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CHARACTERIZATION AND EVALUATION OF OKRA GUM AS A TABLET BINDER

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Abstract

The type and amount of binders decisively influence the characteristics of tablets prepared by wet granulation procedure. Commonly used binders like acacia, gelatin, starch and hydrolyzed starch have natural origin. The aim of this study was to evaluate the effectiveness of a new binder extracted from *Hibiscus esculentus* (Okra gum) in tabletting. Okra gum was extracted from the pods of Okra fruit by maceration in distilled water followed by filtration of viscous solution as well as precipitation of gum extract by using acetone. To evaluate the binder effectiveness, two models, including a placebo formulation (lactose) and a drug formulation (Acetaminophen, Ibuprofen, and/or Calcium acetate) were evaluated. Granules were prepared by different concentrations (0.5-6 %w/w) of Okra gum and tabletted using a Kilian single punch press. Cornstarch (12.5 % w/w) and P.V.P (22 %w/w) were employed as the standard binders for comparison. The physical properties of the granulates and those of the tablets including disintegration time and dissolution rate were studied. The properties of placebo granulates (bulk and tapped density, granule strength, flowability) as well as those of tablets (hardness, friability, disintegration time) were generally good. Moreover, the physical properties of Ibuprofen and Calcium acetate tablets containing Okra gum showed sufficient hardness, desirable disintegration time and low friability. The percent of drug released after 45 minutes were 15 %, 44 % and 96 % for Acetaminophen, Ibuprofen and Calcium acetate tablets, respectively.

Okra gum produces some tablet formulations with good hardness and friability. However, this binder prolongs the dissolution rate of some slightly soluble drugs and hence may be good candidate for sustained release formulations.

Keywords:

Hibiscus esculentus, Okra, Tablet, Binder, Wet granulation.

Introduction

Tablets, due to their portability and convenience are the most widely prescribed dosage forms in the world. One major class of excipients that is used to improve tablet formulations is the pharmaceutical binders or some time referred to as adhesive (1). The properties of wet granulates, and of the tablets into which they are processed, are decisively influenced by binders (2). *Abelmoschus esculentus (L.) Moench* belongs to the *Malvaceae* plant family. The name Abelmosch is derived from the musky odor of the seed (3). Its common name is Okra and also known as lady's fingers, *gombo*, *bamia*, in Spanish Okra is *quibo-*

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mbo, in India is *bhindi* and in the eastern Mediterranean and Arab countries *bamies*. The natural gums and mucilage are often preferred to synthetic materials due to no toxicity, low cost and free availability (4). On the other hand, Okra gum produces high viscosity mucilage at low concentrations (5). The aim of this study was to investigate the possibility of using Okra gum as a tablet binder and evaluate it against two well-known binders, PVP K30 and Cornstarch. Calcium acetate, Ibuprofen and Acetaminophen were used as freely water-soluble, slightly water-soluble and practically insoluble drug models, respectively. Acetaminophen was also chosen because of its poor compression properties, requiring an efficient binder to form satisfactorily strong tablets (6). The influence of different types and amounts of binders both on granulate properties (i.e. bulk and tapped density, granule strength, angle of repose and flow properties) and tablet quality (i.e. crushing strength, friability, disintegration time and dissolution time) were investigated.

Materials

The fresh fruits of Okra , Acetaminophen (Atabay, Turkey), Ibuprofen (Sekhsaria chemicals, India), Avicel PH 101 (FMC, USA), Calcium acetate, starch, lactose, magnesium stearate, sodium lauryl sulfate, Na-CMC, Aerosil, sodium saccharine, acetone, stearic acid and PVP K30 (Merck, Germany) were obtained from indicated sources .

Methods

Extraction of the pods of Okra fruit mucilage

Okra gum was extracted from the pods of Okra fruits. The fruits were cleaned, washed, sliced, crushed and then macerated in distilled water for 10 hours with intermittent stirring. The mucilage was filtered through a white muslin cloth to extract the gum and acetone was added to precipitate the extracted gum. The gum was then filtered under vacuum to remove acetone and dried in a desiccator (5, 7). Physicochemical properties of Okra gum binder like specific gravity, pH, water content, total ash content, acid insoluble ash, water soluble ash and microbial limit were determined as suggested by U.S. pharmacopoeia (7, 8).

Preparation and evaluation of prepared granulates

Granules of lactose, Calcium acetate, Acetaminophen and Ibuprofen were prepared using wet granulation method. Granulation was carried out using planetary mixer at a speed of 40 rpm. Binder solutions (Okra gum 3%, PVP 22% and starch 12.5% (w/w)) were gradually added to the powder mass to form a coherent wet granulate. The prepared mass was passed through a 10-mesh sieve, dried at 50^{o}C overnight and finally passed through a 20-mesh sieve. The bulk density (ρ_b) of granules was determined by filling the material into a tarred graduated cylinder to the 100 ml mark. The graduated cylinder was weighted and the bulk density calculated as the ratio of the sample weight to sample volume (9). The graduated cylinder was then tapped from a height of about 2 inches until constant volume. The tapped density (ρ_t) was calculated as the ratio of the sample weight to the final sample volume .The test was repeated three times and the mean values were calculated .The changes occurring in packing arrangement during the tapping procedure are expressed as the Carr's Index as shown by the following equation(10).

$$\text{Carr's Index} = (1-\rho_b/\rho_t) \times 100$$

Angle of repose determination was conducted to investigate the flow properties of the granules. The freestanding cone (dynamic) method was employed to calculate the angle of repose (11). As the angle of repose increased, indicating a

reduction in the ability to flow. The granule strength was determined by friability test using the Roche oscillating friability testing machine. A sample of 10 g granulate from the 250-850 µm sieve fraction was poured in Rosch friabilitor (10). After the drum movement stopped, the granulate was sieved through a 60-mesh sieve, and the residue remaining on the sieve was weighed. The granule strength was calculated using the following formula:

$$\% \text{ Friability} = (\text{Initial weight} - \text{Final weight} / \text{Initial weight}) \times 100$$

Preparation and evaluation of tablets

The tablets containing lactose (as a control), Calcium acetate (400 mg), Acetaminophen (300 mg) and Ibuprofen (150 mg) were separately prepared by wet granulation method using various binders (starch paste, PVP and Okra gum). The resultant granules were lubricated and compressed using a Killian single punch press machine. The tablets were evaluated for weight variation, hardness, friability and disintegration time according to the USP 29 requirements (8). Tablet dissolution behavior was carried out using a PTWS3 Pharmatest dissolution tester. The settings of dissolution test for different tablets were summarized in Table 1.

Results and Discussion

Okra gum is a natural polysaccharide composed of d-galactose, L-rhamnose and L-galacturonic acid (12). It is soluble in cold water and used in the food industry as an emulsifying and foam-stabilizing agent (12). Addition of diluted lead acetate to the gum produces a white precipitation resemble to acacia gum (8). The results of physicochemical properties of Okra gum are shown in Table 2.

Microbial count showed 200 CFU/g. There was no colony of *E coli* and *Salmonella* in the culture medium (8). The effect of different Okra gum concentrations and standard binders (PVP and Cornstarch) on the characteristics of lactose granules are listed in Table 3.

The Carr's index and angle of repose of resultant granules were lower than 15 and 25, respectively. They were in acceptable range for flowability properties (10). Based on Table 3, Okra gum is appropriately comparable with standard binders. Okra gum at concentrations of 3 and 4 % (w/w) could produce suitable lactose granules.

Table 1: The setting of dissolution test for different tablets

	Calcium acetate	Acetaminophen	Ibuprofen
Apparatus	Paddle	Paddle	Basket
Medium type	HCl 0.1 N	Buffer (pH=5.4)	Buffer (pH=7.2)
Volume of Medium	500 ml	900 ml	900 ml
rpm	75	50	150
Temperature	37°C ± 0.5	37°C ± 0.5	37°C ± 0.5
Procedure	Atomic Abs. (λ=422.9 nm)	UV (λ=242 nm)	UV (λ=221 nm)

Table 2: Physicochemical features of *Okra* gum paste

pH (1% solution)	7.32
Specific Gravity (0.01% solution) (g/ml)	0.999
Surface Tension (0.1% solution) (dyn /cm)	52.3
Total ash (%)	7.931
Water soluble ash (%)	6.492
Acid insoluble ash (%)	0.62
Microbial count (CFU/g)*	200

*No colony of E coli and Salmonella were grown

Therefore, concentration of 3% for Okra gum was chosen as the optimum level to produce granules. However, based on our preliminary studies (data was not shown) the 5% concentration of binder was preferred for granulation of the poor compressible (Acetaminophen) and high dosage (Ibuprofen) drugs.

The effect of Okra gum concentration on physicochemical characteristics of lactose tablets are shown in Fig.1.

Table 3. Physicochemical characteristics of Lactose granules prepared by different concentrations of *Okra* gum, PVP and Cornstarch

Binder type	PVP	Cornstarch	*Okra* gum				
Concentration % (w/w)	22	12.5	1	2	3	4	5
Bulk density (g/ml)	0.48	0.51	0.45	0.49	0.52	0.55	0.57
Tapped density (g/ml)	0.55	0.6	0.52	0.57	0.59	0.62	0.66
Carr's index	12.7	15	13.5	14	11.9	11.3	13.6
Strength of granules (%)	18	13.6	15	17.1	17.8	18.3	18.6
Angle of repose	21.5	24.6	23.1	23.5	20.3	19.8	23.5

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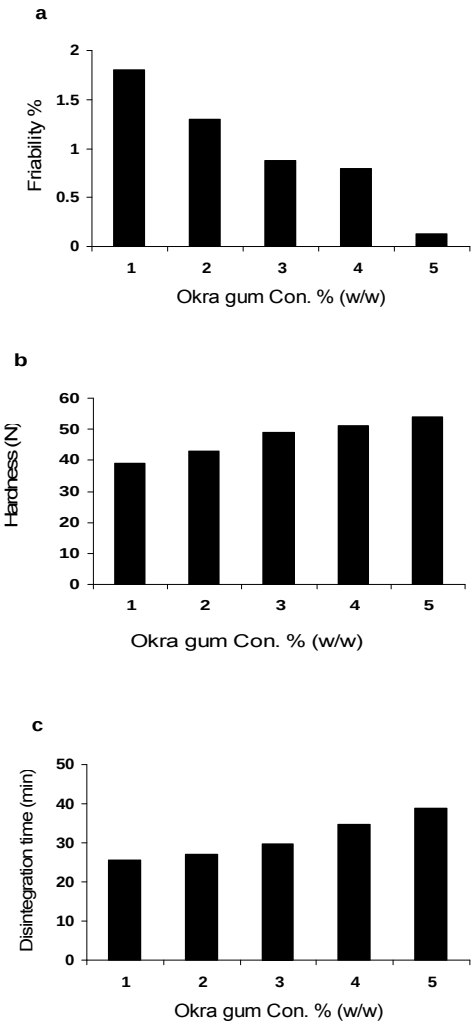

Fig. 1: The effect of *Okra* gum concentration on a) friability b) hardness and c) disintegration time of lactose tablets

An increase in binder concentration increased the hardness and disintegration time and decreased friability values of the tablets. This finding may be attributed to gel forming property of Okra gum in the tablet matrix and is in line with the study of Onunkwo and Mba (5).They have formulated sodium salicylate tablets by Okra gum as a binder and investigated the effectiveness of gum on tablet properties. Antony and Sanghavi have also reported similar behavior for a biodegradable polysaccharide, gellan gum when they compared gellan with several standard binders such as starch, acacia, gelatin, PVP and PVA (13). Gellan gum and PVP produced tablets with the highest level of hardness and the least friability (13).

Table 4 compares the physicochemical properties of lactose tablets (control) and the tablets prepared of model drugs, Acetaminophen, Ibuprofen and Calcium acetate. In general, the tablet hardness between 40-50 Newton, friability less than 1% and the disintegration time less than 30 minute lied in pharmacopoeial limits(8).

According to Table 4, all formulations except for Acetaminophen are in acceptable levels.

The dissolution profiles of the Ibuprofen and Calcium acetate tablets are shown in Fig. 2. It shows the influence of Okra gum binder on the release of a freely soluble model drug, calcium acetate and a slightly soluble drug, Ibuprofen.

Calcium acetate was completely released from the tablet during a period of 45 min.

Table 4: Physicochemical properties of different model tablets formulated by *Okra* gum

Tablet	Lactose			Acetaminophen	Ibuprofen	Calcium acetate
Type of binder	PVP	Cornstarch	*Okra* gum	Okra *gum*		
Binder Con. % (w/w)	22	12.5	5	5	5	*5*
Friability %	0.9	0.8	0.2	6	0.72	*0.71*
Hardness (N)	55.5	57.6	54	19.5	55	*59.3*
Disintegration time (min)	*15.35*	*2.5*	*38.9*	*43.4*	*33.2*	*24.2*

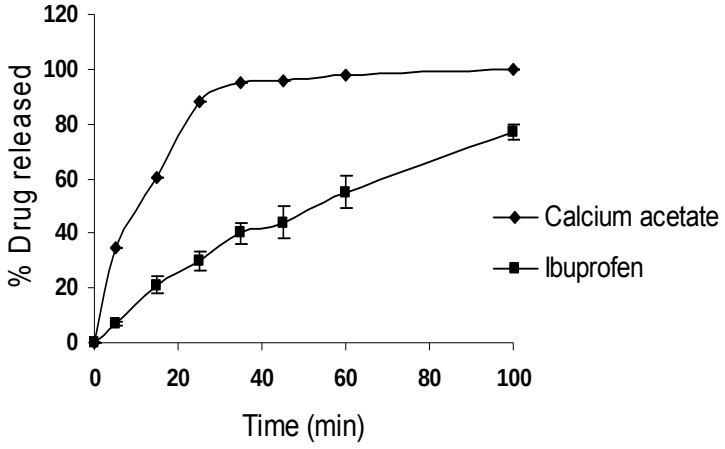

Fig. 2: Dissolution profiles of Calcium acetate and Ibuprofen tablets prepared by *Okra* gum.

This effect in turn may lead to reduction of side effects, notably gastrointestinal adverse reaction of Ibuprofen (14). Acetaminophen tablets formulated by However, comparison of drug release from Ibuprofen tablets prepared by Okra gum and standard binders indicated that Okra had a retarding effect on drug release from the tablets (data was not shown).Okra gum failed to release drug content at a desirable duration of time (15% in 45 min). Onunkwo and Mba have shown that the release rate of a water-soluble drug, sodium salicylate, from the tablets decreased as the binder concentration increased (5).

Conclusion

Okra gum as a binder produces some tablet formulations with good hardness, friability, disintegration time and dissolution rate. However, this binder prolongs the dissolution rate of some slightly soluble drugs and may be consider as a good candidate for sustained release formulations.

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