Nigerian Journal of Pharmaceutical Research
Vol. 3 no. 1, pp. 49-55 (September 2004)

A STUDY OF THE EMULSIFYING PROPERTIES OF BINARY MIXTURES OF *COLOCASIA ESCULENTA* AND *ABELMOSCHUS ESCULENTA* GUMS

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Abstract
A binary mixture of the gums extracted from *Abelmoschus esculenta* (okro) and *Colocasia esculenta* (Cocoyam) has been evaluated for its emulsifying properties. The gums were extracted by precipitation using acetone and subjected to some physico-chemical studies. They were used both singly and in a binary mixture, as emulsifying agent in the formulation of various batches of Arachis oil emulsion. Stability studies were carried out on the formulations using parameters like creaming rate, cracking height, globule size growth and distribution, rheological changes, and influence of temperature. The physico-chemical properties confirmed the identities of the extracted hydrocolloids. Whereas okro gum possessed a better emulsifying characteristic than cocoyam gum, a combination of the gums led to an improvement in the emulsifying behaviour of cocoyam gum. Cocoyam gum can thus be used in admixture with okro gum to improve the emulsifying properties of the later.

INTRODUCTION

Emulsions are intimate mixtures of two immiscible liquids, which exhibit an acceptable shelf life near room temperature (1). There exist some medicaments where objectionable taste or slow rate of absorption makes them highly unsuitable for therapeutic purposes. It becomes imperative that such medicaments be formulated in such a way as to improve their palatability and efficacy i. e. absorption and bioavailability. This can be achieved by incorporating these medical agents into emulsions. Emulsions for internal and external use usually contain water as one of the phases and oil, fat, wax or resin as the oily phase. Pharmaceutical emulsions include both oral and parenteral dosage forms while cosmetic emulsions include creams and ointments (2-4). Basically, there are two types of emulsions namely: oil-in-water (O/W) and water-in-oil (W/O) emulsions (5). Recently however, other types of emulsions have come into existence such as multiple emulsions (6), where the disperse phase contains droplets of another disperse phase. Such multiple emulsions include water-in-oil-in-water (w/o/w) or oil-in-water-in-oil (o/w/o). Microemulsions are also available, where swollen micellar systems consisting of apparently homogeneously transparent systems of low viscosity contain a high percentage of both oil and water and high concentration (15 – 20 %) of emulsifying mixture (2).

In Nigeria today, there is an over-dependence on imported pharmaceutical raw materials for most of our pharmaceutical productions, leading to a depletion of our foreign reserves and an increase in the cost of production, resulting to a concomitant

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ISSN 0189-8434

increase in the price of the products. The need for a re-consideration of our abundant natural resources with a view to finding cheaper and readily available raw materials for our pharmaceutical production processes can therefore not be over-stressed. The use of admixtures in pharmaceutical formulations is as old as the practice of pharmacy. These combination products are used to improve the properties of both or one of the constituents or to reduce the unwanted activity of one of them. Raw materials like Compound Tragacanth readily comes to mind here (7, 8).

Some recent studies have also been carried out on the use of combination raw materials for pharmaceutical formulations (9 - 11). *Abelmoschus esculenta* (Fam: Moliaceae) is a herbacious plant, which originated from the Nile Valley and grows in abundance in Southern United States and many parts of Africa. It is an annual, which bears sticky green pods and measures about 7 – 9 cm in length. The pods are edible and are cooked both as vegetables and in soups. *Colocasia esculenta* belongs to the genus – Colocasia – a monocotyledon and the family, Araceae (12). It is the staple food in the tropical rain forest of some pacific Islands and is widely grown in West Africa, especially Nigeria. It serves as food, and as a thickening agent for soups due to its high gum content. The fresh corm contains 60 – 80 % water, 13 – 30 % carbohydrate, 1.5 – 3.0 % protein and Vitamin C (12).

In this present study, the two plant gums are used both singly and in combinations to evaluate the possibility of using them in admixture as emulsifying agent in pharmaceutical emulsion formulations.

MATERIALS AND METHODS

Materials

The following materials were used in the study as procured from their respective manufacturers: acetone (M & B, England), Compound Tragacanth (M & B, England), acacia (BDH, England) and benzoic acid (Merck, Germany). Cocoyam corms and Okro pods were purchased from Nsukka Central Market.

Extraction of the gums

The okro gum was extracted by slicing and mashing the seeds, which were then soaked in water containing sodium metabisulphite for 24 h. The gum was strained out subsequently using a muslin. Acetone was used to precipitate the gum, which was then oven-dried and pulverised. Cocoyam gum, on the other hand was extracted by maceration. The outer covering was removed, and the corm sliced, washed with water and macerated in distilled water for 36 h with intermittent stirring. The resulting gum was precipitated using acetone and oven-dried before being pulverised.

Identification of the gums

Standard organoleptic properties of the gums were evaluated such as colour, odour, texture and tastes. Tests for sugars, tannins, alkaloids, glycosides, starch, and gums were carried out using official procedures (7, 13). Their solubility behaviours and pH were also determined. The rheology of the two extracted gums was also determined as well as the influence of gum concentration, temperature, pH and electrolyte on rheology.

Rheology of gums

The Universal Torsion viscometer was used to measure the viscosity of a 2 % mucilage of both okro and cocoyam gums.

Effect of concentration on the viscosity of gums

Mucilages of the gum containing 1, 2, 4, 6, 8 and 10 % (w/v) of the gum in water were prepared and their viscosities determined using the Universal Torsion viscometer, at room temperature.

Effect of temperature on viscosity of gums

A 2 % w/v of the gums were prepared and the viscosity determined at $4^{O}C$, $20^{O}C$, 30^{O}C, 40^{O}C, 50^{O}C, 60^{O}C and 70^{O}C using the Universal Torsion viscometer.

Effect of pH on the viscosity of gums

A specific volume of 1 N HCl or 1 N NaOH was added to the gum mucilages to modify the pH, and the viscosity of the resulting mucilages determined using the Universal Torsion viscometer.

Effect of electrolytes on the viscosity of the gums

Varying volumes of a 0.1 M concentration of HCl and NaCl were added respectively, to a 1 % w/v dispersion of the gums in water and the respective viscosities determined using a Universal Torsion Viscometer.

Preparation of emulsions

The wet gum method (14) of emulsion preparation was adopted in the formulation of the emulsions using arachis oil, gum and chloroform water in the ration 4 : 2 : 1. Different combination ratios of both the okro and cocoyam gums were used as emulsifying agent in the emulsion preparations according to the following formula (Table 1)

Stability studies on the emulsions

Globule analysis

The microscopic method was used to analyse the globules immediately after preparation and weekly for six (6) weeks. Two drops of the emulsion were placed on the microscopic slide and two drops each of glycerin and nigrosin added. These were mixed and viewed in the microscopic field for direct globule count and size distribution.

Creaming rates

A 50 ml quantity of each emulsion batch was placed in different sets of graduated 50-ml measuring cylinders. These were stored at 4^{O}C, 28^{O}C and 50^{O}C respectively for 6 weeks. The heights of the upper cream layers were measured daily for the first week and then weekly for six weeks. The creaming rate was determined using the equation:

% creaming = Vu/Vo x 100

Where Vu is the volume of the upper cream layer and Vo is the total volume of the emulsion.

Cracking height

This was determined by examining and measuring any separated water layer in the formulated emulsion. The determinations were carried out 24 h after formulation and then, weekly for six weeks.

pH measurement

The pH of all the prepared emulsions were measured with a pH meter. The measurements were taken 24 h after formulation and weekly for 6 weeks.

Viscosity measurement

This was carried out using the Universal Torsion Viscometer. A 50 ml quantity of the emulsion was placed in a cylindrical container. The viscometer cylinder was then slowly immersed into the emulsion until three-quarters of the emulsion volume was covered by the cylinder. The pointer was released, the reading taken and the values in centipoise extrapolated from the viscosity graph. The measurements were taken 24 h after preparation and then weekly for six weeks.

RESULTS AND DISCUSSION:

The extracted cocoyam was brownish in colour, tasteless, odourless and powdery, while the okro gum was grayish, tasteless, odourless and powdery. The two extracted gums were soluble in water but insoluble in methanol, ethanol, acetone and chloroform. Ability to dissolve and swell in water is one of the properties of most natural gums. Cocoyam gum was found to contain reducing sugars, and gave positive gum identification tests. It however did not contain tannin, alkaloid, glycoside, protein and starch. Okro gum on the other hand contained reducing sugar, starch, protein and showed a positive result for the natural gum test. These confirmed their identity as plant gums (7, 13).

Tables 2 and 3 show the effects of gum concentrations and temperature on the rheology of the extracted gums respectively. The viscosities of the okro mucilage were higher than those of cocoyam at all the concentrations. However, the viscosities generally increased with increasing concentration of the gums and with increasing temperature. Viscosity has been shown to be inversely proportional to temperature (15). The okro mucilage had the highest viscosity at a pH of 5.2, while the cocoyam gum had the highest viscosity at a pH of 5.8. As the volume of electrolyte added increased, the viscosity of the gum dispersions decreased. Salting out, may be considered as the cause of such coagulation of the gum dispersions leading to reduced viscosity. An increase in the ionic concentration of the medium compresses the diffuse portion and the thickness of the electrical double layer thereby decreasing the energy barrier that opposes aggregation leading to an eventual coagulation and subsequent fall in viscosity (16).

Figure 1 shows the globule size distribution of the emulsions formulated with the two gums and a combination of them, upon storage at room temperature. The 1: 1 admixture of cocoyam and okro gums was chosen for subsequent comparative studies based on its relative superior behaviours during preliminary trials. It is observed from the figure, that the particle sizes generally increased while the number of globules decreased upon storage for all the emulsions. The greatest decrease in size occurred in the emulsion prepared with cocoyam gum alone while the emulsion formulated with okro gum exhibited the greatest size stability. Addition of okro gum to cocoyam gum invariably improved the emulsifying properties of the later. Globule sizes of emulsions are known to increase upon storage due mainly to agglomeration of globules leading to a concomitant decrease in number of particles (17).

Figure 2 shows the rheology of the emulsion formulations at different time intervals. The viscosities were found to increase with time for all the emulsion batches. However, the emulsion produced with okro gum had the highest initial viscosity followed by the emulsion prepared with cocoyam gum. The rate of increment in viscosity was similar for all the emulsions. It is expected that stable emulsions should retain their viscosities as much as possible upon storage.

Figure 3 represents the creaming rates of the various emulsion formulations upon storage at varying temperatures. The emulsion formulated with okro gum alone showed the highest stability to creaming since it creamed least at all the storage temperatures. It was closely followed by the emulsion formulated with a combination of cocoyam and okro gum, while the formulation with cocoyam gum had the least stability, indicating that the presence of okro gum enhanced the properties of the cocoyam gum. Stable emulsions are not expected to cream upon storage. None of the emulsions cracked upon storage at room temperature for six weeks.

The effect of storage on the pH of the emulsion formulations stored at $4^{O}C$ is given in Figure 4. All the emulsions exhibited stable pH during the first three weeks of storage followed by a sharp drop and another segment of stable pH after four weeks. However, the emulsion prepared with okro gum showed the greatest pH stability followed by the emulsion prepared with a combination of okro and cocoyam gums. This result is consistent with the earlier results on viscosity and creaming rate. The emulsion prepared with okro gum equally had the least pH followed by the emulsion containing a binary mixture of cocoyam and okro gums.

Table 1: Formula for formulation of Arachis oil emulsions using different combination ratios of okro and cocoyam gums

Batch	Qty of cocoyam gum (g)	Quantity of okro gum (g)	Ratio (cocoyam/okro)
A	10	0	1:0
B	5	5	1:1
C	0	10	0:1
D	6	4	3:2
E	4	6	2:3
F	8	2	4:1

Table 2: Effect of concentration on the viscosity of the gums

Concentration of gum (mg %, w/v)	Viscosity in centipoise (Cps)	
	Colocasia esculenta (cocoyam)	*Abelmoschus esculenta (okro)*
1	205	210
2	210	225
4	225	230
6	230	240
8	255	265
10	280	295

Table 3: Effect of temperature on the viscosity of the gums

Temperature (^{O}C)	Viscosity in Centipoise (Cps)	
	Colocasia esculenta	*Abelmoschus esculenta*
4	222	225
20	205	212
30	200	210
40	198	208
50	180	185
60	165	170
70	132	135

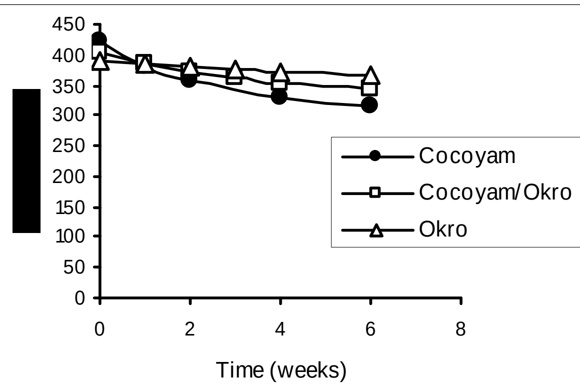

Fig. 1: Globule count for the emulsions prepared with different emulsifying agents upon storage

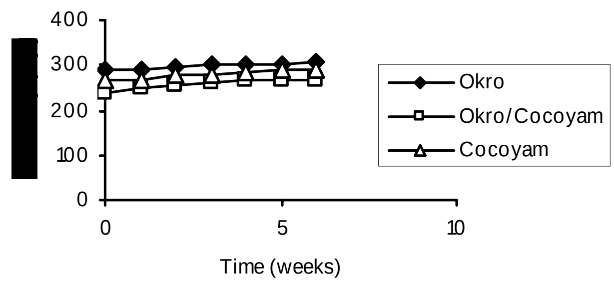

Fig. 2: Effect of storage on the viscosities of emulsions prepared with different emulsifying agents

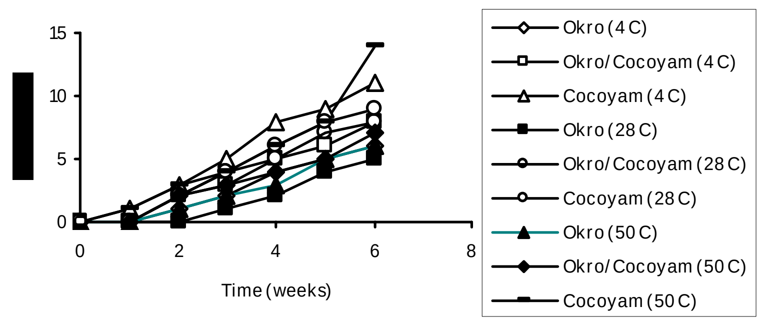

Fig. 3: Creaming rates for the emulsions prepared with different emulsifying agents and stored at different temperatures

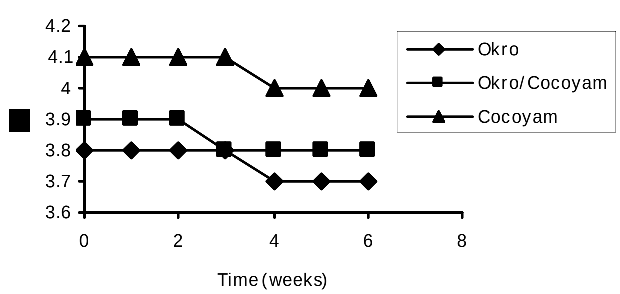

Fig. 4: Effect of pH on the stability of emulsions containing different emulsifying agents and stored at 4 degrees centigrade

CONCLUSION

The gums obtained from okro and cocoyam have been evaluated for their emulsifying properties alone and in combination. The admixture containing 1 : 1 ratio of the gums possessed superior emulsifying properties to other combinations hence was used for comparative studies. Okro gum exhibited the greatest emulsifying behaviours followed by the 1 : 1 admixture of cocoyam and okro gums. Cocoyam gum exhibited the least emulsifying behaviour indicating that okro gum could be used to enhance the emulsifying properties of the more available cocoyam gum.

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