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# Evaluation of some physicochemical properties of *Bombax gum*

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**Abstract**

Gum was extracted from the dried calyx of *Bombax ceiba* by two methods, hot and cold water processes. The gum obtained was subjected to some physicochemical tests using acacia gum for comparison. The hot water extract yielded more gum. The result of particle size distribution showed that 44.3% of hot water extract (HE), 30.4% of cold water extract (CE), and 49.3% of acacia gum (AC) were made of particles less than 150µm in size. Their packing and flow characteristics were evaluated and found as follows; bulk and tapped densities values were in order of AC > HE > CE, while Hausner's Quotient was in the order of CE > HE > AC. Both HE and CE had Carr's compressibility value above 40% while AC had about 27%.The packing fraction and porosity values for HE and CE were the same while their angle of repose measurements showed that HE > CE > AC. Their true densities were in order of AC > HE > CE. The hydration capacity of HE, CE and AC were 17.9, 16.7 and 4.7 respectively, while their swelling indices were 7.9, 7.6 and 2.8 respectively. HE, CE and AC had percentage fat content of 5.92%, 5.13% and 4.18%. The porosity of AC was 48%, while HE and CE had the same value of 87%. The relative viscosity of HE was found to approximately triple with every 0.9% increase in concentration, that of CE doubles while the viscosity of AC increases with about 0.2 units. These findings showed that the gum from *Bombax ceiba* possess interesting physicochemical properties that make it candidate for pharmaceutical use.

*Keywords*: *Bombax ceiba*, packing and flow characteristics, hydration and swelling capacities, viscosities.

## Introduction

Factors that affect the functional properties of gums and mucilages have been elucidated (Ward, 2005) as: active chemical constituents, concentration, molecular weight orientation, and temperature of hydration, pH, and presence of cat ions and particles size distribution. Gums and mucilages have been classified into acidic, neutral and salt forms (Balba, 1976), depending on their chemical composition. Extraction of gums and mucilage from their sources depend on their solubility and viscosity, which vary depending on the source of the gum (Baird and Speicher, 1962), or on the amount of degradation it might have undergone due to weathering, enzyme action and improper storage (Whistler and Smart, 1953). The viscosity of gums and mucilages enable their usefulness as pharmaceutical excipients in drug formulations. Such uses include: as binders in tablets, emulsifying and suspending agents in liquid formulations (Builders *et al.*, 2005). They are also used as disintegrants,

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protective colloids and as adsorbents (Udeala, 1988). For a binder to find usefulness in the formulation of pharmaceuticals, it is necessary that its properties be investigated (Builders *et al.*, 2005). Therefore, this work seek to investigate the physicochemical properties of two samples of bombax gum possessed differently from the same starting material, in order to facilitate its consideration as a raw material in the pharmaceutical industry.

*Bombax ceiba* L. Family *Bombacaeae* is a wildly occurring tropical tree that has economic uses. The stem is used for its timber while the fibre is used in furniture making. The calyx is used for thickening soup in the central region of Nigeria.

## Experimental

*Collection, identification of plant and extraction of the gum. B. ceiba* was collected from the hills of Lamingo village in Jos North LGA Plateau state, Nigeria. It was taken to the Department of Horticulture, Federal College of Forestry, Jos for identification. The flowers were sun dried for 72 h. Then the calyx were removed and pulverized. A 280 g was weighed and boiled in water for 30 min then removed from the heat source and left to cool for 24 h before it was strained through a muslin cloth. The gum was precipitated out using 95% ethanol. The gum was then dried indoors away from sunlight at room temperature for 24 h, then in hot air oven at 45 $^{o}$C for 30 min. It was milled and sieved through sieve number 60 and kept in airtight container for subsequent use. The same procedure was repeated for cold water extraction after soaking the gum in cold water for 24 h.

*Determination of Powder properties.* The particle size determination was carried out using the sieving method for all the samples. The true densities, bulk and tapped densities, Hausner's quotient, Carr's compressibility index, packing and porosity for each sample were determined according to the methods of Staniforth (1988). The moisture content was determined (BP 1980). The angle of repose was determined using similar method to that of Builders *et al.*, (2005). The hydration capacity of the gums were determined by adopting the method of Shangraw *et al.*, (1980), and their swelling indices were determined according to B.P (1980) method. The pH of 2% solution of each of the gums was determined using a pH meter, (Jenway, USA).

*Determination of crude fat content.* A 5.0 g sample was accurately weighed and transferred to Soxhlet extraction apparatus containing petroleum ether at 60 $^{o}$C - 80 $^{o}$C. The samples were extracted for 8 h after which they were dried in a hot air oven (Gallenkamp, England) maintained at 105 $^{o}$C for 24 h. The percentage loss in weight was expressed as fat content (Dayil, 1992). Three determinations were carried out and the mean value reported.

*Determination of relative viscosity.* This was carried out using the Ostwald U-tube viscometer, and the method described by other workers (Murwan, *et al.*, 2008) was adopted. The relative viscosity, Ù, was calculated from the expression:

$$Ù = T - T_o/T_o,$$

Where T is the time of flow of gum solution in seconds and $T_o$ is the time of flow of distilled water in seconds.

## Results and Discussion

The yield of gum from hot water was higher than from cold water extraction method. Particle size analysis revealed that the three samples predominantly consist of particles less than 150 um in size. Particle size is a major factor of consideration in powder rheology as it affects extraction of materials from crude drug sources, drying rate, filtration, sedimentation, absorptive and adsorptive capacities of materials. (Marshall, 1979). The particle size distribution of the

samples is presented in Fig. I. The result of moisture content (Table I) shows that AC had the highest value at 10.8% followed by CE at 7.0% then lastly HE at 2.3%. It can be said here that method of extraction affected moisture content of the gum, and CE extract gave samples with close moisture content to AC, while a comparatively drier sample is obtained with HE extract. Stability of pharmaceuticals significantly depends on their moisture content, high moisture content encouraging bacterial growth and chemical degradation. However, a certain level of moisture content is desirable for good flowability (Craik and Miller1988), and moisture content greatly reduce surface free energy of particles in powders thereby decreasing molecular attraction. (Carter, 1986). Where drier gum is desired, hot water extraction is recommended.

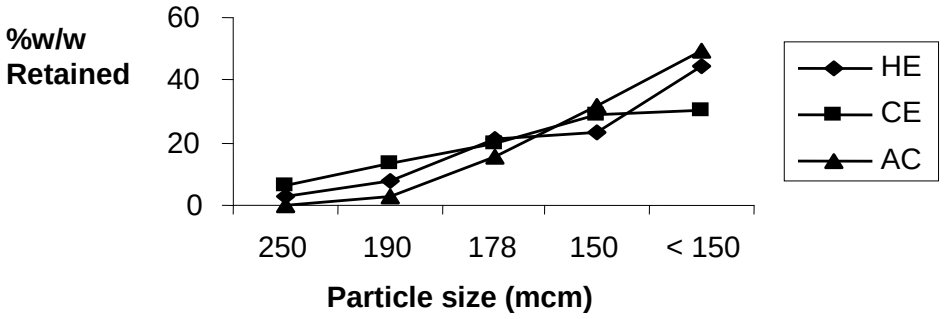


**Fig. I: Particle size distribution of gum powders.**

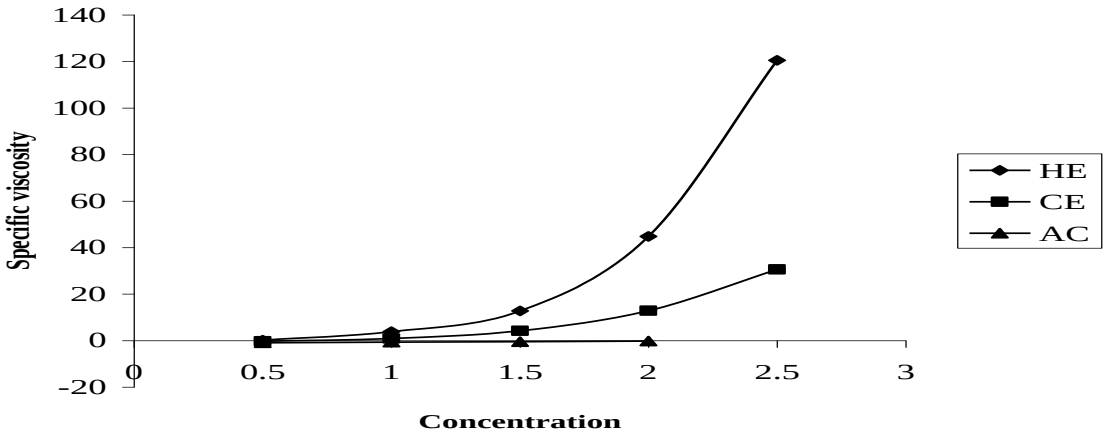


**Fig. II: Effect of concentration on specific viscosity of the gum solution**

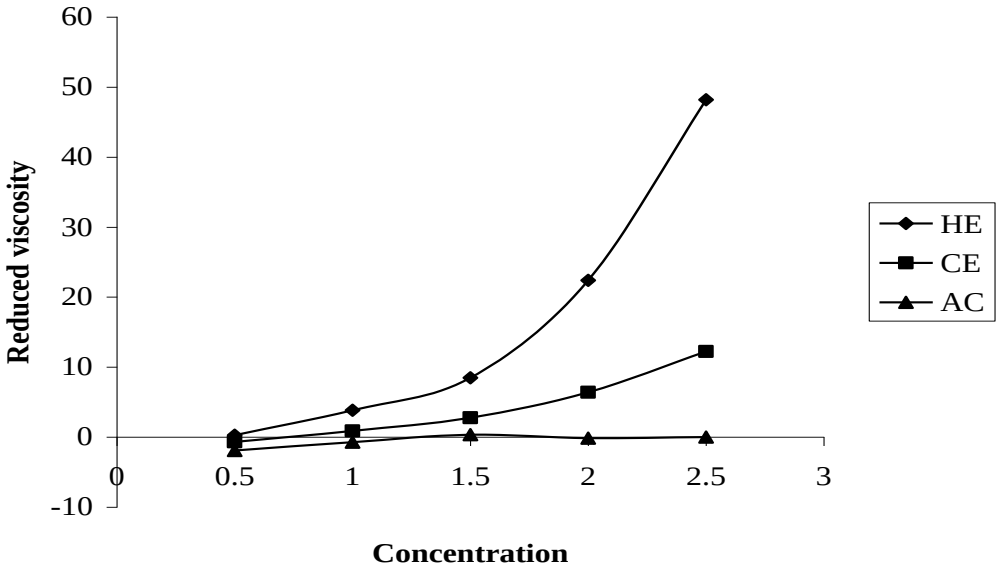


**Fig. III: Effect of concentration on reduced viscosity of gum solution**

**Table I:** Some physicochemical properties of the gum samples.

| | HE | CE | AC |
|---|---|---|---|
| Moisture content (%) | 2.3 | 7.0 | 10.8 |
| pH of 2% solution at 23 $^{o}$C. | 4.17 | 3.96 | 4.13 |
| Hydration capacity* | 17.932 | 16.741 | 4.657 |
| Swelling index | 7.9 | 7.6 | 2.8 |
| Fat content (%) | 5.92 | 5.13 | 4.18 |
| True density (gcm$^{-3}$) | 2.2692 | 2.0392 | 1.1705 |

*Assuming the density of water is 0.997 gcm$^{-3}$ at 23 $^{o}$C

**Table II:** Flow and packing characteristics of the gum samples.

| | HE | CE | AC |
|---|---|---|---|
| Bulk density(gcm$^{-3}$ ) | 0.2912 | 0.2667 | 0.6593 |
| Tapped density (gcm$^{-3}$ ) | 0.4918 | 0.4619 | 0.9091 |
| Hausner's quotient | 1.6889 | 1.7318 | 1.3789 |
| Carr's compressibility index (%) | 40.79 | 42.26 | 27.48 |
| Packing fraction | 0.13 | 0.13 | 0.56 |
| Porosity (%) | 87 | 87 | 44 |
| Angle of repose ( $^{o}$ ) | 35.5 | 31.5 | 21.0 |

The angle of repose values ( Table II) show that HE and CE have values greater than 25 $^{o}$, the limit value for good flowing powder, but less than 40 $^{o}$, the value above which were shown to have poor flow (Staniforth,1988 ). AC had value less than 21 $^{o}$, and it is expected to have good flow. The values for the bulk and tapped densities of the samples show that HE and CE had much lower values than that of AC, and the true density values show that bombax gum is much denser than AC. The values for the Hausner's quotient and Carr's compressibility for bombax gum was greater than 1.2 and 25%, respectively, values at which good flow behaviour was predicted (Nyqvist and Niclasson,1985).Thus bombax gum could not flow through funnel orifice. The pH

measurement for all samples showed they were acidic, acidity decreasing in order of CE > AC > HE. The pH of a substance is directly related to its stability, hence an optimum pH for maximum stability of an active ingredient often exists (Carter, 1986). The fat component for the three samples were less than 6%, the hydrophobic component of the gum is not large enough to cause problem of hydration, dissolution or solubilization. Indeed this can be observed from the hydration values and swelling indices of the gums. The hydration capacity and swelling indices are properties of the gum (Table I) that depends on its interaction with other molecules, number and strength of linkages and the presence of ion in the gelling agents (Sheludko, 1966). The viscosity of a fluid simply has been defined as its resistance to flow or movement (Marriot, 1988).The need for proper understanding of the rheological properties of pharmaceutical materials is an essential fundamental to preparation, development and evaluation of pharmaceutical dosage forms; gelling agents are used mainly to confer visco-elastic properties on products (Marriot, 1988), therefore, most attention has been focused on their viscous behaviour (Bauer and Collins, 1967). The viscosity of HE exceeds that of CE indicating the effect of extraction method on gum viscosity. The relative viscosity of HE increases about three times with every 0.5% increase in concentration that of CE doubles while AC increases by about 0.2 units as shown in Fig.III. Relative viscosity is used to derive specific viscosity from which intrinsic viscosity is derived, ultimately used in approximating molecular mass of polymers (Marriot, 1988).The effect of gum concentration on the specific viscosity of the gums can be observed from Fig. II. Increase in concentration has an expected increase in their viscosity, but more pronounced with HE than CE and AC. This means heating did not affect the viscosity of the gums, but rather enhanced it. Where more viscous gum solution is desired therefore, hot water extraction process should be used. The results obtained showed the potential of bombax gum as a gelling agent in the pharmaceutical and allied industries.

## Conclusion

The extraction method affected some physicochemical properties of bombax gum, better yield being obtained by hot water extraction. The physicochemical properties of the gum so far studied shows great potential for the use of bombax gum in pharmaceutical and allied industries.

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