was 4.5 ppm and Cd^{++} was not detected.

It could be observed that Calcium (Ca^{++}), Potassium (K^{+}) and Magnesium (Mg^{++}) has the higher value in the *Anogeissus leiocarpus* gum may be a source of metals and indicates the nutritive values of this gum. Also the transition metals which form colored complexes, therefore they can be considered to be the main reason for coloration.

Table 2: **cationic composition of *Anogeissus leiocarpus* gum**

Metals	Ca^{++}	K^{+}	Mg^{++}	Na^{+}	Fe^{++}
Actual conc. ppm	4532.5	3520.0	1046.5	600.0	562.5
Metals	Pb^{++}	Zn^{++}	Mn^{++}	Cr^{+++}	Cd^{++}
Actual conc. ppm	258.0	197.25	74.5	4.5	N.d.

Table 3 and figure 1 shows the Intrinsic viscosity in NaCl at various concentrations and extrapolation the concentration to C = 0. The concentration dependence is also determined by expressed by Huggins equation. The value of Huggins constant for sodium chloride was 0.1151 and in water was 0.9142; indicate poor incompatibility of solvent with solute. Increased intrinsic viscosity can be attributed to the interaction between water and the gum molecules. Weak protonation of the hydroxyl groups in *Anogeissus leiocarpus* gum and water molecules caused by high H^{+} may reduce inter and intra molecular hydrogen bonding. It is possible that *Anogeissus leiocarpus* gum molecules are less expanded in sodium chloride media and the hydrogen bonding between sodium chloride and *Anogeissus leiocarpus* gum is less prevalent.

Table 3: **The intrinsic viscosity of *Anogeissus leiocarpus* gum using NaCl as solvent**

Conc.%	T_i. sec	T_i/T_o	$T_i/T_o=\eta_i/\eta_o$	$(\eta_i-\eta_o)/\eta_o=\eta_{sp}$	η_{sp}/C	$\ln((\eta_o/\eta_i)/C)*C$
0.01	1019	1.676	1019	0.676	67.599	-0.392
0.005	844	1.388	844	0.388	77.632	-0.946
0.0025	745	1.225	755	0.225	90.132	-1.490
0.0013	690	1.135	670	0.135	103.745	-2.003
0.0006	658	1.082	658	0.082	137.061	-2.498

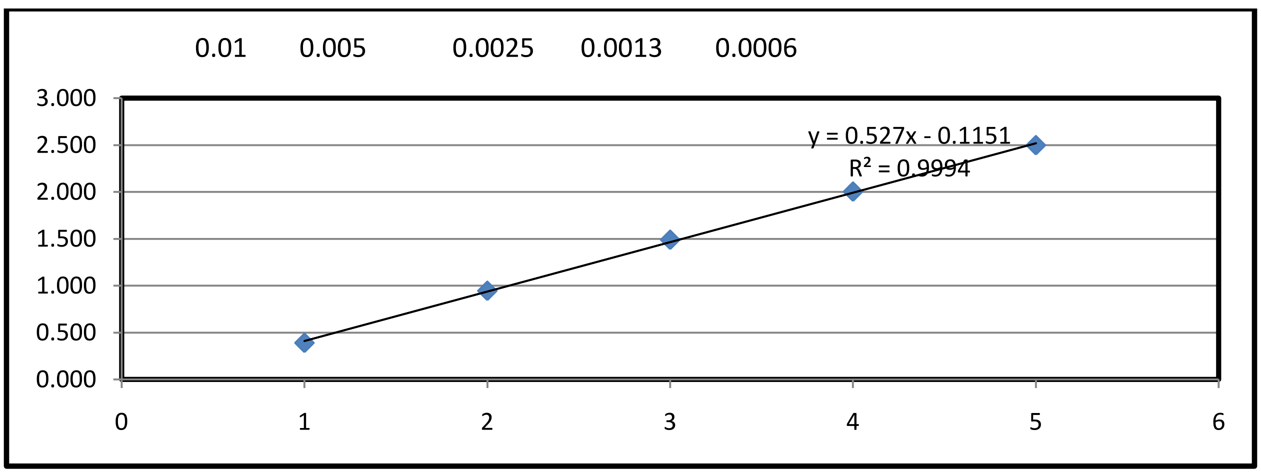

Figure 1: Logarithmic plot of the intrinsic viscosity of *Anogeissus leiocarpus* gum using NaCl as solvent. ($[\eta_{red.}]$, cm^3/g) Vs (concentration, mg/ml) (Arrhenius plot)

Table 4: **The intrinsic viscosity of *Anogeissus leiocarpus* gum using water as solvent**

Conc.%	T_i. sec	T_i/T_o	$T_i/T_o=\eta_i/\eta_o$	$(\eta_i-\eta_o)/\eta_o=\eta_{sp}$	η_{sp}/C	$\ln((\eta_o/\eta_i)/C)*C$
0.01	1503	2.472	2.472	1.472	147.204	0.387
0.005	1149	1.890	1.890	0.890	177.961	-0.117
0.0025	919	1.512	1.444	0.512	204.605	-0.670
0.0013	790	1.299	1.286	0.299	230.263	-1.206
0.0006	720	1.184	1.184	0.184	307.018	-1.692

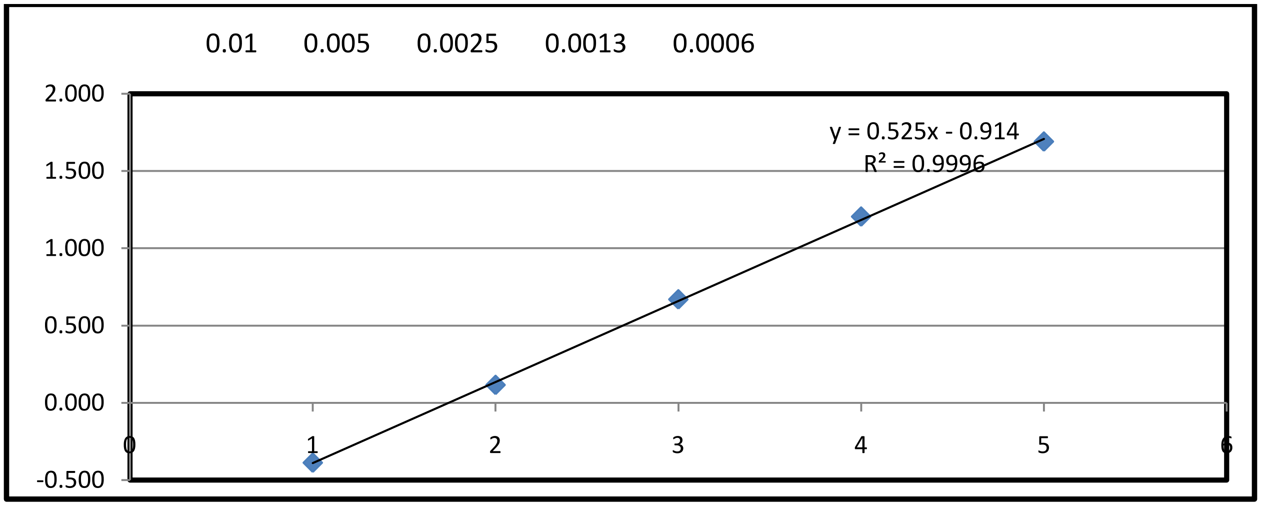

Figure 2: Logarithmic plot of the intrinsic viscosity of *Anogeissus leiocarpus* gum using water as solvent. ([η], cm^3/g) Vs (concentration, mg/ml) (Arrhenius plot)

Figure 3 show The FT-IR spectrum of *Anogeissus leiocarpus* Gum powder was strong vibrational mode located at 3000-3600 cm^{-1} is assigned to the stretching vibrations of the O-H bond, the other strong vibrational mode located at 1624 cm^{-1} is assigned to the stretching vibrations of the C=O bond of carboxylate group associated with the *Anogeissus leiocarpus* Gum molecules, the two vibrational modes located at 1066 and 1430 cm^{-1}, with relatively low intensity, are assigned to the stretching vibrations of the C-O bond, and the weak vibrational mode located at 2930 cm^{-1} is assigned to the stretching vibrations of the C-H bond [13]. The absorption band located at 2309 cm^{-1}, with relatively low intensity, is usually assigned to the CO_2 vibration [13].

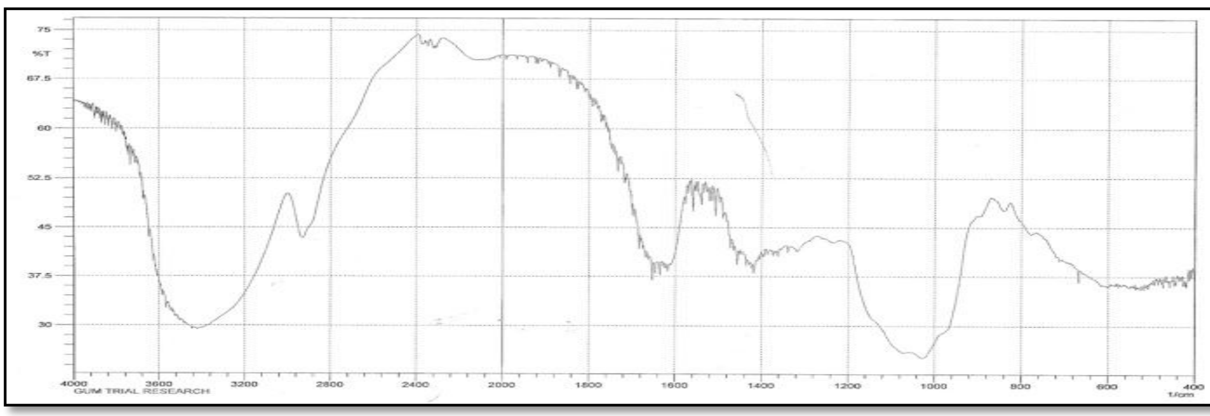

Figure 3: FT IR spectrum of *Anogeissus leiocarpus* Gum

The ultraviolet (UV)-visible spectra from 190 to 400 nm were measured for sample of *Anogeissus leiocarpus*, shows λ_{max} of gum solution was distinctive in having higher relative absorbance of the light above 190 nm and gum sample had a main peak in the 194.8 to 276.6 nm range.

4. Conclusion

Natural gums are promising biodegradable polymeric materials. Many studies have been carried out in fields including food technology and pharmaceuticals using gums. It is clear that gums have many advantages over synthetic materials. Various applications of gums have been established in the field of pharmaceuticals.

However, there is a need to develop other natural sources as well as with modifying existing natural materials for the formulation of novel drug delivery systems, biotechnological applications and other delivery systems. Therefore, in the years to come, there will be continued interest in natural gums and their modifications aimed at the development of better materials for drug delivery systems.

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