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Original Article

EMULSIFYING PROPERTIES OF AFZELIA GUM IN LIQUID PARAFFIN EMULSION

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ABSTRACT

Objective: *Afzelia africana* gum has been shown to possess surface activity. It is a good alternative to sodium carboxy methylcellulose in terms of suspending properties. This work was aimed at evaluating the emulsifying properties of the gum in liquid paraffin emulsion.

Methods: Liquid paraffin emulsions (200 ml each) were prepared with different concentrations (1, 2, 3, 5 and 10 % w/v) of afzelia gum as an emulsifying agent. Similar preparations containing standard acacia gum at corresponding concentrations were also made. Liquid paraffin emulsions (200 ml each) were equally prepared using 60 ml liquid paraffin as the oily phase and 6 g of various combinations of afzelia gum and tween 80 as emulsifier blends. The emulsifier blends were of ratio 1:5, 1:2, 1:1, 2:1 and 5:1. The preparations were assessed for density and viscosity; and then for stability after 5 d of storage.

Results: The viscosity of emulsion containing 10 % w/v afzelia gum was 668.90 mPa.s while that of an emulsion containing the same concentration of acacia gum was 23.56 mPa. s. Emulsion containing 3 % w/v afzelia gum (having a creaming index of 16 %) was found to be more stable compared to the emulsion containing 10 % w/v acacia gum (having creaming index of 28 %). The viscosity and stability of emulsions containing emulsifier blends of afzelia gum and tween 80 increased with increase in the proportion of afzelia gum.

Conclusion: The gum is suitable for use at a concentration of 3 % w/v as an emulsifier in 30 % v/v liquid paraffin emulsion, and it is about three times better than acacia gum as an emulsifier. It is a good alternative to standard acacia gum for emulsification.

Keywords: Afzelia gum, Liquid paraffin, Emulsifying properties, Density, Viscosity, Creaming

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INTRODUCTION

Liquid preparations, apart from being the only means by which certain medicinal agents can be delivered, are very useful means of administration of drugs to children under the age of 5 y and for patients who have difficulty in swallowing [1]. These delivery systems include solutions, suspensions, and emulsions. They all have the advantage of fast delivery of medicaments, masking of disagreeable tastes and ease of dose adjustment. Therefore, they are important delivery systems. Suspensions and emulsions have the added advantage of the possibility of modifying drug release and duration of action [2].

A pharmaceutical emulsion is usually made up of the aqueous phase, the oily phase and an emulsifying system [3]. An emulsion could be oil-in-water or water-in-oil depending on which phase is the dispersed and which one is continuous. It is also possible to have a multiple emulsion as oil-in-water-in-oil or water-in-oil-in-water. Emulsions of high viscosity for topical application are called creams and are of semi-solid consistency. Hence, the choice of an emulsifying agent depends largely on its emulsifying properties, the type of emulsion to be formulated and the use of the final product [2].

Afzelia africana (family: *Fabaceae*) is widely distributed in Africa, and its gum is hemicellulose [4]. Physico-surface characterization of the gum showed that it has a critical micelle concentration of 0.25% w/v, HLB value of 9.74 and capable of reducing the surface tension of water from 72.00 to 69.00 N/m at its critical micelle concentration [5]. The gum has been evaluated for its suspending properties by Okorie *et al.* [6]. It was found that binary combination of afzelia gum and sodium carboxymethyl cellulose in equal proportions brought forth better-suspending properties (rheological property and degree of flocculation) compared to the same concentration of the individual agent. Natural gums are generally useful as suspending and emulsifying agents [7].

Liquid paraffin is a mineral oil that is normally formulated as oil-in-water emulsion [8]. Natural gums stabilize this type of emulsion by forming a strong multi-molecular film round each oil globule so that coalescence is retarded by the presence of the hydrophilic barrier between the oily phase and the aqueous phase. Oil-in-water emulsion type has a lot of applications in drug delivery. For examples, fats and oils for oral administration either as a medicament or as a vehicle for oil-soluble drugs are formulated as oil-in-water emulsions. Emulsions for intravenous administration must be the oil-in-water type. Also, water-soluble drugs for topical application are formulated as oil-in-water emulsions [2].

Afzelia gum has been shown to be surface active [5] and to be useful as a suspending agent [6]. However, its use as an emulsifying agent was not obtainable from available literature. This study was aimed at evaluating the emulsifying properties of the gum in liquid paraffin emulsion.

MATERIALS AND METHODS

Materials

Materials used include: liquid paraffin, tween 80 and acacia gum (BDH Chemicals, England), purified water prepared at processing laboratory of Department of Pharmaceutics and Pharmaceutical Technology of University of Uyo, Uyo–Nigeria; and afzelia gum extracted from *Afzelia africana* seeds [5].

Preparation of liquid paraffin emulsions with different concentrations of gum

Liquid paraffin emulsions (200 ml) were prepared with different concentrations of afzelia gum and acacia gum based on the formula in table1. The appropriate amount of the gum was weighed and transferred into a stainless steel container. Liquid paraffin (60 ml) was measured and added to the gum inside the container. This was triturated together. A 40 ml portion of purified water was measured and added to the oil/gum mixture. Emulsification was achieved by mixing the system for 5 min using a homogenizer (Silversons Machine Ltd., England) to obtain the primary emulsion [9]. The preparation was made to 200 ml and homogenized for further 5 min.

Table 1: Formula for emulsions containing different gum concentrations

S. No.	Ingredients	Batches				
		I	II	III	IV	V
1	Liquid paraffin (% v/v)	30	30	30	30	30
2	Gum (% w/v)	1	2	3	5	10
3	Water to (%)	100	100	100	100	100

Preparation of liquid paraffin emulsions with emulsifier blends

Oil-in-water emulsions (200 ml) were prepared using 60 ml liquid paraffin as the oily phase and 6 g of various combinations of *Afzelia africana* gum and tween 80 as emulsifier blends based on table 2. The emulsifier blends were of ratio 1:5, 1:2, 1:1, 2:1 and 5:1.

The appropriate quantity of the gum was weighed and distributed in the oily phase contained in a stainless steel cup. The calculated quantity of tween 80 was measured, diluted with 60 ml of purified water and then triturated with the oily phase. The volume was made up to 200 ml with purified water. Emulsification was effected by mixing each preparation for 5 min using a homogenizer (Silversons Machine Ltd., England).

Table 2: Formula for emulsions containing emulsifier blends

S. No.	Ingredients	Batches				
		I	II	III	IV	V
1	Liquid paraffin (ml)	60	60	60	60	60
2	Gum (g)	1	2	3	4	5
3	Tween 80 (g)	5	4	3	2	1
4	Water to (ml)	200	200	200	200	200

Evaluation of emulsions

Determination of density

The densities of the different emulsions were determined by weighing a specific volume of the emulsions (20 ml). The mass (g) obtained was divided by the volume of the emulsion.

Determination of viscosity

The viscosities of the different emulsions were determined at 27.4 °C using a viscometer (Brookfield NDJ-5S Digital viscometer), model LVF (with spindle #2) at 30 rpm.

Assessment of stability

The emulsions were examined for both cracking and creaming. A 50 ml volume of each preparation was transferred into 50 ml capacity cylinder and left for 5 d. The stability of each preparation was determined on the basis of coalescence or creaming. For creaming, the volume of the separated layer was determined and the percentage creaming was calculated as:

$$\% \, creaming = \frac{Amount\ creamed\ (ml)}{Total\ volume\ (ml)} X \ 100\ \%$$

Data analysis

Data analysis was done using one-way analysis of variance followed by Turkey-Kramer multiple comparison tests using Graph Pad Instat-3 software. Differences were taken as significant at *p-values* less than 0.05.

RESULTS

The densities of liquid paraffin emulsions containing different concentrations of acacia and afzelia gums are shown in table 3. There was no significant difference in the density of emulsions containing different concentrations of acacia gum neither was there any significant difference in the density of emulsions containing different concentrations of afzelia gum. Also, there was no significant difference in the density of emulsions containing similar concentrations of acacia gum and afzelia gum.

Table 3: Densities of liquid paraffin emulsions containing different gum concentrations

Gum conc. (% w/v)	Density of emulsion (g/cm³)	
	Acacia gum	Afzelia gum
1	1.06±0.02[a]	1.00±0.02[a]
2	1.07±0.03[a]	1.04±0.01[a]
3	1.07±0.02[a]	1.04±0.02[a]
5	1.08±0.01[a]	1.04±0.04[a]
10	1.10±0.02[a]	1.05±0.02[a]

N = 3, Results are expressed as mean±SEM, For each column, same letter code means no significant difference at $p<0.05$.

The viscosities of liquid paraffin emulsions containing different concentrations of acacia and afzelia gums are shown in table 4. There was no significant difference in the viscosity of emulsions containing 1–5 % w/v of acacia gum and their values were significantly lower than the viscosity of emulsion containing 10 % w/v of the gum**.** There was a significant difference in the viscosity of emulsions containing different concentrations of afzelia gum and the viscosity increased with increase in the concentration of the gum. The viscosity of emulsion containing afzelia gum was significantly higher than that containing acacia gum at all the concentrations used.

Table 4: Viscosities of liquid paraffin emulsions containing different gum concentrations

Gum conc. (% w/v)	Viscosity of emulsion (mPa. s)	
	Acacia gum	Afzelia gum
1	14.64±0.23[a]	47.49±2.09[a]
2	14.94±0.35[a]	89.87±5.33[b]
3	15.84±0.41[a]	141.90±6.43[c]
5	16.08±0.95[a]	226.30±6.53[d]
10	23.56±1.63[b]	668.90±11.65[e]

N = 3, Results are expressed as mean±SEM, For each column, same letter code means no significant difference at $p<0.05$.

The conditions of liquid paraffin emulsions containing different concentrations of acacia and afzelia gums after 5 d of storage are shown in table 5. Coalescence of the oil globules (cracking) was observed with emulsions containing 5 % w/v acacia gum and below. It was also observed with emulsions containing 1 % w/v afzelia gum while different levels of creaming were observed with emulsions containing 2 % w/v afzelia gum and above.

Table 5: Conditions of liquid paraffin emulsions containing different gum concentrations after 5 d of storage

Gum conc. (% w/v)	Condition of emulsion	
	Acacia gum	Afzelia gum
1	Cracked	Cracked
2	Cracked	36% creamed
3	Cracked	16% creamed
5	Cracked	4 % creamed
10	28% creamed	No creaming

The properties of emulsions containing different emulsifier blends are shown in table 6. There was no significant difference in the density of emulsions formulated with the different blends of tween 80 and afzelia gum. The viscosity increased and the creaming index decreased with increase in the proportion of afzelia gum.

Table 6: Properties of emulsions containing different emulsifier blends

S. No.	Emulsifier blend Tween 80: Afz gum	Density (g/cm^3)	Viscosity (mPa. s)	Condition of emulsion after 5 d of storage
1	5: 1	1.08±0.02[a]	10.62±0.45[a]	48.00% creamed
2	2: 1	1.08±0.03[a]	20.78±0.37[b]	46.33% creamed
3	1: 1	1.07±0.02[a]	60.48±1.43[c]	43.67% creamed
4	1: 2	1.06±0.03[a]	98.20±2.33[d]	32.67% creamed
5	1: 5	1.06±0.03[a]	124.80±3.03[e]	25.33% creamed

N = 3, Results are expressed as mean±SEM, For each column, same letter code means no significant difference at $p<0.05$.

DISCUSSION

Even though there was no significant difference in the densities of emulsions containing different concentrations of afzelia gum and those containing acacia gum, the densities of emulsions containing afzelia gum were generally lower than those containing the same concentration of acacia gum. The density of liquid paraffin oil which is $0.80g/cm^3$ [10] is lower than the density of each of the emulsions. The difference between the density of emulsion containing afzelia gum and the density of paraffin oil is smaller than the difference between the density of emulsion containing acacia gum and the density of paraffin oil for all the emulsifier concentrations used. Besides, the work of Ibezim *et al.* [11] showed that the density of dispersion of afzelia gum is lower than the density of dispersion of same concentration of acacia gum. Instability of an emulsion is directly related to the difference between the density of the dispersion medium and that of the dispersed phase [2]. Therefore, emulsions containing afzelia gum might be more stable compared to those containing acacia gum.

According to Billany, hydrophilic colloids are viscosity enhancers; and this character is part of their emulsifying properties [2]. It was also stated that high viscosity is needed for stability of emulsions and that the viscosity of the continuous phase is directly related to the stability of the emulsion [2]. Dispersion of afzelia gum has higher viscosity compared to that of the same concentration of acacia gum [11]. Therefore, better stability observed with emulsions containing afzelia gum could be linked to the higher viscosity observed with the gum as an emulsifier.

Concentrations of 1-5 % w/v acacia gum are unsuitable for the formulation of liquid paraffin emulsions as cracking was observed with all these emulsions. The relatively higher density and lower viscosity of dispersions of acacia gum are contributing factors to the instability of these emulsions. Besides, it is recommended that emulsions containing mineral oil as liquid paraffin and acacia should be such that ratio of oil: water: gum be 3:2:1 in the primary emulsion. Considering the concentrations of 1-5 % w/v acacia gum in the emulsions, the proportion of acacia gum was inadequate. Inadequate quantity of emulsifying agent is one of the known causes of cracking [10]. Hence, the observed cracking of emulsions containing this range of concentrations of acacia gum was not unexpected. The concentration of 10 % w/v acacia gum complies with the ratio 3:2:1 (oil: water: gum) in the primary emulsion formula, hence, the relative stability of the emulsion formulated with this quantity of acacia gum.

The emulsion containing 3 % w/v afzelia gum is comparable with that containing 10 % w/v acacia gum. Therefore, afzelia gum is about three times better than acacia gum in terms of emulsification. Its pronounced emulsion stabilization can also be linked to its protein fraction. Gel permeation chromatography of afzelia gum shows a protein-rich fraction [12] and proteins have been implicated in the enhanced surface activity of gums [13]. Since 3 % w/v afzelia gum is comparable with 10 % w/v acacia gum, the former could be suitable for incorporation into primary emulsion formula (oil: water: gum) as 4:2:0.3, 3:2:0.3 and 2:2:0.3 for fixed oil, mineral oil and volatile oil respectively.

The ability of afzelia gum to form oil-in-water emulsion type is in agreement with the previous work [5] where afzelia gum was found to have HLB value of 9.74 which is within the range of 8-16, the HLB values of oil-in-water emulsifiers [14]. Applications of oil-in-water emulsification include the formulation of fats and oils for oral administration, formulation of oils for intravenous administration and formulation of water-soluble drugs for topical application. The oil-in-water emulsions for oral administration are more pleasant to take in this form, those for intravenous use have good flow and those for topical administration do not have a greasy texture and are easily washed from skin surfaces [2].

There was no significant difference in the densities of emulsions containing different emulsifier blends (table 6). Hence, the contributions of afzelia gum and tween 80 to the density of the dispersion medium are not significantly different. The observed increase in viscosity of emulsion with an increase in the proportion of afzelia gum shows that afzelia gum has better ability to increase the viscosity of the dispersion medium. The increase in viscosity of emulsion with an increase in the proportion of afzelia gum has a direct relationship with increase in the stability of emulsion which manifested as a decrease in creaming index.

CONCLUSION

The effects of afzelia gum and acacia gum on the density of liquid paraffin emulsion are not significantly different, but the former is a better viscosity enhancer. Liquid paraffin emulsion containing 3 % w/v afzelia gum is comparable with the emulsion containing 10 % w/v acacia gum in term of stability. Hence, the experimented gum could be used at one-third of the concentration of acacia gum to achieve emulsions of similar stability. It is a good alternative to acacia gum as an emulsifying agent.

CONFLICT OF INTERESTS

Declared none

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