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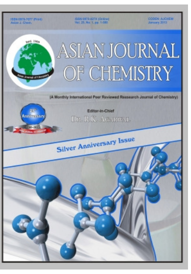

Rheological Modeling, Surface Morphology and Physico-chemical Properties of *Anogeissus leiocarpus* Gum

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Physicochemical studies on *Anogeissus leiocarpus* gum (AL gum) indicated that the gum is mildly acidic, ionic, odourless, yellowish-red and is soluble in water (but insoluble in ethanol, acetone and chloroform). The gum has significant concentration of essential elements (Mg, Ca, Fe, Cu, Mn) and low concentrations of heavy metals (Pb and Cd). The protein content of the sample was also found to be low (≈5 %). Scanning electron micrograph of the gum revealed that the gum is irregularly shaped and amorphous. Rheological study indicated that the viscosity of the gum increases with increasing pH and concentration but decreases with increase in temperature. The apparent activation energy of flow for *Anogeissus leiocarpus* gum (calculated from Arrhenius-Frenkel-Eyring plot) was 3.16 suggesting the presence of fewer inter and intra molecular interaction. Values of intrinsic viscosity obtained from Huggins and Kraemer plots were similar (8.82) while those obtained from Tanglertpaibul and Roa plots ranged from 3.50 to 11.82 dL/g. From the plot of speed of rotation *versus* viscosity, viscosity *versus* shear rate and shear stress *versus* shear rate, a non Newtonian behaviour (dilatant) with characteristics shear thickening property was verified for *Anogeissus leiocarpus* gum. Calculated 'b' value of 1.108 was obtained through the application of the power law equation and is associated with random coil conformation or entanglement. Analysis of the master's curve shows that random coil conformation or entanglement is proposed to occur at C[η]~ 4.0, *i.e.* at $\eta_{sp} = 2.19$ ($\eta_{rel} = 3.19$).

Key Words: *Anogeissus leiocarpus* gum, Characterization, Rheological modeling.

INTRODUCTION

Anogeissus leiocarpus (locally called Marke in Hausa) belong to *Combertaceae*, a family of 20 genera and 600 species tropical and subtropical trees and shrubs. The genera include *Terminals, Combertum, Quisqualis, Myrobolans* and *Anogeissus*[1]. Some gums from *Combertaceae* are being increasingly utilized commercially for example *Ghatti* gum and *Leiocarpus* gum. *Anogeissus leiocarpus* tree is widely distributed in Africa including Senegal, Sudan, Ethiopia and Northern Nigeria[1]. Specimen from dried areas tends to have smaller leaves and more hairy flowers[2]. Hollist[3] reported that *Anogeissus leiocarpus* is one of the major plants commonly used as chewing stick in Nigeria. Gums have also been found to be useful in pharmaceutical, paint, mining and mineral processing industries, as food additives and as corrosion inhibitors[4-8]. Most gums found wider application because of their physicochemical and rheological properties, elemental constituents and surface morphology, among others[9]. Much studies have been carried out on the physicochemical and elemental composition of some plant gums including, gums from *Albizia* species[9,10], Oleo-gum-resin from *Ferula gummosa*[11], gum Arabic, karaya gum, ghatti gum, guar gum, locust beans gum and tragacanth gum[12]. Similarly, literature is not scanty on rheological properties of some gums, for example Higiro *et al.*[13] investigated rheological properties of locust beans gum in dilute solution and found that molecular conformation of the gum can be assessed using the power law and Huggins equation. Khounvilay and Sittikijyothin[14] investigated rheological behaviour of tamarind seed gum in aqueous solution and used Huggins and Kraemer equations to obtain the molecular conformation parameters for the polymer. However, in all these and related studies, literature is scanty on rheological, physiochemical, surface morphology and cationic properties of *Anogeissus leiocarpus* gum. Therefore, the present study is aimed at investigating cationic, surface morphology, physicochemical and rheological properties of *Anogeissus leiocarpus* gum (AL gum).

EXPERIMENTAL

Collection of samples: Crude *Anogeissus leiocarpus* gum was obtained as dried exudates from their parent trees grown at Falgore forest in Doguwa LGA of Kano State, Nigeria. The gum exudates were collected from the plant species by tapping during the mid of July and in the day time[15].

Purification of the gum: The procedure adapted for the purification of the gum was that of Femi-Oyewo *et al.*[16]. The crude sample of the gum was dried in an oven at 40 ºC for 2 h and the size reduced using a blender. It was hydrated in double strength chloroform water for 5 days with intermittent stirring to ensure complete dissolution of the gum and then strained through a 75 μm sieve to obtain particulate free slurry which was allowed to sediment. Thereafter, the gum was precipitated from the slurry using absolute ethanol, filtered and defatted with di-ethyl ether. The precipitate was re-dried at 40 ºC for 48 h. The dried flakes were pulverized using a blender and stored in an air tight container.

Physicochemical analysis: In order to characterize the gums, it was subjected to the following physicochemical tests.

Determination of percentage yield of the purified gums: The dried, precipitated and purified gum(s) obtained from the crude dried exudates were weighed and the percentage yields were obtained using the weight of the crude gum(s), as the denominator.

Determination of solubility: The solubility of the gum was determined in cold and hot distilled water, acetone, chloroform and ethanol. 1 g sample of the gum was added to 50 mL of each of the above mentioned solvents and left overnight. 25 mL of the clear supernatants were taken in small pre-weighed evaporating dishes and heated to dryness over a digital thermostatic water bath. The weights of the residue with reference to the volume of the solutions were determined using a digital top loading balance (Model.XP-3000) and expressed as the percentage solubility of the gums in the solvents[17].

Determination of concentration of metals: Concentrations of Mg, Ca, Mg, Mn, Fe, Cu, Cd and Pb were determined using Perkin Elmer Atomic Absorption Spectrophotometer. Calibration curve for each metal was prepared and the concentration of the metal in the analyte was estimated by extrapolation.

Determination of nitrogen and protein content: The nitrogen content of the gum was determined using the Kjedahl method and the protein content was estimated by multiplying the nitrogen content by a conversion factor.

Determination of pH: This was done by shaking a 1 % w/v dispersion of the sample in water for 5 min and the pH was determined using a pre-calibrated Oaklon pH meter (Model 1100).

Viscosity measurements: The intrinsic viscosity of *Anogeissus leiocarpus* gum samples was determined in distilled water using a Cannon Ubbelohde capillary viscometer (Cannon Instruments, model I-71) which was immersed in a precision water bath maintained at 25 ºC. The apparent viscosity of the mucilage was measured using a digital Brookfield DV I prime viscometer.

Scanning electron microscopy: The morphological features of the gums were studied with a JSM-5600 LV Scanning Electron Microscope. The dried sample was mounted on a metal stub and sputtered with gold in order to make the sample conductive and the images were taken at an accelerating voltage of 10 kV.

RESULTS AND DISCUSSION

Physicochemical properties of the gums: Table-1 shows physicochemical parameters of *Anogeissus leiocarpus* gum (AL gum). The physical parameters examined were colour, odour, taste, pH, solubility in water and organic solvents. From the results, it is evident that the colour of *Anogeissus leiocarpus* gums was yellowish red (Fig. 1). The shapes of gum nodules as exuded naturally were irregularly globular or pear shaped. The gums were also found to be odourless. From the measured pH value, it can be inferred that *Anogeissus leiocarpus* gum is mildly acidic.

TABLE-1
PHYSICOCHEMICAL AND RHEOLOGICAL PROPERTIES OF *Anogeissus leiocarpus* gum

Parameter	Properties
Colour	Yellowish–red
Odour	Odourless
Taste	Bland
pH	4.1
Solubility % w/v in	
Cold water	8.2
Hot water	8.0
Acetone	0.00
Chlorofoam	0.00
Ethanol	0.00
Nitrogen (%)	0.83
Protein (%)	5.478
Percentage yield (% w/w)	71.0
Swelling capacity	100.00

Crude *Anogeissus leiocarpus* gum Purified *Anogeissus leiocarpus* gum

Fig. 1. *Anogeissus leiocarpus* gum

The nitrogen content of *Anogeissus leiocarpus* gum was found to be 0.83 %. This gave percentage protein content of 5.48 %. Nitrogen and amino acid contents of gums are useful parameters for distinguishing gums of different species. For example, JECFA/FAO (1990) stated that the range of value expected for the nitrogen content of purified gum arabic is 0.26-0.39 %. The immune responses, which are important in providing evidence for the safety of food additives, are customarily accredited to the proteinaceous component of food. According to Pablyana *et al.*[18], the presence of protein in polysaccharide can induce inflammatory response to tissue and the response may inhibit the pharmacological use of materials based on polysaccharide. Therefore, the low protein content of *Anogeissus leiocarpus* gum may have a vital role to play in its pharmacological applications. *Anogeissus leiocarpus* gum is soluble in cold and hot water but insoluble in ethanol, acetone and chloroform indicating that the gum is ionic. Upon purification, the percentage yield of the gum was found to be 71 %. This is high compare to most plant gums.

Fig. 2 shows water sorption isotherm for *Anogeissus leiocarpus* gum. From the plot, it can be seen that the swelling capacity of *Anogeissus leiocarpus* gum tend to increase toward a maximum after 5 days and then decreases to peak minimum after 10 days. This behaviour is not uncommon to most plant gums and indicates that the gums contain linear polymers. Gennero *et al.*[19] stated that the swelling of a linear polymer without dissolution indicates the existence of cross-links and that these cross-links tie the macromolecular chains together by primary covalent bonds thereby transforming each particle into a single giant molecule. Cross linked polymers are suitable for use as disintegrants because they form hydro gels. The results obtained for the variation of % water sorption with time also revealed that if *Anogeissus leiocarpus* gum is stored in a damp environment, it will quickly be hydrated and also has the tendency to rapidly loose such water molecules in the presence of desiccants (within five days). The observed results is consistent with the findings of Abdulsamad *et al.*[20] for cashew and acacia gums Generally, susceptibility to microbial and physicochemical deterioration as a result of high moisture content may be some of the factors that can be associated with the water sorption potentials of *Anogeissus leiocarpus* gum.

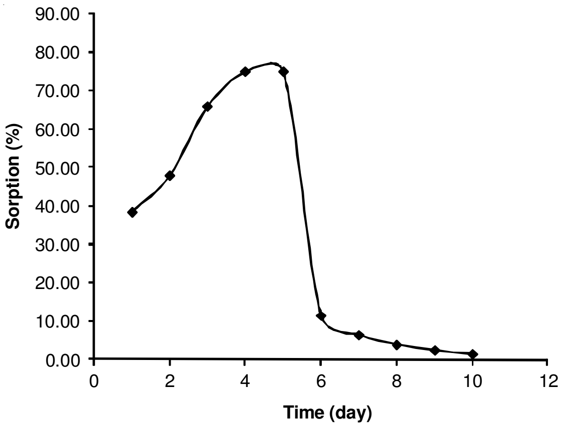

Fig. 2. Water sorption isotherm for *Anogeissus leiocarpus* gum

Ionic composition of *Anogeissus leiocarpus* gum: Table- 2 presents concentrations of cations in *Anogeissus leiocarpus* gum. The cations included major ions such as Na, Mg, Mn, Cu, Fe and Zn (essential for living organism) and heavy metals, which included Pb and Cd (toxic to the body at concentration above tolerance limit). From the result obtained, it can be seen that the trend for the decreasing concentration of the metals is Mg > Ca > Mn > Fe > Cu > > Zn > Pb > Cd indicating that the concentration of the essential elements is higher than those obtained for the heavy metals. Magnesium is involved in maintaining the electrical potential in nerves and activation of some enzyme systems while calcium is needed by the human body for bone and teeth formation. Copper is an essential nutrient for all living beings. In humans, it is a component of more than 30 enzymes and is necessary for the healthy development of connective tissue, nerve covering and bone. Copper is not synthesized in the human body. Therefore, nutritional source of Cu is essential in order to meet the dietary reference intake of copper which stipulates a minimum and maximum intake of 0.9 and 10 mg of Cu per day. Fe is needed for the functioning of certain enzymes and blood in human beings. Pb is a heavy metal that is toxic even at low concentration. However, Pb and Cd content of *Anogeissus leiocarpus* gum are below the permissible limits (British Pharmacopoeia[21]).

TABLE-2
CATIONIC COMPOSITION OF AL GUM

Element	*Anogeissus leiocarpus* gum
Mg (% w/w)	1.76
Ca (% w/w)	1.09
Zn (ppm)	12.70
Mn (ppm)	127.00
Fe (ppm)	26.50
Cu (ppm)	14.20
Cd (ppm)	2.20
Pb (ppm)	7.30

From the above, it can be seen that *Anogeissus leiocarpus* gum is richer in concentrations of the essential minerals but poorer in heavy metal concentrations. Therefore, *Anogeissus leiocarpus* gum may be a good source of mineral nutrition.

Rheological study: According to Khounvilay and Sittikijyothin[14], information on rheological properties of polysaccharide gums in aqueous solution is useful and plays an important role in developing structure-function relationships for the system of polysaccharide solution, the concentration regimes of several polysaccharide gum in aqueous solutions have been observed. Fig. 3 shows the variation of viscosity of *Anogeissus leiocarpus* gum with pH, temperature and with concentration. The figure shows that the viscosity of *Anogeissus leiocarpus* gum increases with increase in pH. Therefore, the viscosity of the gum is pH dependent and the gum is ionic[22,23]. The viscosity of *Anogeissus leiocarpus* gum was also found to increase at first instant with increasing temperature but decreases with increasing temperature after a critical point. The sharp increase in viscosity as a result of a slight increase in temperature can be attributed to the extra energy needed to overcome the molecular forces within the gum (*i.e.* the apparent activation energy of flow). In order to verify the onset of degradation or conformational transition, the viscosity of the gum was measured during heating and cooling and there was no significant differences in the two set of data indicating the absence of degradation or conformational change. Considering the effect of concentration on the viscosity of *Anogeissus leiocarpus* gum, it was found that the viscosity increases with increasing concentration. This may be due to increase in the strength of molecules-molecules interaction and the corresponding reduction in molecule-solvent interaction.

Viscosity of a liquid is related to the ease with which the molecules can move with respect to one another. This indicates that the viscosity of a liquid depends on the strength of attractive forces between molecules, which depend on their composition, size and shape and also on the kinetic energy of the molecules, which depend on the temperature. This implies that the strength of hydrogen bonding between the molecules of the gums can partly be a factor in accounting for the increased in viscosity with pH. At higher pH (that is increasing alkalinity), the viscosity of the gums is expected to increase and at higher temperature, the kinetic motion of the molecules is increased due to the weakening of the attractive forces within the molecular system, hence the viscosity is expected to decrease.

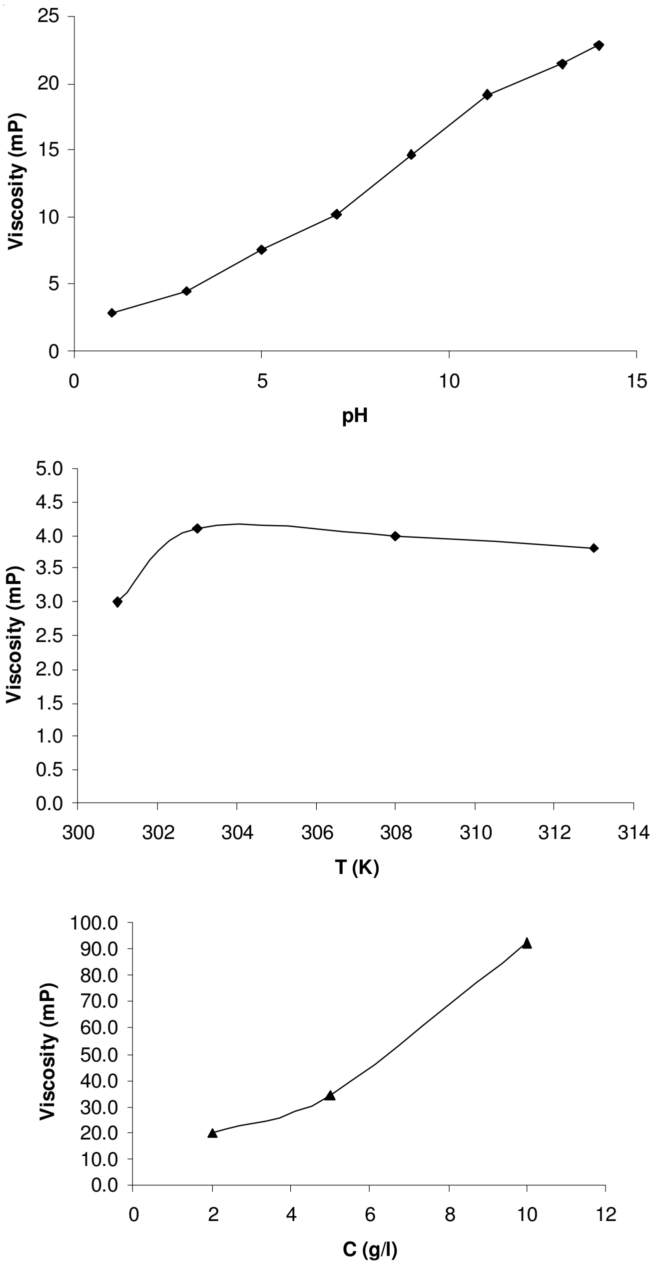

Fig. 3. Variation of viscosity of *Anogeissus leiocarpus* gum with pH, temperature and with concentration

The absence of conformational transition in *Anogeissus leiocarpus* gum was confirmed by applying the Arrhenius-Frenkel-Eyring equation (eqn. 1) to data obtained for viscosity of the gum[24];

$$\eta = \eta_0 \exp(E_a/RT) \quad (1)$$

where, T is the temperature, η_0 is the Arrhenius coefficient, E_a is the apparent activation energy of flow and R is the gas constant. From the logarithm of eqn. 1 and 2 was obtained:

$$\log(\eta) = \log(\eta_0) + E_a/2.303\ RT \quad (2)$$

The significance of equation 2 is that a plot of log(η) *versus* 1/T should be linear with slope and intercept equal to E_a/2.303 R and log(η_0). Fig. 4 presents the Arrhenius-Frenkel-Eyring plot for *Anogeissus leiocarpus* gum ($R^2 = 0.992$). From the slope and intercept of the plot, calculated values of the apparent activation energy of flow and Arrhenius coefficient are 3.16 J/mol and 1.85 respectively. The calculated activation energy of flow is relatively low when compared with data obtained for some plant gums such as *Albizia lebbeck* gum (15.9kJ/mol)[9]; Arabic gum (15 kJ/mol)[26] *A. occidentale* gum (16.2 kJ/mol)[25] and *A. macrocarpa* gum (16.8 kJ/mol)[27]. According to de Paula *et al.*[9], low activation energy of flow indicates few inter- and intra interactions between polysaccharide chains in the concentration range investigated. Therefore, within the investigated concentrations and temperatures, the polymer chain in *Anogeissus leiocarpus* gum is not strongly bonded.

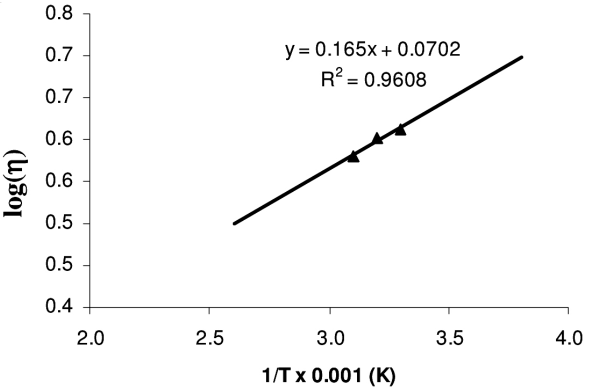

Fig. 4. Arrhenius-Frrenkel-Eyring plot for *Anogeissus leiocarpus* gum

The intrinsic viscosity [η] of a gum is a measure of the hydrodynamic volume occupied by macromolecule and is related to the size and conformation of the macromolecular chains in a particular solvent[28]. Generally, the relationship between solution (η_{sol}) and solvent (η_{solv}) viscosities can be defined in the following ways,

$$\text{Relative viscosity: } \eta_{rel} = \eta_{sol}/\eta_{solv} \quad (3)$$

$$\text{Specific viscosity: } \eta_{sp} = \eta_{rel} - 1 \quad (4)$$

$$\text{Reduced viscosity: } \eta_{red} = \eta_{sp}/C \quad (5)$$

The intrinsic viscosity is a measure of inherent ability of a polymer to increase solution viscosity and the most general relationship between intrinsic viscosity and the viscosity of the dilute polymer solution is a power series in concentration and can be written as follows[29]:

$$\eta_{sp}/C = [\eta] + k_1[\eta]^2C + k_2[\eta]^3C^2 + k_3[\eta]^4C^3 \quad (6)$$

At very dilute concentration, *i.e* C → 0, η_{sp} becomes [η]. Hence equation 6 is often truncated to a linear approximation known as Huggins equation (eqn. 7),

$$\eta_{red} = [\eta] + k[\eta]^2C \quad (7)$$

where, η_{red} is the reduced viscosity, [η] is the intrinsic viscosity (in dL/g), k is the Huggins coefficient ($k \approx k_1$) and C is the concentration of the polymer (in g/dL). It can be deduced from eqn. 7 that a plot of η_{red} *versus* C should be linear with slope equal to $[\eta]^2$ and intercept equal to [η]. Hence $k = \text{slope}/[\eta]^2$. Fig. 5 shows Huggins plot for *Anogeissus leiocarpus* gum. Huggins parameters deduced from the plots are presented in Table-3. From the calculated results, it can be seen that calculated value of [η] and k are 8.8217 and 0.4253 respectively. The calculated value of Huggins constant is relatively low when compared to values obtained for some plant gums. This indicates that polymer-polymer interaction in *Anogeissus leiocarpus* gum is favourable over polymer-solvent interaction.

This value (0.4253) also falls out of range of values (0.5 to 0.7) expected for most polymers in a theta solvents[29]. Therefore, the formation of molecular aggregates in *Anogeissus leiocarpus* gum is favourable.

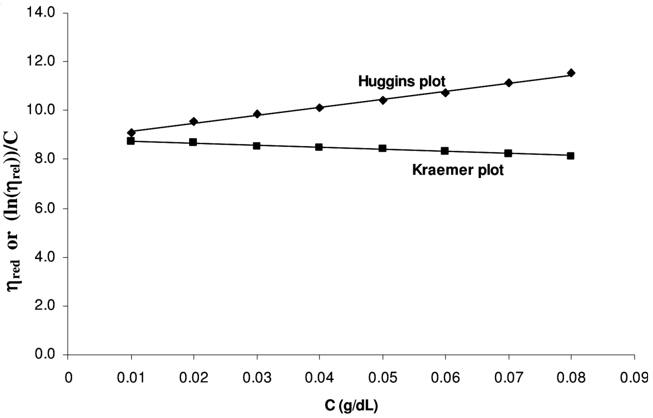

Fig. 5. Huggins and Kraemer plots for *Anogeissus leiocarpus* gum

TABLE-3
HUGGINS AND KRAEMER PARAMETERS
FOR *Anogeissus leiocarpus* GUM

$[\eta]$	$[\eta]^2$	Slope	K	R^2
8.8217	77.82239	33.095	0.425263	0.9921
8.8177	77.75183	8.3066	0.106835	0.9901

Apart form using Huggins equation for the determination of $[\eta]$, other empirical equations were also adopted in order to compare the two set of results. One of such equation is that of Kraemer, which can be written as follows[30],

$$[\ln(\eta r_{el})]/C = [\eta] + k[\eta]^2C \tag{8}$$

From eqn. 8, a plot of $[\ln(\eta_{rel})]/C$ *versus* C should be a straight line with slope and intercept equal to $k[\eta]^2$ and $[\eta]$ respectively. Kraemer plot for *Anogeissus leiocarpus* gum is also presented in Fig. 5. Also, values of Kraemer parameters obtained from the plot are recorded in Table-3. From the results obtained, the $[\eta]$ is found to be 8.8177, which is similar to the one obtained from Huggins plot. However, k value obtained from Kraemer's plot (0.168) is lower than the value obtained from Huggin's plot. Inspite of this, both values reflect similar molecular interpretation.

The methods of determination of the intrinsic viscosity based on the slopes of plots have higher correlation coefficient and lower standard errors, compared with those obtained from intercept of plots. On the strength of these findings, three major equations were developed by Tanglertpaibul and Roa[31] for estimating the intrinsic viscosity of polymer solutions. The equations are as follows:

$$\eta_{rel} = 1 + [\eta]C \tag{9}$$

$$\eta_{rel} = \exp([\eta]C) \tag{10}$$

$$\eta_{rel} = 1/(1-[\eta]C \tag{11}$$

It can be deduced from eqn. 9 that $[\eta]$ is the slope obtained by plotting values of hrel against C. From eqn. 10, $[\eta]$ is the slope obtained by plotting $\log(\eta_{rel})$ against C and from eqn. 11, $[\eta]$ is the slope obtained from the plot of $1-(1/\eta_{rel})$ *versus* C. In Fig. 6, we present Tanglertpaibul and Roa plots based on eqns. 9-11. Calculated slope hence $[\eta]$ were 11.816, 5.616 and 3.503 respectively. Apparently, within the framework of Huggins, Kraemer and Tanglertpaibul-Roa models, the value of the intrinsic viscosity of *Anogeissus leiocarpus* gum is within the range, 3.503 to 11.816.

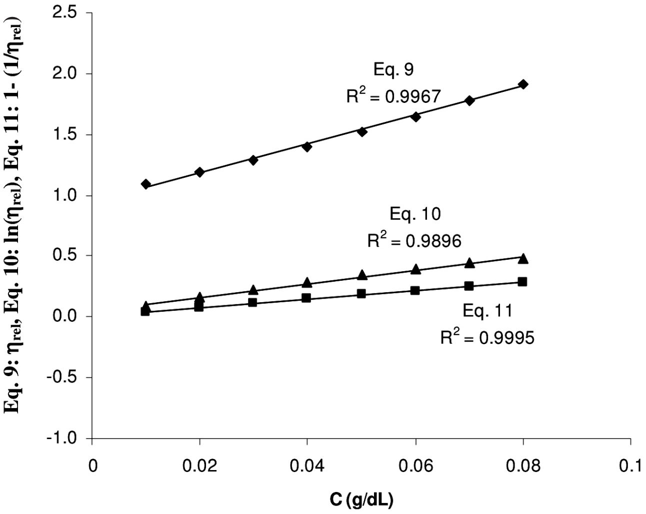

Fig. 6. Tanglertpaibul and Roa plots for *Anogeissus leiocarpus* gum based on equations 9, 10 and 11

The power law equation (eqn. 12) is significant in studying the conformation of polysaccharides[32].

$$\eta_{sp} = aC^b \tag{12}$$

Taking logarithm of eqn. 12 yields eqn. 13

$$\log \eta_{sp} = \log(a) + b \log C \tag{13}$$

From eqn. 13, a plot of $\log(\eta_{sp})$ *versus* C should be linear as shown in Fig. 7. From the slope of the plot, the values of 'a' and 'b' were found to be 3.2078 and 1.108 respectively. According to Higiro *et al.*[13], value of b greater than unity is associated with random coil conformation or entanglement while b value less than unity is associated with rod like conformation[28]. Therefore, the molecular conformation of *Anogeissus leiocarpus* gum is more random coil like than rod like.

In order to classify *Anogeissus leiocarpus* gum as Newtonian or non-Newtonian, several models were adopted. A Newtonian fluid is one in which the viscosity is independent of the shear rate. In Newtonian fluids all the energy goes into sliding molecules by each other. In non-Newtonian fluids, the shear stress/strain rate relation is not linear and typically the viscosity drops at high shear rates. One of the most acceptable methods for analyzing non Newtonian flow involves the construction of a plot of viscosity *versus* spindle speed using same spindle. If such plots are linear, then the fluid is said to be non-Newtonian. Fig. 7(a) shows plots of viscosity *versus* speed of rotation for *Anogeissus leiocarpus* gum. From the plot, it can be seen that R^2 values approximate unity indicating that *Anogeissus leiocarpus* gum is non-Newtonian fluid. Also from the plot, the yield stress (*i.e.* the amount of force needed to be applied to the gum before it can flow) was calculated by extrapolating to zero rpm. The angle the plot forms with the y-axis, the power law index was calculated using the following relation, power law index N = tan(the angle between the plot line and y-axis). Results obtained from the above analysis gave yield stress value of 17, tan θ = 18.582 and θ = 86.92 degrees. It has been found that value of θ greater than 45 degrees indicate that the polymer is a dilatant. Therefore, *Anogeissus leiocarpus*

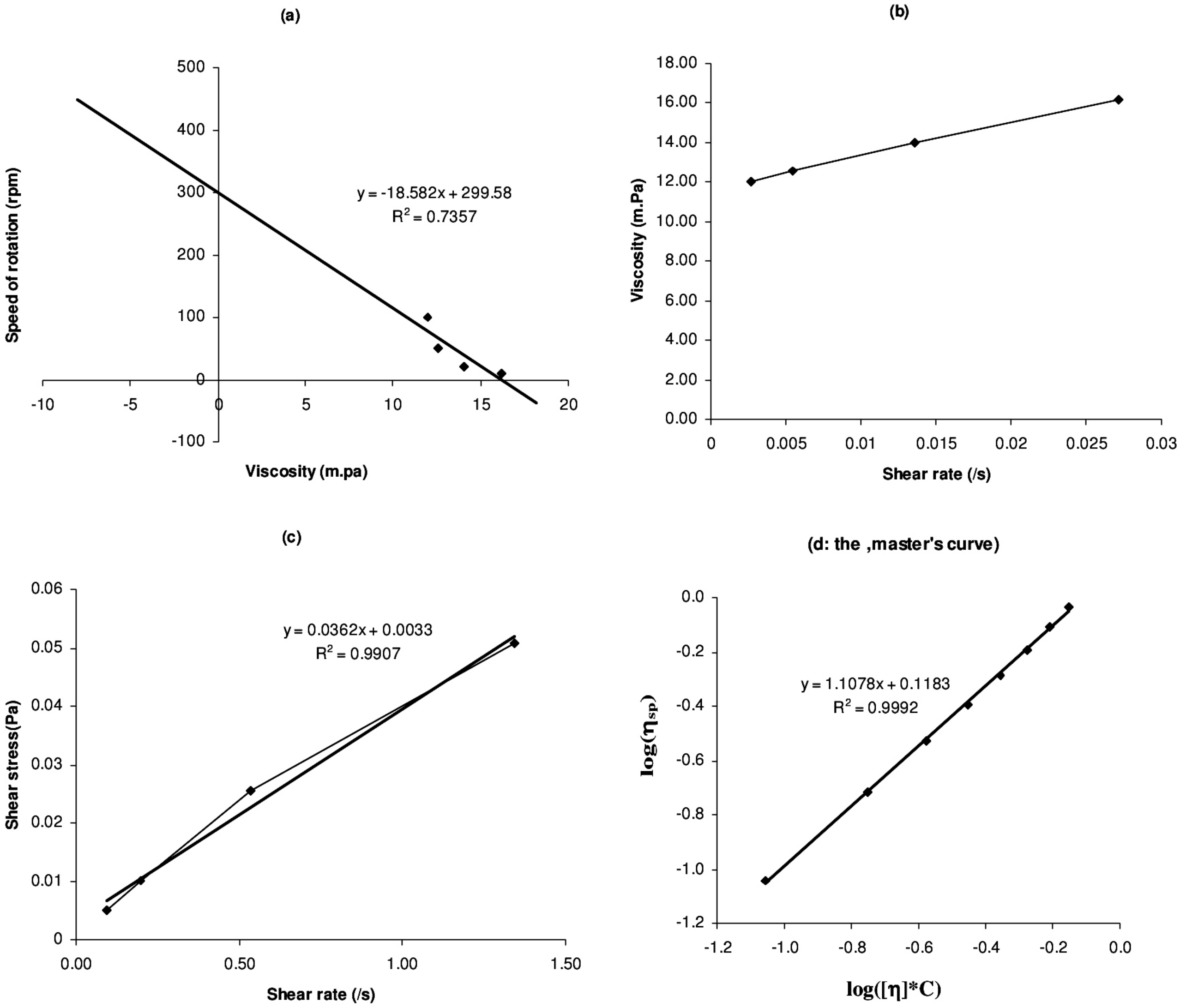

Fig. 7. Variation of (a) speed of rotation with viscosity (b) viscosity with shear rate and (c) shear stress with rate (d) log η_{sp} *versus* log([η]*C) for *Anogeissus leiocarpus* gum

gum is a dilatant with characteristics shear thickening properties. In Fig. 7a-c, the variation of (a) speed of rotation with viscosity (b) viscosity with shear rate and (c) shear stress with shear rate are presented. The trend obtained for the Figures confirmed that *Anogeissus leiocarpus* gum is a non-Newtonian fluid and is a dilatant with characteristics shear thickening property[14].

In the polysaccharide gum solution, the onset of coil overlap and entanglement depends both on the number of coils present (proportional to concentration) and on the volume that each occupies (proportional to intrinsic viscosity, [η]) and can therefore be characterized by the (dimensionless) "coil overlap parameter", C[η]. For most random-coil polysaccharides, the plots of viscosity against C[η] (the master's curve) were closely super imposable, irrespective of polymer type, molecular weight or solvent conditions and the critical concentration (C^*) transition occurred at a value of C[η]- 4.0. In Fig. 7d, a plot of log(η_{sp}) *versus* log($[\eta]^*C$): the master's curve for *Anogeissus leiocarpus* gum is presented. From the plot, at C[η]- 4.0, the viscosity reading is 2.19 ($\eta_{rel} = 3.19$), which represent the value of η_{sp} at which coil overlap and entanglement occurred in *Anogeissus leiocarpus* gum.

Fig. 8 shows scanning electron micrograph of *Anogeissus leiocarpus* gum at 500 × magnification and 50 µm scale. SEM is a strong analytical instrument that can be used to study the mophology of polymers such as gums and from the figure, it is evident that all the molecules of the gums are irregular, large granules and slightly elongated with rugged appearance.

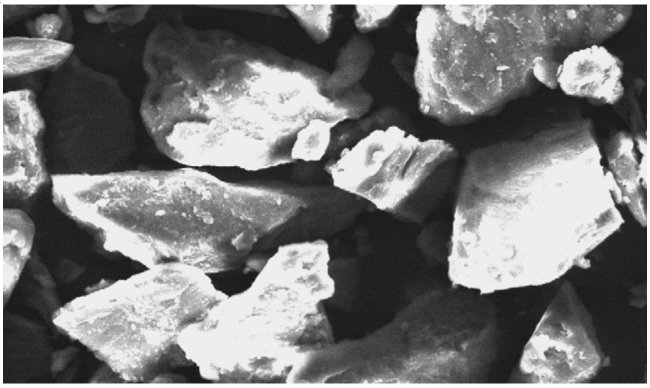

Fig. 8. Scanning electron micrograph of *Anogessus leocarpus* gum

Conclusion

From the results of the study, the following conclusions are made: (i) *Anogeissus leiocarpus* gum is mildly acidic and ionic gum with characteristic bland taste (ii) The viscosity of the gum increases with increase in pH and concentration but decreases with increasing temperature (iii) The intrinsic viscosity of *Anogeissus leiocarpus* gum ranged from 3 to 11 dL/g. The *Anogeissus leiocarpus* gum polymer-polymer interaction is favoured over polymer-solvent interaction (iv) The surface morphology of the gum reflects random like shapes than rod like shape (v) The gum is characterized with low value of flow activation energy (vi) Huggins, Kraemer and Tanglertpaibul and Roa models are useful in predicting the intrinsic viscosity of *Anogeissus leiocarpus* gum and the range of values obtained for the intrinsic viscosity of the gum is 3 to 11 (vii) From the variation of speed of rotation with viscosity, viscosity with shear rate, shear stress with shear rate, it can be confirmed that *Anogeissus leiocarpus* gum is a non Newtonian fluid with characteristics shear thickening property (viii) The results obtained from elemental analysis indicate that *Anogeissus leiocarpus* gum is a good source of mineral nutrition (ix) Coil overlap and entanglement in *Anogeissus leiocarpus* gum is expected to occur at C[η] *ca.* 4.0, when the viscosity reading is 2.19 (η_{rel} = 3.19).

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