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EMULSIFYING AND SUSPENDING PROPERTIES OF CASHEW GUM

***A. Abdulsamad, P. G. Bhatia and J. E. Ojile**
Department of Pharmaceutics and Pharmaceutical Microbiology, Ahmadu Bello University, Zaria, Nigeria

Abstract
The emulsifying and suspending (thickening) potentials of the gummy exudates derived from cashew (*Anacardium occidentale* L.) tree were investigated and compared (at selected concentrations) with those of standard acacia. Both gums were found to form deflocculated suspensions when used to prepare 10%w/v sulphamethoxazole suspensions. Cashew gum (CG) gave suspensions that appear fluffier and were easier to re-disperse than does acacia gum (AG) at same concentrations. Emulsifying abilities of CG were juxtaposed with those of established AG and both gums were found to produce emulsions of liquid paraffin with varying stabilities. At 10%w/v emulsifier concentration, emulsions made with CG creamed within 24 hours of formulation but at 20%w/v, the emulsion remained stable throughout the 8 weeks period of observation. While none of the emulsion samples cracked over the period of observation a direct correlation was noticed between globule size and emulsion age. Nonetheless 15%w/v CG suffices as appropriate for the stabilization of extemporaneous preparations.

Keywords: *Cashew gum; acacia gum; emulsion; suspension; creaming; sedimentation; globule, stability*

INTRODUCTION

The search for pharmaceutical excipients from new sources has increased markedly in recent years particularly in developing economies where there is abundant potential raw materials lying untapped. Shrubs or tree exudates offer a promising source of commercially useful gums and hydrocolloids that are employed in foods, cosmetics and pharmaceutical preparations. Gums, like acacia, tragacanth, karaya are the commonly used exudate gums of plant origin (Tyler *et al.,* 1981), but these gums are expensive and with a one-track economic worthiness. Cashew (*Anacardium occidentale* L.), a multipurpose tree with great economic importance principally because of its commercially popular nut, a succulent apple, a good soil binding attribute, is often used for landscaping and is known to thrive on soils unfit for other crops. The tree is known to exude a gummy substance that is similar to gum Arabic and which may be used as a substitute in the pharmaceutical, cosmetic and food industries (Lima *et al.,* 2002). Difficulty in swallowing solid dosage forms by some categories of patients require drugs to be dispersed in a liquid (Billany, 1988), and this, coupled with some drugs being oily or poorly water soluble, necessitates their formulation in emulsified or suspended states. To our knowledge the investigation of the potentials of cashew gum (CG) in pharmaceutical formulations is scanty.

This work, therefore, reports the preliminary investigations of the emulsifying

* Corresponding author. E-mail: abdulbnabdul@yahoo.com; Tel: +234-(0)-803-397-4922
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and suspending potentials of CG for possible use as an emulsifying, suspending and thickening agent.

MATERIALS AND METHODS

CG as hardened cakes was obtained from the stems of cashew trees available in the Ahmadu Bello University botanical garden in Zaria, Northern Nigeria. The method of purification of gums and mucilages by Karawya *et al*., (1971), as modified by Abdulsamad *et al*., (2006), was adopted.

One litre (1L) stock of preserved-water containing a duplex of chloroform water with 0.1% Benzoic acid (Oladimeji and Ifudu, 1988) was prepared and used as diluent for the formulations.

Sulphamethoxazole powder BP (May and Baker Nig. PLC) at various concentrations was used to make the suspensions.

Emulsifying property

Batches of liquid paraffin emulsions containing 4:6 oil-water ratios were formulated respectively with CG and AG at selected concentrations of 10%, 12.5%, 15% and 20%w/v.

The weighed amount of gum was sprinkled onto the measured amount of oil and enough preserved water added. The mixture was blended for 10 minutes with a Silverson mixer (Silverson machines Ltd. England). The emulsion obtained was passed through a homogenizer (Ormerod Engineers Ltd. Rochdale England) to promote globule uniformity, made up to 100 ml in plain bottles, tightly sealed and stored at 29°C, on a dark vibration free surface.

Visual observation

The emulsions were visually observed over a period of 8 weeks for possible physical changes such as colour changes, creaming rate and extent.

Microscopical examination and globule count

Globule count using the method of Cockton and Wynn (1952) was performed on each emulsion, 24 hours after preparation and weekly thereafter for 8 weeks.

A 1:400 dilution of the emulsion was carried out using 50% aqueous glycerol, by thoroughly mixing 0.05 ml of the emulsion with 20 ml of 50% aqueous glycerol, followed by two drops of 10% nigrosin dye. The dye was to provide a contrasting blue-black background, which makes the globules appear conspicuously as bright circles.

An improved Neubour counting chamber was used for the counting. A drop of the diluted emulsion was placed on the counting chamber, covered with a cover slip and viewed under the microscope, with an eyepiece for appropriate magnification (x10). Globules contained in 20 small squares selected at random were counted after thoroughly searching the entire depth of each small square for small globules. After each complete count, the chamber and cover slip were thoroughly washed with soap solution, rinsed with distilled water and dried with a clean cloth.

Methods of calculation

The number of globules, N, derived from an mm^3 of oil was calculated using the method of Cockton and Wynn (1952)

$$N \quad \frac{C}{256} \quad f \quad \frac{100}{p} \quad \frac{10^4}{2.5}$$

Where C is total count of globules
F is dilution factor of the emulsion
P is percent of oil in the emulsion

The root mean cube diameter, d, of the globules at 24 hours and after storage was calculated from

$$d \qquad 10^3\sqrt{\frac{6}{N}}$$

The rate of globule coalescence k, was calculated from the expression (Sherman, 1963)

$$N_t = N_o e^{-kt}$$

Where N_o and N_t are the numbers of globules per unit volume at zero time and storage time respectively.

Values obtained were used to plot graphs of globule size against time to see how the globule size varied with time. Graphs of effect of time on rate of coalescence were also plotted, since the rate of coalescence is a measure of the emulsion stability.

Suspending potentials

Mucilages containing 10, 12.5, 15 and 20%w/v concentrations of the CG and AG were respectively made using the preserved water, stirred for 1 h, at room temperature (Mothe and Rao, 1999).

Ten grams (10 g) of Sulphamethoxazole BP powder was used to make the suspensions in each case, where the drug in fine powder and an appropriate volume of the mucilage were thoroughly blended using Silverson mixer. The resultant slurry was then transferred into a 100 ml glass cylinder. Enough preserved water to make up the volume of the suspension to 100 ml was used to rinse the beaker and the mixer head and then added to the suspension in the cylinder. The cylinders were stoppered and stored at a room temperature of about 29°C, on a dark vibration free surface.

Physical examination

The suspensions were observed over a period of 8 weeks for any physical changes.

Sedimentation volume

The sediment volume was recorded daily for the first 7days and thereafter weekly for 8 weeks. The following relationship was used to calculate the sedimentation volume, F.

$$F = \frac{V_s}{V_t}$$

Where V_s and V_t expressed in cm stand for sediment volume and total volume of suspension respectively.

Graphs of sedimentation volume (F) against time were plotted.

Re-dispersibility test

Two 50 ml suspensions containing respectively 12.5%w/v and 15% w/v CG and AG powders and 10% w/v drug powder were prepared, packed in a narrow mouthed container and stored on a vibration free surface. The suspensions were shaken manually after 7 days to see and compare the extent to which the suspensions from the two gums got re-dispersed.

RESULTS AND DISCUSSIONS

Test on emulsions

Macroscopic Examinations

Many emulsions cream on standing (Kayes, 1988) and creaming, though not desirable in emulsion formulation, is not a criterion of physical stability in the colloidal sense (Rowe, 1965). At 10% emulsifier concentration, emulsions prepared with CG creamed within 24 hours of preparation, while at 15% emulsifier concentration, the emulsion lasted two weeks after which it creamed. Samples containing 20% CG, 12.5%, 15% and 20% AG as emulsifier were found to remain stable throughout the 8weeks period of observation.

The creamed emulsions easily re-disperse after being gently agitated and remain so for a reasonably long time, long enough to permit the appropriate withdrawal of uniform doses. Nonetheless, creaming in emulsions renders the product inelegant and is thus not desirable from the pharmaceutical point of view.

Higher emulsifier concentration, in both the test gum and the standard was found to be associated with the slowing down of the creaming process.

Microscopic Examination

Globule count conducted on the liquid paraffin emulsions using the method of Cockton and Wynn (1952), showed a trend of decreasing number of globules in all the samples observed, as the emulsions aged as shown in Table 1.

Emulsions prepared with AG showed greater number of globules compared to those made using CG at similar concentrations and subjected to similar shearing process. Shearing

of oil in liquid medium leads to the subdivision of the former into small droplets. Maintenance of these droplets in their subdivided state is a function of the emulsifier capability and concentration as well as the shearing process the mixture is subjected to. As concentration and shearing process are similar for both the CG and AG stabilized emulsions, the greater number of globules in AG containing samples is likely to be associated with the superior emulsifying capability of AG over CG.

Globule size, taken as the root mean diameter was determined using the relationship (Cockton and Wynn, 1952) $d \quad 10\sqrt[3]{\frac{6}{N}}$

For both CG and AG stabilised emulsions, the samples observed, showed a progressive increase in globule size (d) with a corresponding decrease in population of globules (c) with time; consequence of coalescence of the globules as shown in Table 1. Ageing in emulsions, owing to their thermodynamic instability, usually results in substantial changes in the degree of dispersion of the discontinuous phase (Sherman, 1963). There is usually a progressive increase in globule size, before it separates out in the bulk (Sherman, 1963). Emulsions prepared with AG were found to have smaller globule sizes compared to those made using CG as emulsifying agent. Decrease in globule size should enhance emulsion stability and this may explain why AG produces more stable emulsions than does CG, as shown in Fig. 1. Similar relationship was observed by Udeala and Uwaga, (1981), when mucuna gum was compared with acacia.

Rowe, (1965) reported that increase in percentage of acacia was accompanied by a decrease in the size of the oil globules. Fig. 1, however, was not found to go with this observation. The figure shows an increase in globule size with increase in emulsifier concentration in both the test sample and the standard AG emulsified emulsions. As a tradition in any comparative experimental procedures, attempts are always made at uniformity in sample treatments. Thus, all samples were subjected to the same shearing rate and duration and the oil globules were viewed using the same microscopic lens, irrespective of the emulsifier type or concentration. Hence, though unexpected, this behaviour may be explained by any of the following possibilities: Increase in the concentration of emulsifier in an emulsion results in an increase in the turbidity of the system, which in turn may retard the extent of breakdown of the oil globules at the adopted mixer speed. It is also possible that, the oil globules may be so sub-divided and effectively coated, that any increase in emulsifier concentration may sort of coat a cluster of these fine globules making them appear as single larger globules.

In either case, an increase in concentration of emulsifier may result in increase in diameter of the globules and a reduction in globule count.

Rate of Coalescence

The thermodynamic instability in emulsions, as disperse systems, tends to favour the coalescence of the oil globules in an attempt to reduce the excess free energy resulting from the increased globule surface area, a consequence of globule size reduction during manufacturing shearing stresses. Globule sizes in all the samples observed as shown in Fig. 2 were found to initially increase at a considerably higher rate compared to the slower rate as the emulsions aged. Thermodynamic instability following globule size reduction is more pronounced immediately after the shearing process, but gets reduced with time as the globules spontaneously coalesce to counter the instability. This may be a function of the emulsifier concentration available for adsorption at the interface. Rowe, (1965) suggested that, the initial coalescence rate could be attributed to the instability caused by incomplete oil surface coverage, while in some instances the initial fast increase in the globule sizes may be ascribed to lack of complete

hydration of the emulsifying agent.

This assertion can be seen to explain the slowness of the rate of increase of (d) as the emulsifier concentration increased for both samples as represented in Table 1.

Tests on suspensions

Physical Examination

Both gums were observed to produce suspensions that darken on storage, with those made with cashew gum appearing darker possibly be due to microbial or enzymic action.

Sedimentation Volume

Sedimentation volume, a ratio of the equilibrium volume of the sediment to the total volume of suspension, was used to assess the suspensions prepared by using varying concentrations of CG and the standard AG over a period of storage.

It is seen from Fig. 3 that the sedimentation ratio tends to be smaller, the smaller the ratio, the higher the concentration of the suspending agent in both the test and standard gums. This is as a result of increase in suspending power associated with the higher viscosity of the suspending medium, which in turn is a consequence of increase in concentration of suspending agent. The net effect being, the maintenance of the particles in suspended state for relatively longer periods of time. Maintenance of the particles in suspended state is a function of the suspending power and concentration of the suspending agent in use.

Suspensions formulated using AG were found to have smaller sediment volumes than those formulated with CG, possibly, suggesting a superior suspending power of the former.

The obvious appearance of small sediment within 24 hours of the formulation of the suspensions and the cloudiness of the supernatant were suggestive of the type of suspension formed, that is, deflocculated suspension in structured vehicle. Martin, *et al.,* (1983) proposed that a completely deflocculated suspension would have ultimately small volume of sediment.

Fig. 3 shows a rapid fall of sediment ratio value from 1 to values smaller than 0.2 for all the suspensions monitored, followed almost immediately with a slight rise in the sediment volume. The suspended particle settlement is a function of the particles' weight and as the settlement is influenced by gravity, the bigger/heavier particles will sediment faster leaving the finer ones in suspended state for a relatively longer time. Eventual settlement of these finer particles will cause a rise in the sediment volume, though, possibly slightly. This is a feature that is generally associated with hydrophillic colloids.

Sulphamethoxazole powder is practically insoluble in water and owing to its indiffusibility profile when sheared in water; it forms large porous clumps on the surface and becomes attached to the upper part of the container. CG and AG being hydrophillic colloids basically act by imparting hydrophilic character on the particles via the formation of a multi-molecular layer around the individual hydrophobic solid particles. This action produces dual effect of wetting and suspending of the particles, leading to the deflocculating of the system with its attendant formation of hard and not easily dispersible cake after the particles have eventually settled.

A disadvantage of deflocculated system is the formation of a compact cake when the particles eventually settle. This can be avoided when the system is flocculated. Flocculation in a system is imparted by the controlled addition of electrolytes, polymers, or surfactants (Billany, 1988).

The ability of CG to suspend sulphamethoxazole powder, composed of deflocculated particles, makes it a good candidate for use in flocculated systems.

Optimum physical stability and appearance will be obtained when the suspension is formulated with flocculated particles in structured vehicle of the hydrophilic colloid type (Martin *et al.*, 1983). No attempt,

however, was made at flocculating the system in this study.

Re-dispersibility tests

Re-dispersibility tests carried out have shown that particles suspended using CG as suspending agent, got re-dispersed faster and with relatively greater ease than those formulated with the standard AG as suspending agent, at similar concentrations.

Table 1: Effect of Ageing on the Globule Count Data of Emulsions Prepared with Selected Concentrations of Cashew and Acacia Gum Mucilages

Emulsion Dilution factor	Conc. of Gum (%w/v)	Total globule count		No. of globules/ mm^3		Mean diameter (μm)		Rate of coalescence (k day^{-1})
		C_0	C_t	N_0	N_t	d_o	d_t	
				DAY 7				
Cashew gum 1:400	10	579	398	56.54	38.88	3.23	3.66	0.054
	12.5	462	371	45.12	36.23	3.48	3.75	0.031
	15	380	343	37.11	33.50	3.72	3.84	0.015
	20	291	266	28.42	25.98	4.07	4.19	0.013
Acacia gum 1:400	10	720	511	70.31	49.90	3.01	3.37	0.049
	12.5	534	445	52.15	43.46	3.32	3.53	0.026
	15	402	392	41.26	38.28	3.65	3.68	0.011
	20	332	303	32.42	29.59	3.90	4.01	0.013
				Day 14				
Cashew gum 1:400	10	579	324	56.54	31.64	3.23	3.92	0.041
	12.5	462	305	45.12	29.79	3.48	4.00	0.030
	15	380	299	37.11	29.20	3.72	4.03	0.017
	20	291	231	28.42	22.56	4.07	4.40	0.017
Acacia gum 1:400	10	720	477	70.31	46.58	3.01	3.45	0.029
	12.5	534	416	52.15	40.63	3.32	3.61	0.018
	15	402	354	39.26	34.57	3.65	3.81	0.009
	20	332	290	32.42	28.37	3.90	4.06	0.010
				DAY 21				
Cashew gum 1:400	10	579	304	56.54	29.69	3.23	4.01	0.031
	12.5	462	278	45.12	27.15	3.48	4.13	0.024
	15	380	276	37.11	26.95	3.72	4.14	0.015
	20	291	212	28.42	20.70	4.07	4.52	0.015
Acacia gum 1:400	10	720	434	70.31	42.38	3.01	3.56	0.022
	12.5	534	402	52.15	39.26	3.32	3.65	0.014
	15	402	360	39.26	35.16	3.65	3.79	0.005
	20	332	272	32.42	26.56	3.90	4.16	0.009
				DAY 28				
Cashew gum 1:400	10	579	298	56.54	29.10	3.23	4.03	0.024
	12.5	462	250	45.12	24.41	3.48	4.28	0.022
	15	380	222	37.11	21.68	3.72	4.45	0.019
	20	291	204	28.42	19.92	4.07	4.57	0.013
Acacia gum 1:400	10	720	404	70.31	39.45	3.01	3.64	0.021
	12.5	534	366	52.15	35.74	3.32	3.77	0.014
	15	402	314	39.26	30.66	3.65	3.96	0.009
	20	332	262	32.42	25.59	3.90	4.21	0.008

Where: C_0 is total globule count at zero time
C_t is total globule count at time of storage
N_o is number of globules/mm^3 at zero time
N_t is number of globules/mm^3 at time of storage
d_o is mean diameter (μm) at zero time
d_t is mean diameter (μm) at time of storage

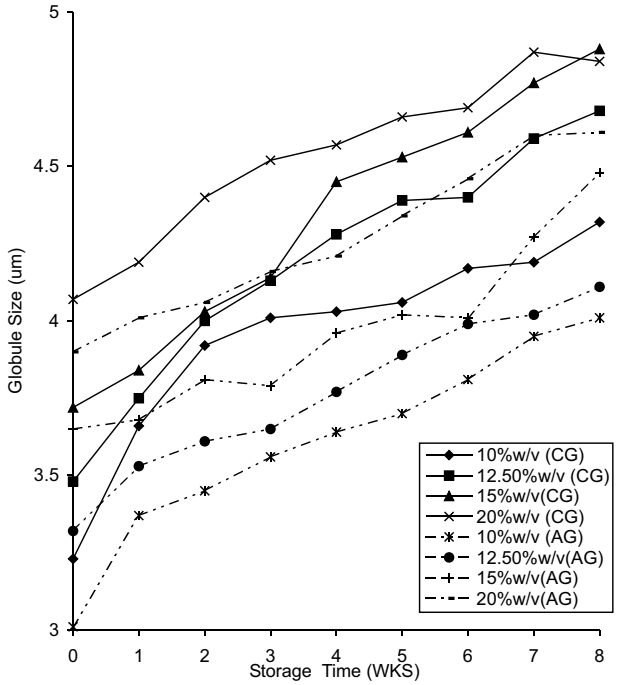

Fig. 1: Globule Size (mcm) Vs Storage Time (wks) for Liquid Paraffin in Water Emulsions Stabilised with Different Concentrations of Cashew and Acacia Gums

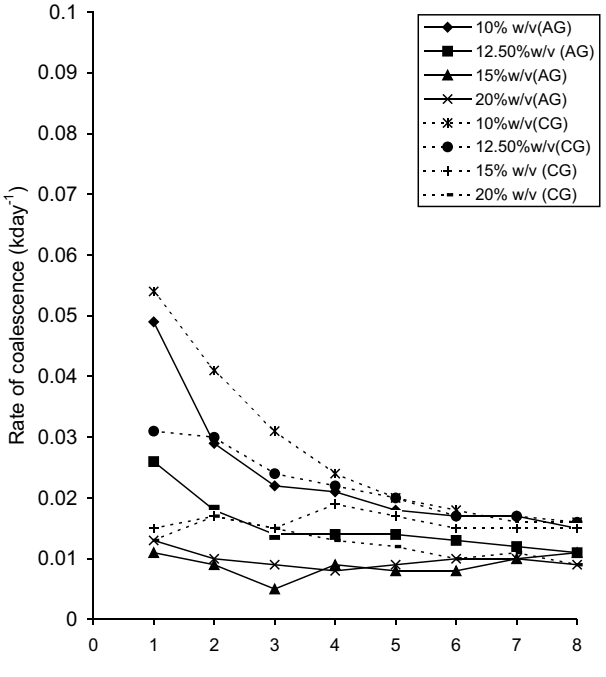

Fig. 2: Rate of Coalescence (K day1) Vs Storage Time (wks) for Liquid Paraffin Emulsions Formulated with Different Concentrations of Cashew and Acacia Gums

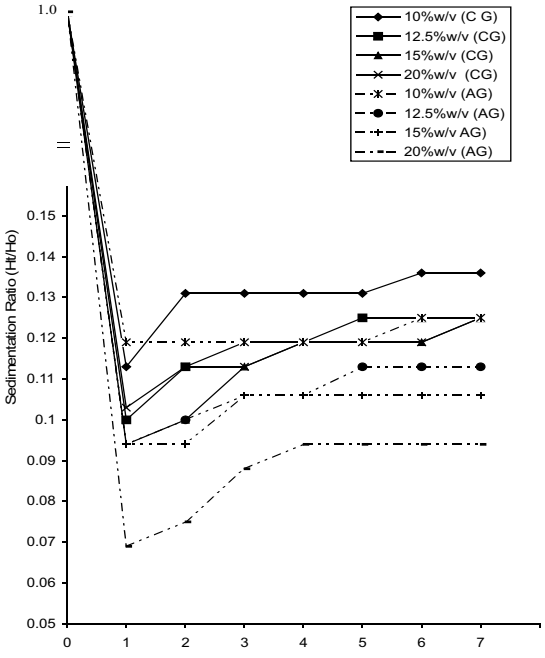

Fig. 3: Sedimentation Ratio Vs Storage Time (days) for sulphamethoxazole Suspensions Formulated with Cashew and Acacia Gums as suspending Agents

Conclusion

CG has been found compare to a certain extent with a standard AG as suspending and emulsifying agent. 15% CG concentration has been found to suffice for use in extemporaneous pharmaceutical preparations; even though, owing to the low viscosity of the mucilages and also its safety (Abdulsamad *et al.*, 2006), use of higher quantities may not be impracticable for better performance. Identifying, selecting, and growing cashew trees that would produce a high grade CG, would definitely present an economic supplement if not a substitute emulsifying, suspending and thickening agent.

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