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EVALUATION OF SUSPENDING PROPERTIES OF A NATURAL HYDROCOLLOID GUM FROM *AFZELIA AFRICANA*

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ABSTRACT

The suspending property of a new polysaccharide gum derived from *Afzelia Africana* (family Fabaceae) seed have been investigated using Sodium carboxymethylcellulose as reference standard. Deflocculated and flocculated(using 1% solution of Aluminium Chloride) Zinc oxide suspensions were prepared using 0.5%w/v,1.0%w/v,2%w/v and 4%w/v of A*fzelia africana* gum, sodium carboxymethylcellulose and binary(1:1) combinations of the polymers. Suspension stability was evaluated by comparing the rheological behavior, sedimentation volume and degree of flocculation. The study revealed that a 2% w/v binary combination system exhibited better rheological properties, highest degree of flocculation, increased sedimentation volume and reduced settling in comparison with other concentration of the same system as well as other suspending agents alone.

Keywords: *Afzelia africana Gum (AAG); Zinc oxide suspension; flocculation; Deflocculation; Sedimentation volume;Sodium carboxymethylcellulose (SCMC).*

INTRODUCTION

Pharmaceutical suspensions (flocculated and deflocculated), biphasic and thermodynamically unstable; consist of dispersion containing finely divided insoluble material suspended in a liquid medium[1, 2]. Flocculated systems achieved by addition of electrolytes has phase separation where materials readily resuspend with simple shaking whereas in deflocculated system, there is little or no phase separation with insoluble particles settling slowly over a long time.

To obtain a pharmaceutically acceptable, thermodynamically stable suspension, there is need to include in the dosage form, a stabilizer or suspending agent which maintains a uniform dispersion of particles that would otherwise settle rapidly to form a closely packed sediment and prevent the removal of an accurate dose both by forming physical barrier to aggregation and increasing the consistency of the suspending medium[2-4]. Among the commonly used suspending agents are natural polysaccharides (Acacia, Guar gum, Agar, Xanthan gum, Tragacanth); semi synthetic polysaccharides (Carmellose sodium, Sodium carboxymethylcellulose); clays and synthetic agents[5,6]. Gums (plant hydrocolloids) are widely employed in pharmacy as thickeners, suspending agents, emulsifying agents, binders and film formers[6-10].

Afzelia Africana gum derived from the seeds of Afzelia africana belongs to the family Fabaceae. It is one of the most widely distributed species in Africa, abundant in Senegal, Sudan, Nigeria, Uganda, Tanzania and South Asia[9]. Physicochemical characterization of *Afzelia Africana* seed gum showed that it is soluble in water, practically insoluble in ethanol, acetone, chloroform with swelling capacity (%) in water of 660.0 and pH of 4.3 and true density of 1.7g/cc. It is used in local medicine for general pain relief, digestive problems (constipation and vomiting) and for internal bleedings (haemorrhage) and pharmaceutically as tablet binder [9].

In view of the local availability, eco-friendly nature of the plant and increase in demand for the natural gums as pharmaceutical excipients, this study was undertaken to evaluate AAG use as a suspending agent in Zinc oxide suspension.

MATERIALS

Zinc oxide powder and Sodium carboxymethylcellulose (SCMC) (Sigma, U.S.A), Ethanol (Fisher Scientific Company U.S.A), Sodium laurylsulphate (BDH England), Benzoic acid solution, Aluminium chloride BP, *Afzelia africana* seed (sourced locally).

METHOD

Isolation of Afzelia africana gum

The extraction method of Emeje et al (2009) was adopted with modification to prepare the Afzelia Africana gum. Endogenous enzymes were inactivated by boiling 100g of the plant material with 80% ethanol for 1hr. The plant material was heated in water bath at 90^0C for 2hrs to extract the water soluble gum fraction.

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The insoluble solids were separated by filtration through a muslin cloth, while the extract was centrifuged at 2000rpm for 10mins to collect the supernatant. The extract was again precipitated by adding 3 volumes of 95% ethanol, washed 3 times with absolute ethanol, air dried and stored in appropriate container.

Preparation of Zinc Oxide Suspension

Twelve batches of the Zinc Oxide Suspensions were formulated using dispersions of 0.5%, 1%, 2% and 4%w/v concentrations of AAG, SCMC and 1:1 binary combinations of both agents. A 10.0g quantity of Zinc Oxide was weighed and triturated with 0.5g sodium laurylsulphate, wetted with distilled water and thoroughly mixed. A 0.5%w/v dispersion of the suspending agent was introduced and the suspension was mixed to form a pourable paste, transferred to a 50ml measuring cylinder and made up to 50ml volume with several rinsings from mortar and shaken vigorously for 3 mins making 0.5%w/v of AAG in the preparation. The procedure was repeated using 1%, 2% and 4%w/v of AAG, SCMC and their 1:1 binary combination. All suspensions were deflocculated and contained 0.1%w/v benzoic acid as preservative. To determine the degree of flocculation, flocculated suspensions were made using 0.1%w/v Aluminium chloride as flocculating agent. Batches of suspensions were stored at room temperature (27^{0}c).

EVALUATION OF SUSPENSION

Sedimentation Volume

Sedimentation volumes were determined by keeping 50ml of each suspension in stoppered measuring cylinder and stored undisturbed at room temperature. Separation of clear liquid was observed and recorded at intervals of 24hrs for 7days and then 7days (1week) for 4 weeks. The sedimentation volume F(%) was calculated using equation[4]

$F = V_u / V_o$…………………..(1)

Where V_u = Volume of sediment

V_o = Original height of sample.

The ratio V_u/V_o is plotted against time and the slope used to assess suspension stability.

Degree of flocculation

Degree of flocculation (β) was determined as the ratio of the sedimentation volume of the flocculated suspension to that of deflocculated control after complete sedimentation[1], calculated as:

$\beta = F/F\alpha$

Where F = Sedimentation volume of flocculated suspension,

Fα = sedimentation volume of deflocculated suspension.

Viscosity of suspension

The viscosity (in centipoises) of the sample was determined at 25^{0}c using the Brookfield synchroelectric viscometer, (model LVF Brookfield Laboratories, Massachusetts) at 30 revolutions per min (spindle # 4). Triplicate determinations were made and results obtained expressed as the mean values.

Redispersibility of Suspension

A 50ml volume of each suspension kept in calibrated tubes were stored at room temperature (27^{o}C) for intervals of 1week to 4 weeks during which a tube was removed and shaken vigorously to redistribute the sediment and the presence of deposit (if any) was recorded.

RESULTS AND DISCUSSION

The sedimentation volume profile of suspension prototypes prepared with different concentrations of AAG, SCMC and their 1:1 binary combination are shown in Figures 1 – 3. The sedimentation volumes of the suspensions prepared with AAG are comparable with those of the standard. It was evident that AAG produced partially flocculated suspensions which settled rapidly with the formation of a distinct boundary (Fig. 1a).The volume of sediment was found to be dependent on polymer concentration used. However as the concentration of the test polymer increased from 0.5 – 2% after flocculation (Fig.1b) by addition of electrolyte, there was increased sedimentation volume. At 4%w/v concentration, increased rate of change of F with time was observed in comparison to systems without electrolyte, an implication that this concentration is above its optimal use in making Zinc oxide suspension with Aluminium Chloride as flocculant, hence there could be sensitivity of steric stabilization induced by the polymer in the presence of electrolyte in aqueous vehicle [11].

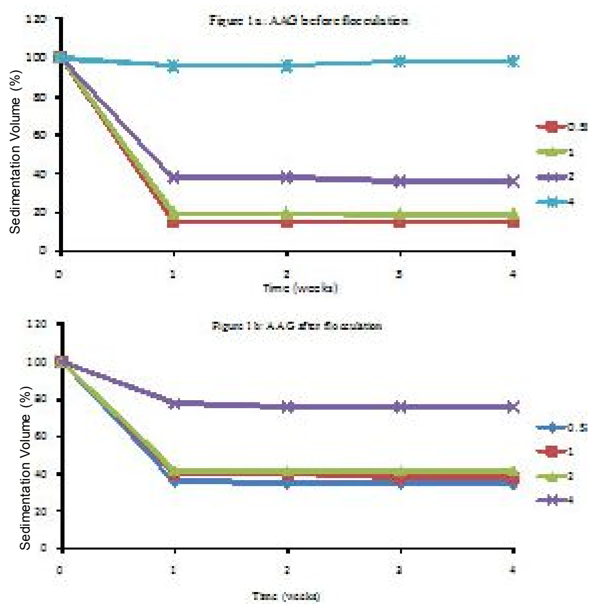

Fig. 1*: Effect of Concentrations of AAG on Sedimentation volumes.*

SCMC made suspensions were well dispersed except 4% w/v concentration that yielded a jelly-like system[12] with increased viscosity and difficulty in redispersion. SCMC and other cellulose-derivative-polymers (branched) enhance physical stability and modify rheological properties of oral suspensions at <3%w/v concentration[11]. After flocculation (Fig2b), there was a change from the sigmoid sedimentation curve pattern to biphasic, L-shaped curve. This may be attributed to presence of ionic polymers which may act as a bridge by interacting both with particle surface and charged moieties on the polymer [11], thus preventing particle interaction at the primary minimum.

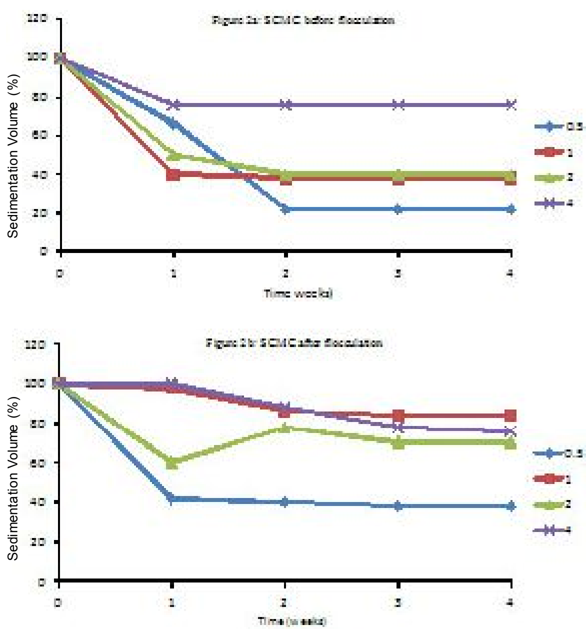

***Fig. 2**: Effect of Concentrations of SCMC on Sedimentation volumes.*

Interestingly, this incompatibility was not observed in binary (1:1) combinations of the gums. The addition of the test gum (AAG) may probably be responsible for the abolition of this interaction. The combination enhanced stability, resulting in higher sedimentation volume over the storage period before and after flocculation.

According to James et al[13], a better parameter for comparing flocculated systems is the degree of flocculation β which is the ratio of ultimate sedimentation volume in the flocculated and deflocculated systems. A comparison of β values (Table 1) of suspensions prepared with AAG,SCMC and binary combinations of the polymers showed that all suspensions were flocculated with the degree of sustained flocculation reducing with increased concentration of polymer during storage. However, binary combination systems showed the highest degree of flocculation with storage.

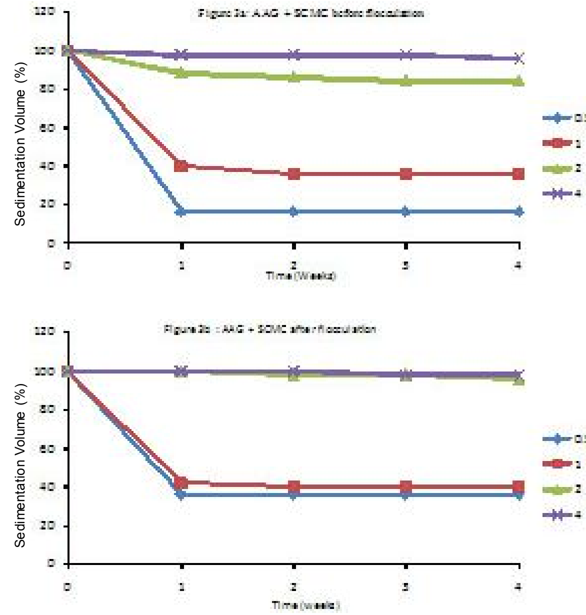

***Fig. 3**: Effect of Concentrations of Polymer binary combinations on Sedimentation volumes.*

In deflocculated systems, increased concentration of polymer resulted in slight increase in viscosity but in the presence of flocculant, reverse was the case (Table 1). Significantly, suspensions prepared with >2%w/v concentration of polymer and/or their combination yielded reduced viscosity in the presence of 0.1%w/v Aluminium chloride suggestive of possible polymer-electrolyte interactions.

***Table 1:** Effects of the type and concentration of suspending agents on viscosity, redispersibility and degree of flocculation of Zinc oxide suspensions.*

Suspending agent	Conc. (%w/v)	Redispersibility	Viscosity (centipoise)		Degree of Flocculation (β)
			Flocculated	Deflocculated	
AAG	0.5	RR	285	285	7.63
	1.0	RR	290	285	5.00
	2.0	RR	280	290	4.63
	4.0	NRR	270	295	4.38
SCMC	0.5	RR	290	285	3.80
	1.0	RR	285	295	4.23
	2.0	RR	285	295	4.00
	4.0	NR	286	294	3.00
AAG + SCMC	0.5	RR	290	280	3.75
	1.0	RR	285	280	4.25
	2.0	RR	313	330	10.75
	4.0	NRR	270	350	11.00

Keys : RR= Readily redispersible, NRR= Not readily redispersible, NR= Not redispersible.

CONCLUSION

In view of these results, AAG can be employed as both a flocculant probably by an adsorption dependent flocculation mechanism; and a viscosity enhancer to support the floc once formed.

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