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SOME PHYSICOCHEMICAL PROPERTIES OF THE GUM OBTAINED FROM THE SEEDS OF *BRACHYSTEGIA EURYCOMA*

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Abstract
Recently, emphasis has been on pharmaceutical education through research and development. The researchers, therefore, examined the physicochemical characteristics of brachystegia gum as a pharmaceutical excipient, with a view to contributing to pharmaceutical education through this research.. *Brachystegia eurycoma* seeds were bought from Elele market and roasted for 15 min before soaking in water for 24 h, to enable removal of the testa; the seeds were dried at 60^0C for 2h and milled into powder. The milled gum powder was defatted with solvent mixture (chloroform and methanol ratio 2:1). The gum was extracted from the aqueous colloidal dispersion of the residue with acetone, dried in a hot air-oven at 60^0C for 2h, sieved and stored in air – tight container before use. Physical tests (particle size analysis, angle of repose, bulk and tapped densities, etc. and phytochemical tests were carried out on the gum. Results showed a moderately fine light brown powder, (mean particle size 135 ± 30 µm), porous (bulk and tapped densities 0.57 and 0.71 g/cm^3 respectively), compressible (C.I:20.3), dense (true particle density 1.7g/cm^3), swellable (S.I 474.4 % w/v), soluble in water, has good flow property, and weakly acidic (pH 5.4) Phytochemical content include carbohydrate, starch and proteins. The physicochemical properties indicate that brachystegia gum has potential to be applied as pharmaceutical excipient.

Key Words:Physicochemical, properties, brachystegia gum.

INTRODUCTION

With global economic recession, emphasis on research and development has been on the increase, especially in developing countries, stressing the need for local sourcing of raw materials for the industries, especially pharmaceutical excipients.

Pharmaceutical excipients are inactive substances used as a carrier for the active ingredients of a dosage form. They are components of dosage forms that enable the formulations acquire some characteristics which will establish the basic features of the formulated product. Excipients are also sometimes used to bulk up formulations that contain very potent active ingredients (Ram 2004), to allow for convenient and accurate dosage. They control physicochemical properties as well as the release profiles and availability of the drug in the system. The physicochemical properties of a compound are measurable characteristics by which the compound may interact with other systems. One of the commonly used groups of compounds as excipients is natural gum (polymer).

Natural gums are polysaccharides with varying chemical composition and a wide range of molecular weights. They

are characterized by low toxicity, high stability and biodegradability. These properties make them appealing as pharmaceutical excipients (Anekant *et al.*, 2007). Since the ability of these gums (polymers) to provide its intended action chiefly lies on its physical and chemical properties, properties such as solubility, water sorption, swelling capacity, pH and viscosity among others should be established for any potential excipient. Natural gums that have been used as excipients in pharmaceutical formulations include acacia, tragacanth, guar gum and irvingia gum (Uzondu and Okor, 2009). They are used as binders and disintegrants in tablets and as suspending and flocculating agents.

Brachystegia eurycoma is a dicotyledonous plant (legume) commonly called "achi" by the south eastern part of Nigeria, family: leguminosae. The seed flour has gelatinous properties and imparts a gummy texture when used in soups (Keay *et al*., 1971). When in powdery form, it swells in water, thus increasing the viscosity in traditional soups.

The seed contains 10.47% protein, 71.94% total carbohydrate content (Enwere, 1998), fat 15.5 $\pm$ 0.04 and 14, 0.01 for the undehulled and dehulled samples respectively; sodium, potassium, calcium and magnesium contents were less than 1%. The phytochemical analysis showed the presence of alkaloids, tannins, saponins and flavonoids (Uhegbu *et al.*, 2009). Ikegwu *et al*., 2010 investigated the swelling power, solubility, water and oil sorption capacities, viscosity etc of the seed flour. *Brachystegia. eurycoma* gum in right combinations with mucin and honey has been found to heal wound, prevent bacterial infection, promote regeneration of the follicles (Adikwu *et al*., 2007). Uzoma *et al*., (1999) studied the rheological properties of brachystegia gum in comparison with *Irvingia gabonensis* and found that irvingia gum appeared to be more pseudoplastic than brachystegia gum.

The present study attempted to investigate the physicochemical properties of brachystegia gum - the available literature shows that no such work has been done on brachystegia gum. The second objective is to investigate the potentials of the gum for application as excipients in pharmaceutical f ations

MATERIALS AND METHODS

MATERIALS

The test gum was brachystegia gum, obtained locally by extraction as described below. It is available as a light brown, moderately fine powder, tasteless, possesses a strong aromatic odour when freshly prepared, but which fades on storage.

Tragacanth gum powder made by BDH, Syria was used as the reference standard gum in the investigation.

The reagents used included chloroform, methanol, acetone, benzene, lead subacetate solution 1%, Draggendorffs reagent (all of Analar grade, manufactured by BDH, Poole, England).

METHODS

Preparation of the gum

Dry seeds of *B* 2 *stegia eurycoma* were bought from Elele market in Rivers State, Nigeria. The seeds were sorted out and cleaned to eliminate the bad ones. The seeds were roasted for 15mins, then soaked immediately in cold distilled water for at least one hour to remove the seed coat, after which the seeds were soaked again overnight, in distilled water. The seeds were dried in hot air oven (Model DHG-9101, Ceword Medical Equipment, England) at 60^{o}C and milled into powder using electronic milling machine (Saisha, Japan). A

sample of the milled seeds was macerated in 1500 ml of solvent mixture consisting of chloroform and methanol in the ratio of 2:1 for up to 8 h stirring occasionally with a spatula. This solvent system, and the maceration time, 8 h, were selected for effective defatting of the milled seeds based on the procedure by Udeala *et al*. (1980) and Uzondu and Okor (2009). The supernatant solvent mixture was decanted and the residue (the crude gum) was strained to remove excess solvent.

The crude gum was hydrated to a colloidal solution in distilled water for 8 h. The pure gum was obtained by extracting with acetone (ratio 1ml colloid: 3 ml acetone), filtered by squeezing through a muslin cloth, and drying in a hot air oven at 60^{o}C for 2 h. The dried gum was pulverized using a mortar and a pestle, screened with size 60 BSS stainless steel sieve. The resulting particles were stored in air tight container for 24 h prior to use. The yield of brachystegia gum was 20.65 ± 2.75%w/w.

Identification test

(1). A 1 g quantity of brachystegia gum powder was dispersed in 100 ml of hot water and the effect observed. (Harbonne, 1973; Chukwu, 2008). A viscous dispersion was obtained which suggested the presence of gum.

(2.) 5ml of 10% dispersion of brachystegia gum was added to 1ml of dilute lead subacetate solution and the effect noted (Harbonne, 1973). A white precipitate confirmed the presence of gum.

Test for complete removal of fat from the gum

A sample of the purified gum (10g) was added to 227ml of the acetone/benzene/water mixture (ratio 97:30:8) (Harbonne, 1973), and stirred for 10mins with a glass rod. The mixture was filtered and the filtrate was subjected to TLC analysis for presence of fat using wool fat as standard (Harbonne, 1973). The test was repeated with milled seeds, and from the difference the degree of defatting (%) was calculated. Extent of defatting of brachystegia gum was complete as its Rf value was zero, while those of wool fat and milled brachystegia seeds were 0.663 and 0.461 respectively.

Physical characterization of the gum

Study of physical properties of a drug / excipient is very crucial so as to achieve a stable effective product (York, 2002).

(a) Particle size analysis and determination of shape of particles.

The techniques for representing particle size distribution are all based on the assumption that particles could be adequately represented by an equivalent circle or sphere (Staniforth, 2002). However, in some cases, particles deviate markedly from circularity and sphericity (Martin, 2001). Particle- size distribution of a new gum: brachystegia gum and its particle shape were determined as described below in order to assess its physical characteristics.

Particle-size analysis of *Brachystegia eurycoma* gum powder was carried out by sieve method using a nest of sieves decreasing in pore size serially from 700μm to 210μm. A sample of the powder (50g) was placed on the top-most sieve and shaken for 5min with a sieve shaker (Endecott Ltd, UK), (Martin , 2001). Fractions retained on each sieve were collected and weighed to determine the size distribution. The mean particle size ($\overline{X}$) was calculated as follows:

$$\overline{X} = \frac{\sum fx}{\sum f} \quad \text{---------- (1)}$$

Where f = frequency, ($\overline{X}$) mean particle size.

To determine particle shape, samples of the gum powder were spread thinly on a slide and examined with a light microscope (Model 745917 Kyowa, Tokyo) at various magnifications up to x 40 iu.

(b) Determination of packing property of the gum powder:

By slight vibration of a powder bed, particles can be mobilized so that if the vibration is stopped, the bed is once more in static equilibrium but occupies a different spatial volume than before (Richards, 1972; Staniforth, 2002**.** Bulk density (BD) of a powder bed is simply the weight of the powder comprising it divided by the volume of the bed.

Tapped density (TD) of a powder bed is given as the weight of the powder divided by the volume obtained after 100 taps.

To determine the flowability of a powder, a simple test has been developed by Carr, 1965, by comparing the bulk density of the powder with the tapped density. Carr's Compressibility Index (C. I.) has been an empirical guide to this determination as shown in the equation below:

$$\text{C. I. (\%)} = \frac{\text{TD} - \text{BD}) \times 100}{\text{TD}} \quad \ldots\ldots (2.)$$

A value less than 20 % (Carr) implies good flow whereas greater than 33% (Carr) indicates poor flow.

Packing properties of brachystegia gum were, therefore, determined using tragacanth gum as standard, as shown below.

The bulk density (BD) and the tapped density (TD) were determined using standard procedures as described by Staniforth (2002). To determine BD, a sample of the gum powder (30g) was placed in a 250ml dry measuring cylinder, and the volume, V_0, occupied by the sample was noted. BD was calculated as 30g/ V_0. After 100taps using a stampfvolumeter (Model STAV 2003 JEF, Germany), the reduced volume, V_{100} was noted. TD was calculated as 30g/ V_{100} . The determinations were carried out in triplicate and mean result expressed.

Hausner's quotient of the powder due to tapping was expressed as Hausner (1967):

$$\text{H.Q.} = \text{TD/BD.} \quad \ldots\ldots (3).$$

Hausner's quotient is a measure of interparticulate friction and could be used to predict flow behaviour of a powder

(c) Determination of true particle density:

Density is universally defined as weight per unit volume. The difficulty arises when one attempts to determine the volume of particles containing microscopic cracks, internal pores and capillary spaces (Martin, 2001). When a solid is nonporous, true and granule density are identical, and both can be obtained by the displacement of helium or a liquid such as mercury, benzene, water, liquid paraffin (Martin, 2001). If the material is porous, as is the case with most powders, the true density may be determined by use of a helium densitometer.

The weight of liquid paraffin filling a specific gravity (SG) bottle (of known weight) was determined by difference (Sugita et al, 1995). The specific gravity bottle was thoroughly cleaned and dried to a constant weight. A sample of brachystegia gum powder (1g) was poured into the specific gravity bottle. To ensure that the gum sample has been freed completely from entrapped air the S G bottle and content was subjected to vacuum for 30 min. The weight of the SG bottle filled with the liquid paraffin only was noted and from the difference, the weight and hence volume of liquid paraffin displaced by the weight of the gum was obtained.

The particle density was calculated as:

$$\rho = \frac{(W_3 - W_2)}{V} \text{ ----------(4)}$$

W_2= weight of density bottle + liquid paraffin

W_3 =weight of density bottle + liquid paraffin + gum powder

ρ is the sample weight of the gum powder/ V (the volume of liquid paraffin displaced) (Richard 1972). Determinations were made in triplicate and mean result presented. The above procedure was repeated for tragacanth gum as the standard.

(d) Determination of powder flow property-angle of repose

This is the maximum angle between the plane of a heap of powder and the horizontal surface on which the heap of powder rests (Train, 1956, Richards, 1972). The tangent of the angle of repose can be determined using the equation (Train, 1956; Richards, 1972):

$$\text{Tan } \theta = 2h_t / D \text{ - - - - - (5)}$$

Where h_t = height of heap of powder,

θ = the static angle of repose.

D = diameter of heap of powder.

Angle of repose has been used as indirect method of quantifying powder flowability, because of their relationship with interparticle cohesion. As a general guide, powders with angles of repose greater than 50^0 (Staniforth, 2002) have unsatisfactory flow properties, whereas angles close to 25^0 correspond to very good flow properties.

Flowability of brachystegia gum powder was determined by measuring the angle of repose formed when a sample of the powder (20g) was allowed to fall freely through the stem of a funnel (orifice diameter 4.6mm) to a horizontal surface. Angle of repose was expressed as ^oC. The determination was carried out in triplicate and the mean results reported. Tragacanth was used as reference standard.

To calculate angle of repose, experimental values were substituted in equation 5.

(e) Solubility of brachystegia gum:

In British Pharmacopoeia (2005) statements given in the monograph under the side-heading "solubility" are intended as information on the approximate solubility at 20^0 C.A sample of gum (1g) was added to 10ml of the test solvent (water), and stirred continuously with a glass rod for 30min after which the excess solute (i.e. the gum powder) was removed by filtration. The filtrate was assayed for gum content gravimetrically by drying to constant weight in a tarred crucible. Solubility was expressed as mg/ml. The experiment was repeated using organic solvents such as ethanol, ether, methanol, and n-butanol.

(f) Determination of charring temperature, total ash value and acid insoluble ash:

The melting point (charring temperature) of a pure solid is strictly defined as the temperature at which the liquid and solid exist in equilibrium (African Pharmacopoeia, 1986).Determination of melting point was made by tapping a sample of brachystegia or tragacanth gum (0.2 g) into 3 capillary tubes sealed at one end. The tubes were inserted in a melting point apparatus (GallenKamp Model 2110). The temperature (^0C) at which the gum powder contained in the tube changed colour from brown to black was taken as the charring temperature.

Determination of ash value was done by placing a sample of the powder (i.e.

W_o) in a suitable tarred crucible (previously ignited and weighed) and weighing accurately, the powder was ignited by heating at 450^0 C for 1 h. in a muffle furnace (Model 2110, Gallenkamp England) cooled and dried to a constant weight (W_1). The ash value was calculated as %w/w of the gum powder as follows:

W_1/W_o x 100% - - - - - (6)

Where W_o = the initial weight of powder W_1 = the final weight of powder.

The acid – insoluble ash is the residue obtained by boiling the ash with dilute hydrochloric acid, collecting the insoluble matter in a filter, washing and igniting (African Pharmacopoeia 1986).The acid insoluble ash was determined by boiling the ash in concentrated hydrochloric acid (2M, 25ml) for 5min. The residue (i.e. the acid insoluble ash) obtained by filtration was air-dried to a constant weight and expressed as %w/w of the gum powder.

(g) Swelling index (S.I).

Swelling index is a measure of the swelling properties of crude drugs. It is the volume in millilitres occupied by the swelling of 1g of drug in water (BP, 2005), African Pharmacopoeia, 1986) or the liquid specified.

Swelling index (S.I.) is given by:

S.I. = V_1 - Vo/V_o x 100% - - - - (7)

Where V_0 is the initial volume occupied by the swelling substance, V_1 is the final volume of substance.

The method described in the British Pharmacopoeia (2005) as above, was followed. A sample of brachystegia or tragacanth gum, (1g), was first moistened with 1ml of 96%w/v ethanol. The moist material was transferred to a graduated measuring cylinder and 10ml water was added slowly. The initial volume (V_o) occupied by the gum was noted. After standing for 4h (time to attain equilibrium swelling) the final volume (V_1) occupied by the gum was also noted. The swelling index was calculated from the expression as in the equation above.

(h). Determination of pH

1g sample of brachystegia gum powder was dispersed in distilled water and made up to 100 ml with water. The gum dispersion was homogenized with Silverson homogenizer (Model AXR, England). The pH of the gum mucilage was read with a pH meter (Model PHS 25, England) (B.P, 2005). Determinations were made in triplicate and mean results reported.

All the above experiments were repeated using tragacanth gum as the reference standard.

(i) Determination of apparent viscosity of gum mucilage

A digital Ni Run viscometer (Model NDJ- 5S) was used for the study. It measures the torque required to rotate an immersed spindle in a fluid. The instrument features a rotating spindle with multiple speed transmission and interchangeable spindles that measure a variety of viscosity ranges. Different concentrations (1.0, 2.0 and 3.0%w/v) of the gum mucilage samples were prepared in a beaker, enough to allow immersion of the spindle groove in the fluid. For each concentration, triplicate measurements were made, and mean result computed.

All the experiments above were repeated using tragacanth gum as the reference standard.

PHYTOCHEMICAL TEST

(1) Test for presence of carbohydrates

The method described by Harbourne, (1973) and Baker, (2002) was applied. Molisch reagent was prepared by

dissolving 20g of α - naphthol salt in 100 ml of methanol and kept in a coloured bottle (Alexander and Griffith, 1988). 2 drops of the reagent were added to 2 ml each of an aqueous dispersion of brachystegia gum (4% w/v) in a test tube. 1ml of conc. H_2SO_4 was carefully poured down the side of the tube, which was in a slanting position. The junction of the two layers was observed for colouration. Deep violet ring coloration indicates presence of carbohydrates.

Confirmatory test was made using Anthrone reagent. Anthrone reagent was prepared by dissolving 0.1g of the anthrone powder in 100ml of concentrated sulphuric acid. To 2ml of the gum dispersion, was added 5drops of the anthrone reagent and mixed by shaking. A greenish coloration confirms the presence of carbohydrate (Harbonne, 1973).

(2) Test for presence of starch.

The procedure by Harbourne (1973) was followed. Iodine solution was prepared by dissolving 0.5g iodine crystals in 100ml potassium iodide solution in distilled water (1%). Two drops of iodine solution were added to the sample of the gum powder and observed. A deep blue coloration indicates presence of starch.

(3) Test for presence of reducing Sugar

Fehling's solution 1 (containing copper sulphate solution with potassium tartrate) was mixed with Fehling's solution 2 (dilute sodium hydroxide solution). The mixture (2ml) was added to 2ml of the gum dispersion (4%w/v) in a test tube and boiled for 5 min. 2ml of 1% glucose (as reference standard) solution was similarly treated. A red colouration indicates presence of reducing sugar e.g. glucose.

For confirmation, 2ml of a 1% dilute sulphuric acid was added to the gum dispersion (2ml) in a test tube, boiled and filtered. 1% sucrose solution was similarly treated. To each of the filtrate was added 1% sodium hydroxide solution in water until the reaction medium became neutral. 2ml Fehling's solutions 1 and 2 were added separately to the test tubes. A red colouration confirms presence of reducing sugars (Baker, 2002)

(4)Test for presence of proteins (Biuret Test)

5 drops each of copper sulphate (1% solution) were added to 2ml of 4% w/v aqueous dispersion of the gum powder followed by 2ml of 1% sodium hydroxide in water and mixed. A violet colouration indicates the presence of protein. 0.5g albumin in saline (0.9% NaCl) was used as the control.

(5) Test for presence of alkaloids

2ml of 1% H_2SO_4 was added to 5ml of the gum dispersion in water (4% w/v). The mixture was heated in a water bath at 60^0C for 10 min. and filtered. 0.1ml of the filtrate was added to 2ml of Draggendorff's reagent (solution of bismuth iodide) and allowed to stand for 2 min. and examined for turbidity or colour change, presence of which indicates presence of alkaloids.

(6) Test for Saponins

Frothing test: 5ml water was added to a sample of the gum powder and shaken vigorously. Tragacanth gum powder was used as reference standard. Frothing indicates presence of saponins (Baker, 2002).

(7) Test for presence of flavonoid

A sample of aqueous gum dispersion (10mls of 4 % w/v gum dispersion) was heated with 10ml of ethyl acetate in a boiling water bath for 3 min. The mixture was cooled under running tap water and filtered through a No. 1 Whatman filter paper. Dilute ammonia was added to 5ml of the filtrate in a flask. The flask was shaken gently and the lower alkaline layer was observed; quercetin extract was used as control.

(8) Test for the presence of tannins (Phenazone Test)
1g quantity of sodium acid phosphate was added to 10ml of the test samples and warmed on a Bunsen burner, cooled and filtered. 4ml of 2% phenazone solution (lead acetate solution) was added to the filtrate and observations were made. A red precipitate indicates presence of tannins (Harbourne, 1973).

(9)Test for presence of glycosides
To 2ml each of the test samples of the gum dispersion, was added 5ml dilute H_2S0_4 and boiled gently for 5min. Senna Leaf extract was similarly treated. The filtrate was made neutral with 1% sodium bicarbonate. 2ml Fehling's solution (1 and 2) was added with shaking. A red precipitate indicates presence of glycosides. Extract of Senna leaf was used as control

RESULTS AND DISCUSSION

(a) Particle size analysis
Results in Table 1 showed that brachystegia gum particles are moderately fine (mean particle size 135 ± 30 µm) and free-flowing. Particle size can be optimized for therapeutic activity. For example higher dissolution rates may be achieved through reduction in particle size i.e. micronization (Hamed *et al*., 2000). Because cohesion and adhesion are phenomena that occur at surfaces, particle size will influence the flowability of a powder. In general, fine particles with very high surface to mass ratios are more cohesive than coarser particles, which are influenced more by gravitational forces (Staniforth, 2002). Particles larger than 250 µm are usually relatively free flowing, but as the size falls below 100µm, powders become cohesive and flow problems are likely to occur. This might explain why brachystegia particles are free flowing (mean particle diameter is 135 ± 30 µm). Powders having a particle size less then 10µm are usually extremely cohesive and resist flow under gravity, except possibly as large agglomerates, (Staniforth, 2002).

(b) Packing properties of brachystegia gum powder
The values of bulk and tapped densities of brachystegia gum (0.57 ± 0.01; 0.713 ± 0.02 respectively) in Table 1 showed that brahystegia gum compact readily upon tapping. The change in bulk volume upon tapping has been produced by rearrangement of the packing geometry of the particles. In general, such geometric rearrangements result in a transition from loosely packed particles to more tightly packed ones, thus cohesion increases. This also means that tightly packed powders require a higher driving force to produce flow more than loosely packed particles of the same powder.
Brachystegia's compressibility index: 20.31 ± 1.23%, and Hausner's quotient (0.82 ± 0,51) indicate good consolidation. However, these indices are one- point determination and do not always reflect the ease or speed with which the powder consolidates (Staniforth, 2002). Indeed, some materials have a high index (suggesting poor flow) but may consolidate rapidly. Rapid consolidation is essential for filling on tablet machines when the powder flows into the die.

(c). Angle of repose (flowability) The values of angle of repose in (Table 1) showed that brachystegia gum is free flowing ($28.32^o \pm 4.5$.) compared with tragacanth gum powder which appears to be more cohesive ($29.80^o \pm 3.1$).

(d) True Particle Density.
The true particle density of brachystegia gum was found to be 1.74

Table1 1: Physical characteristics of brachystegia and tragacanth gums

Parameter	**Brachystegia**	**Tragacanth**
Bulk density(g cm-3)	0.576 ± 0.01	0.564 ± 0.005
Tapped density(g cm-3)	0.713 ± 0.02	0.792 ± 0.015
True particle density (g cm-3)	1.74 ± 0.52	1.81± 0.
Particle size range (μm)	100 – 300	200 – 700
Mean particle size (μm)	135 ± 30	461 ± 15.5
Compressibility index (%)	20.3 ± 1.23	29.11 ± 0.85
Hausner's quotient	0.82 ± 0.51	1.41 ± 0.01
Angle of repose (^{0})	28.32 ± 4.5	29.8 ± 3.2
Swelling index (%)	471.4 ± 2.1	250 ± 3.2
Charring temperature (°C)	132^o ± 10	215^o± 0
Total ash (%)	2.3 ± 0.03	3.0 ± 0.03
Acid in soluble ash (%)	0.505 ± 0.05	0.72 ± 1.5
pH (1 % dispersion)	5.4 ± 0.5	4.61 ± 0.15
Solubility in water	7 in 100	6.0 in 100
Solubility in organic solvents	Insoluble	Insoluble

± 0.00 1gcm-^{3} (Table 1) which compared favourably with that of tragacanth gum powder, 1. 81 ± 0.001g cm-3.

Brachystegia and tragacanth gum powders will, therefore, sediment readily in water unless flocculated.

Table 2: Result of viscosity determinations

Viscosity (MPa)

Gum dispersion (% w/v)	**1**	**2**	**3**
Brachystegia	59.03 ± 2.32	73.0 ± 1.51	89.02 ± 3.332
Tragacanth	49.5 ± 3.21	57.3 ± 4.67	74.6 ± 1.58

(e) Swelling Index

The swelling index of brachystegia gum was 471.4 ± 1.15% (Table1) compared with tragacanth 250± 0.3%.Brachystegia gum can be said to be highly swellable in water while tragacanth is moderately swellable in water. Both gums, however, hydrates slowly in water at ambient temperature. Brachystegia gum can, therefore, be investigated for application as a tablet disintegrant.

(f) Solubility of brachystegia gum

The brachystegia gum powder is soluble in water, 7 in 100 parts at room temperature (Table 1). However, the gum gelled in hot water (70^o C) and hydrated overnight to form colloidal dispersion. Tragacanth gum powder also gelled in water at room temperature, and hydrated overnight in water to form colloidal dispersion. This probably is the basis for the use of these gums as viscosity-imparting agents (Uzondu and Okor, 2009). Brachystegia and tragacanth gums were insoluble in all the organic solvents used for the study.

(g) Charring temperature and ash values

The charring temperature of brachystegia gum was132 ± 10^oC while that of tragacanth gum was 215 ± 0^oC (Table 1). Brachystegia gum chars rather than melts at high temperature. Thus, it is stable to high temperature.

The ash values for brachystegia and tragacanth gums were 2.3 ± 0.02 and 3.0 ± 0.01 respectively. The corresponding values for the acid insoluble ash were 1.11 ± 0.03 (brachystegia) and 1.31+ 0.03 (tragacanth). The ash values showed that the amount of foreign organic matter in the new gum (brachystegia) is low.

(h) pH of brachystegia gum dispersion

The pH of 1%w/v of aqueous dispersion of brachystegia gum was 5.4 ± 0.5 (Table 1), while that of tragacanth gum was 4.61 ± 0.15 at 1%w/v concentration. This means that tragacanth is more acidic than brachystegia gum.

(i) Viscosity of brachystegia gum powder.

The viscosity of brachystegia gum increased with increase in concentration. These flow patterns are of immense importance in liquid formulations such as suspensions owing to their ability to keep the preparation suspended, and in application as binder in tablet formulation.

PHYTOCHEMICAL CONTENT

Generally, brachystegia gum powder gave negative reactions to tests for reducing sugar, saponins and glycosides showing the absence of these in brachystegia gum. Carbohydrate, starch, and protein, were however, found to be present.

On heating brachystegia gum dispersion with dilute H_2SO_4 (1%) in a water bath for 5 min and neutralizing with dilute NaOH solution, there was no noticeable reaction with a mixture of Fehling's solutions 1 & 2.The control (sucrose) being a disaccharide, showed red precipitate with Fehlings solutions on hydrolysis with sulphuric acid, indicating that it was hydrolysed to reducing monosaccharides by the acid, thus confirming the absence of reducing sugar in brachystegia gum.

The phytochemical content of brachystegia gum powder, however, showed that it is a complex polysaccharide.

CONCLUSION

From the results obtained for brachystegia gum powder, it can be seen that this gum has good flow properties, is highly swellable in water and forms viscous dispersions in water - the viscosity of which increases with concentration. These properties indicate that brachystegia gum can find application as a disintegrant and binder in tablet formulation, as hydrogel in modified release dosage forms and as a suspending and stabilizing agent in liquid formulations. These can be investigated by further studies. Also, based on the results of its physical properties, brachystegia can be applied as a substitute for tragacanth gum, and by so doing, would have saved the scarce foreign exchange for the country, since it is sourced locally.

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