CURRENT RESEARCH

BINDING PROPERTIES OF GUM FROM KHAYA SENEGALENSIS: I. GRANULES

By

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ABSTRACT

The binding properties of gum obtained from Khaya senegalensis Juss. family. Meliaceae was evaluated in comparison with gum acacia. The results of the investigation, as estimated from the granular characteristics of lactose granules prepared with the Khaya gum as binder, show that the Khaya gum has a good binding potential in tablet granulations.

A 3% w/w of Khaya gum exhibits similar binding ability to 5% w/w acacia gum.

INTRODUCTION

Binders are used in tabletting to impart cohesiveness to powdered materials, converting them to granules thereby improving their flow properties. Due to the importance of binders in tablet science, various studies have been made into the use of various natural and synthetic materials as tablet binders, and into their effect on the properties of the granules and/or tablets (Patel and Shah, 1965: Hunter and Ganderton, 1972: Davies and Gloor, 1972: Sakr et al, 1972, Schoefer and Worts, 1978; Nasipuri, 1979, Boyinbode and Iranloye, 1968). However, very little of these works were carried out on gums obtained from West African plants.

This investigation therefore aims at evaluating the binding properties of the gum obtained from a tree indigenous to West Africa, Khaya senegalensis Juss, family Meliaceae. The binding properties of the gum is determined in relation to that of acacia mucilage (5%w/w). Acacia was chosen because it is a gum and has long been established as an efficient binder. It is hoped that an optimum binder concentration of the gum will be established.

MATERIALS AND METHOD

1. **Collection and Preparation of the Gum.**
   This has been reported elsewhere (Mgbahurike 1988)

2. **Preparation of the Granules.**
   The wet granulation method was employed in which various concentrations of the Khaya gum was used as binding agent. The concentrations studied were between 1%w/w, and 5%w/w as well as 5%w/w acacia mucilage. Higher concentrations of Khaya gum above 5%w/w gave a semi-solid mass. This indicates a different binding behaviour from the gum obtained from Khaya Granifolia (Boyinbode and Iranloye 1986). For each batch, 0.5kg of lactose B.P. was added into Erweka Z blade (Model, Erweka Apparatebau, Ottostri, W.Germany) and dry mixed for 30 seconds. A total of 75ml of granulating fluid was added in four portions and massing carried out for two minutes after each addition. After the last addition, massing was done for a further 2 minutes making a total of 10 minutes. The moist mass was screened in a rotary granulator (Jackson Crockatt Manufacturing Co. Ltd., Glasgow) fitted with 1.5mm size screen. The granules formed were dried using thermostatically controlled tray drier at 60°C to a moisture content of 1.2%. The dried granules were dry-screened through 1.0 size screen, then packed in dry air tight glass jars.

3. **Characterization of Granules**

(a) **Granule size Analysis**

The size distribution of the granules was determined by sieve analysis using Endecott sieves. 100gm of each batch of unfractionated granules was shaken for 4 minutes on an Endecott test sieve shaker (Model EFLI. Endecotts Ltd., London). The weights retained on each sieve was determined. The determination was repeated three times and the average reading recorded.

(b) **Bulk Density**

A loose bulk density was measured on all granulations. 30gm of each granulation was gently and slowly poured through a short stemmed glass funnel into a 100ml graduated cylinder. The orifice of the funnel was aligned with the 100ml graduation mark. The volume occupied by the granules was read to the nearest 0.5ml and the bulk density calculated in gm/ml. The recorded results were average of three determinations.

(c) **Tapped Density**

This was determined by modifying the method of Newmann (1953). 30gm of each batch of unfractioned granules was poured into 100ml burette clamped to a retort stand and fitted in Pascall sieve tapping shaker. The initial reading of the volume was taken and then the change in volume after 50 taps was recorded. The tapped density was calculated in g/ml. The recorded values were average of three determinations.

(d) **Percentage Compressibility**

The precentage compressibility of each batch of granulation was calculated from the difference between tapped and bulk densities divided by the tapped density, and the ratio expressed as percentage (Schwartz et al. 1975).

Granule Friability

This was assessed by determining the resistance to abrasion of granules retained on size 60 mesh (250μm and above using Roche Friabilator). A 10gm sample of each batch of granule was rotated in the friabilator for 4 minutes at 25rpm. The resultant sample was sieved through size 250μm Endecott test sieve for 1 minute on the Endecott Sieve Shaker. The amount retained on the 250μm sieve was weighed and the difference in weight from initial weight expressed as percentage of the original weight. The determination was repaeted three times and the average result recorded.

Flow Rate

(e) This was determined using a glass funnel with stem length of 40mm and 8mm orifice diameter, clamped to a retort stand. The orifice being opened or closed with cardboard paper. 50gm of each batch of unfractionated granule was weighed into the funnel and the time of flow through the orifice recorded. The determination was repeated six times and the average reading recorded.

RESULTS

(f) The results of the size analysis of the granules are shown in Figs 1 and 2. The granule size distribution as illustrated in Fig. 1 by the plot of cumulative percentage undersize against particle size, indicates that 2%w/w and 3%w/w Khaya gum mucilage gave similar granule size distribution as 5%w/w acacia mucilage. There is a significant difference in size distribution of granules prepared with 5%w/w Khaya gum mucilage as binder and that prepared with 5%w/w acacia mucilage as binder.

Fig 2 shows a plot of mean particle size of granules against gum concentration, which indicates an increase in granule mean size as the gum concentration increases. Again, 3%w/w Khaya gum mucilage gave a mean particle size similar to 5%w/w acacia mucilage.

It is seen from fig. 3 that a decrease in percentage friability occured as the gum concentration increased. The least percentage friability was obtained with 5%w/w Khaya gum mucilage at 5.2%w/w, while 3%w/w Khaya gum gave 8.4%w/w friability as compared to 8.1%w/w which was obtained with 5%w/w acacia mucilage.

The observed variation in flow rate and percentage compressibility of the lactose granule with change in gum concentration shown in fig. 4 indicates a general decrease in flow rate as gum concentration increases, with corresponding reduction in percentage compressibility. The result shows that 3%w/w Khaya gum compared favourably with 5%w/w acacia mucilage.

DISCUSSION

The increase in the mean granule size observed with increase in the gum concentration shown in Fig 2 may be attributed to the increase in the coating of the lactose particles by the mucilage as the binder concentration increases (Davies and Gloor, 1971). Also an increase in the number of bond formation could have occured as the gum concentration increases. In the formation of individual particles, increasing the concentration of gum produces thicker coatings on the surfaces of the lactose particles as well as thicker liquid bridges between neighbouring particles. These coats and bridges will harden on drying to produce correspondingly thicker (large-sized) granules.

Table 1 showed that the bulk density increased while the tapped density generally decreased as the gum concetration is increased. At lower gum concentrations, the granules are presumably soft with higher percentage of fines. The fines give rise to bridging in the measuring vessel which produces more inter particulate void spaces that subsequently lower the bulk density. Higher gum concentrations produces relatively harder granules with lower percentage of fines which invariably fill the few void spaces that are present. (The reduced percentage of fines produces less bridging of particles and thus reducing the number of interparticulate void spaces). This produces the increase observed in the bulk density at higher gum concentration.

When an external force in the form of vibration or tapping is applied to powders, the particles rearrange and pack more closely (Newmann 1967). This becomes more pronounced if the granules are soft and friable thereby producing higher values of tapped density obtained at lower gum concentrations. However, as the gum concentration increased and the granules become smoother and harder with lower percentage of fines, there seemed to be less attractive force operating between the powder particles leading to more resistance to packing down of the granules. This, presumably, produced the lower vaules of tapped density at higher gum concentrations.

It is seen in Fig. 3 that percentage friability decreases with increase in gum concentration. This indicates that the granules had increased in strength as the gum concentration increases. Granules friability test gives a measure of the relative hardness of the granules. Thus, if a granule is hard, only small surface particles will be lost when one particle rubs against another giving very low values of percentage friability while with soft granules, the entire granule will break into small particles (Davies and Gloor, 1971) giving high prerentage friability values.

Fig. 4 showed a decrease in flow The flowability of granules has been shown to be related to their sizes. (Ahmed and Pipel, 1969). There is a range of size where the flow is at maximum; at very lower size ranges, the flow is retarded due to cohesive forces operating between individual particles until the orifice is finally blocked. At the higher size range, the flow is retarded due to mechanical blockage of the orifice. These effects probably explain the results obtained in this study. At lower binder concentration with average granule size of about 750μm, the flow was maximum. As the gum concentration increased with corresponding increase in average granule size, the flow rate decreased presumably, due to blockage of the orifice. The values of percentage compressibility below 15% indicates good flow characteristics while values above 25% indicate poor flowability (Carr 1965). It may therefore be assumed that with respect to this study, all the batches of granules investigated exhibited good flow, since percentage compressibility values were all below 15%.

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TABLE I
VARIATION OF GRANULE DENSITIES AND COMPRESSIBILITIES WITH GUM CONCENTRATION

Gum Conc %W/W	Bulk Density (g/ml)	Tapped Density (g/ml)	Compressibility (%)
Khaya gum			
1	0.518	0.599	13.59
2	0.520	0.580	10.21
3	0.531	0.575	7.65
4	0.535	0.552	4.94
5	0.541	0.555	6.25
Acacia 5%	0.582	1.202	5.32

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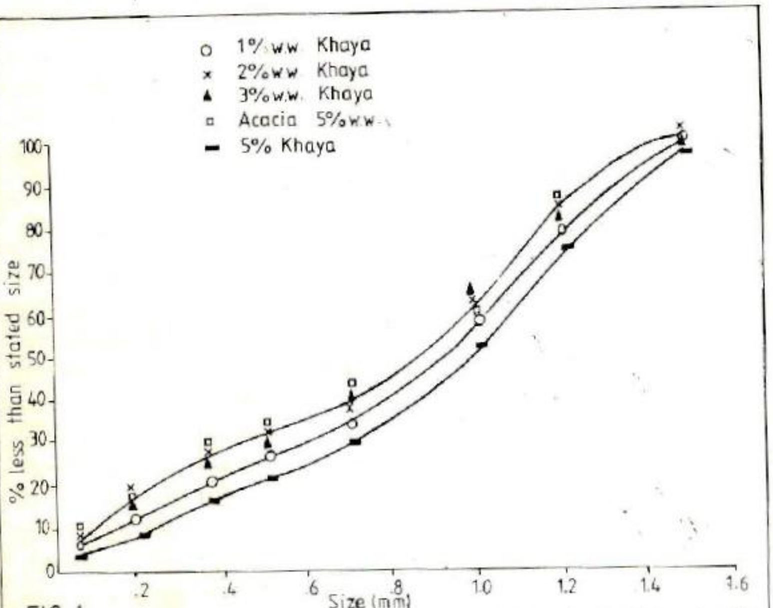

FIG. 1. CUMULATIVE % UNDERSIZE vs PARTICLE SIZE (mm)

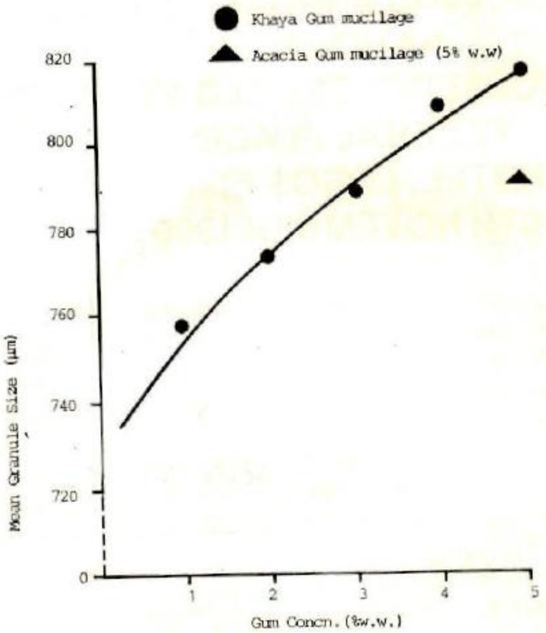

Fig.2: MEAN GRANULE SIZE (μ) VS GUM CONCN. (%w.w)

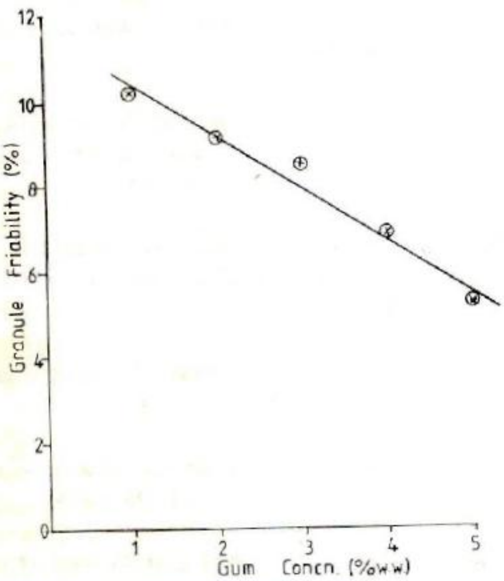

FIG. 3. GRANULE FRIABILITY % vs GUM CONCN. (%w.w)

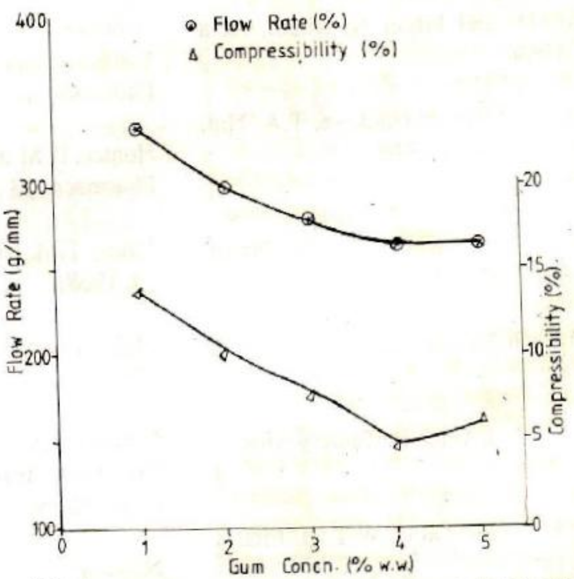

FIG. 4 VARIATION OF FLOW RATE AND COMPRESSIBILITY WITH BINDER CONCENTRATION.