Evaluation of Binding Properties of *Eulophia campestris* Wall. Mucilage

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Present work reports extraction of mucilage of *Eulophia campestris* by multiple maceration technique using water and precipitation by acetone (36% w/w yield). Physicochemical characteristics of mucilage, such as solubility, swelling index, loss on drying, pH and viscosity, were studied and also microbial load was determined. The mucilage was evaluated for its granulating and binding properties in tablets, using paracetamol as a model drug. Mucilage was used in three different concentrations – 6, 8 and 10% w/v. The granules were prepared by wet granulation technique. The prepared granules were evaluated for percentage of fines, average particle size, total porosity, compressibility index and flow properties. The properties were compared with starch, which was used as a standard binder at 10% w/v concentration. The tablets were prepared and evaluated for content uniformity, hardness, friability, disintegration time and *in vitro* dissolution profiles. The tablets had good physicochemical properties, and the drug release was more than 85% within 3 h. The tablets prepared by using 10% mucilage as binder exhibited more hardness than by using 6 and 8% concentrations. Hence, 6 and 8% concentrations can be considered as ideal concentrations for preparation of tablets.

Mucilages are polyuronides consisting of sugar and uronic acid units. They are usually formed from the cell wall or deposited on it in layers. They swell in water and form a gel[1]. The usefulness of mucilages as emulsifying, gelling and suspending agents has been well documented[2]. Some of the mucilages have also been used in tablet formulations as binding agents and also to sustain the drug release[3]. Natural mucilages are nontoxic, non-irritant and act as emollients, stabilizers and stiffening agents[4].

Eulophia campestris Wall. (family Orchidaceae) is a genus of terrestrial orchids, which yield the Salep of commerce. This is an herbaceous plant found throughout India and is indigenous to Persia and Afghanistan. Tubers of *E. campestris* yield a large quantity of mucilage to water and, on boiling even with 40 parts of water, form a thick jelly which is highly nutritious[5,6]. Hence the present work was attempted to evaluate binding properties of mucilage extracted from tubers of *E. campestris.*

MATERIALS AND METHODS

Plant material:

The fresh tubers of *E. campestris* plant were collected from Mandav region of Indore and authenticated in Botany Department, Devi Ahilya Vishwavidyalaya, Indore. Paracetamol was used as model drug in the study, and it was purchased from Zig Pharmaceutical Pvt. Ltd., Indore. All the chemicals and other reagents used in the study were of AR grade.

Isolation of mucilage[2-4]:

Mucilages are viscid, somewhat tenacious and generally adhesive liquids, prepared with water as a solvent. The mucilage was isolated from freshly dried and coarsely powdered tubers of *E. campestris*. The tubers were steeped in water 24 h, boiled for 1 h and kept aside for 2 h to release mucilage into water. The material was squeezed in a muslin bag to remove the marc from the filtrate. The filtrate was again filtered under vacuum and added to equal volume of acetone to precipitate the mucilage. The mucilage was separated, dried in an oven at temperature less than 50°, powdered and passed through sieve number 80. The powdered mucilage was stored in desiccator until further use (yield: 36% w/w).

Physicochemical and microbiological properties of mucilage:

The physicochemical properties such as solubility, swelling index, loss on drying, viscosity and microbial load of the mucilage were determined according to

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Indian pharmacopoeial procedures[7]. The pH of the mucilage was determined using a digital pH meter.

Preparation and evaluation of granules:

Paracetamol was used as a model drug to formulate granules. Starch was used as disintegrant, whereas lactose and talc were used as diluent and lubricant respectively. The binder solution was prepared by dissolving the mucilage of *E. campestris* in water at 6, 8 and 10% w/v concentrations. The granules were prepared by wet granulation process[8]. The batch size was 200 g. The drug, lactose, talc and starch were mixed thoroughly, and a sufficient volume of ~40 ml of 6, 8 and 10% w/v of mucilage of *E. campestris* was added slowly to the powder blend, and kneading was performed for ~10 min until formation of wet mass with enough cohesiveness. The wet mass was forced through a no. 16 sieve (1180 µm) and dried at 50° in a hot air oven for 10 h. The dried granules were re-sieved through a no. 20 sieve (850 µm). The prepared granules were then evaluated for percentage of fines, particle size and flow properties (by measurement of angle of repose)[8,9]. The bulk and tapped densities of the granules were assessed in accordance with the *USP* 25 using a tapped volumeter apparatus (Erweka, SVM101, Heusenstamm, Germany). Compressibility index of the granules was determined by Carr's compressibility index[10–13]. Total porosity was also determined as described before[10–13] by measuring the volume occupied by selected weight of a powder and the true volume of granules.

Preparation and evaluation of tablets:

The tablets were compressed by using Cadmach (Ahmedabad) single punch machine using flat-faced punches. The batch size of 100 tablets was prepared. The prepared tablets were evaluated for content uniformity, hardness, friability, disintegration time and *in vitro* dissolution profile using methods specified in Indian Pharmacopoeia[7].

RESULTS AND DISCUSSION

The dried and coarsely powdered tubers of *E. campestris* yielded high percentage (36% w/w) of mucilage using acetone as mucilage-precipitating solvent. The physicochemical and microbiological properties of mucilage were determined and shown in Table 1. The extracted and purified mucilage was evaluated for microbial count (using bacterial and fungal load) and pH. The microbial count was found to be less than 120 CFU (Colony Forming Units) per gram of mucilage. The pH of the mucilage was found to be 7.5. Since the pH value of this mucilage is near to neutral, it may be less irritating in gastrointestinal tract and hence was suitable for uncoated tablets.

TABLE 1: PHYSICOCHEMICAL AND MICROBIOLOGICAL EVALUATION OF *EULOPHIA CAMPESTRIS* MUCILAGE

Parameter (s)	Result (s)
Solubility	Swells in cold water considerably but quickly dissolves in warm water forming viscous colloidal solution. Insoluble in ethanol, methanol, chloroform and ethyl acetate
Swelling index	12%
PH	7.5
Loss on drying	8.3%
Microbial load	
a. Bacteria (no. of CFU/g mucilage)	100
b. Fungi (no. of CFU/g mucilage)	120

The prepared granules were evaluated for percentage of fines, particle size and flow properties. The results are shown in Table 2. It was observed that the percentage of fines was reduced as the concentration of mucilage was increased. The percentage of fines was a little higher in granules prepared using 6% w/v mucilage as binder. The flow property of granules was determined by angle of repose, which was found to be 30° to 32°. The mean particle size (between 0.38 and 0.40 mm) was found to be satisfactory for preparation of tablets. Hence all the granules exhibited good flow properties. Table 2 shows that the bulk densities of the prepared granules were found to decrease slightly by increasing concentrations of *E. campestris* mucilage. This result may be due to the formation of larger agglomerates and the decrease in fines in the granules, as increasing *E. campestris* mucilage concentrations provide more binding to the granules. The results of compressibility index (Table 2) indicate a decrease in flowability with increasing *E. campestris* mucilage concentrations; however, all formulations show good flow properties. In general, compressibility index values up to 15% result in good to excellent flow properties[11]. Percentage porosity values of the granules ranged from 30.29% to 38.32%, indicating that the granules are loosely packed and confirming that the particles are not of greatly different sizes. In general, a percentage porosity value below 26% shows that the particles in the powders are of greatly different sizes, and a value greater than 48% shows that particles in the powder are in the form of aggregates or flocculates[12]. All

TABLE 2: CHARACTERIZATION OF GRANULES PREPARED USING *EULOPHIA CAMPESTRIS* MUCILAGE AS BINDER

Property (s)	*E. campestris* mucilage as binder			Starch
	6%	8%	10%	10%
Percentage of fines	20.00	17.60	16.4	18.00
Mean particle size (mm)	0.38	0.38	0.40	0.42
Angle of repose (º)	30˚	32˚	30˚	28˚
Loose bulk density (g/cm^3) ± SD	0.543±0.05	0.540±0.03	0.512±0.03	0.498±0.04
Tapped bulk density (g/cm^3) ± SD	0.592±0.06	0.605±0.03	0.588±0.04	0573±0.02
Compressibility Index (%) ± SD	8.28±0.93	10.75±0.76	12.63±0.89	13.09±1.11
Total porosity (%) ± SD	30.29±2.34	35.96±3.32	36.52±3.37	38.32±2.69

TABLE 3: EVALUATION OF TABLETS PREPARED USING *EULOPHIA CAMPESTRIS* MUCILAGE AS BINDER

Property (s)	*E. campestris* mucilage as binder			Starch
	6%	8%	10%	10%
Content uniformity (%) ± SEM	94.80±0.44	96.40±0.54	97.40±0.54	98.00±0.70
Hardness (kg/cm^2) ± SEM	05.96±0.08	06.50±0.10	07.06±0.08	06.50±0.07
Percentage friability	0.30	0.30	0.30	0.20
Disintegration time (sec)	290	315	335	240

Tabulated values are expressed as ± SEM

these results indicate that the granules possessed satisfactory flow properties, compressibility and porosity.

Three batches of 100 tablets were prepared using mucilage of *E. campestris* at three different concentrations – viz., 6, 8 and 10%. Starch mucilage (10% w/v) was used as standard binder for comparison. The prepared tablets were evaluated for content uniformity, hardness, friability, disintegration time and *in vitro* dissolution profiles. The results are shown in Table 3.

All the batches of tablets exhibited good uniformity in content. The hardness of tablets increased with increase in percentage of binding agent used. The tablets prepared with 10% mucilage of *E. campestris* showed more hardness when compared to tablets prepared with 10% starch mucilage. The percentage friability values were constant in all the batches of tablets prepared by using different concentrations of mucilage. This mucilage had given increase in disintegration time with increase in concentration, but all the values were within pharmacopoeial limits. At 10% concentration, the disintegration time was higher for the tablets prepared by using 10% starch mucilage.

The *in vitro* dissolution profile is shown in fig. 1. It was found that the drug release decreased with increase in concentration of mucilage. This study showed that the drug release from the tablets prepared using mucilage at three different concentrations was more than 85% in 3 h. These tablets had given reduced diffusion of drug, since

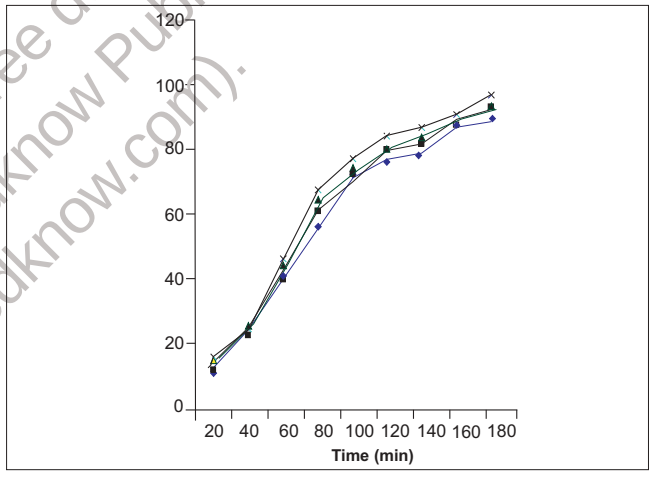

Fig. 1: *In vitro* dissolution profile of paracetamol tablets prepared with *Eulophia campestris* mucilage as binding agent Legends: -◆- 6% Mucilage; -■- 8% Mucilage; -▲- 10% Mucilage; -x- 10% Starch

the tablets produced a sticky film of hydration on the surface. This may be the reason for the reduced dissolution with increased mucilage concentration.

From the present study, it can be concluded that *E. campestris* mucilage may be used as binding agent in tablet formulations. Mucilage (6 and 8% w/v concentrations) can be used for the preparation of uncoated tablets. This mucilage can be used for sustaining the drug release from tablets, since the prepared tablets using mucilage of *E. campestris* produced a sticky film of hydration on the surface, which ultimately reduces drug release rate. Hence *E. campestris* mucilage can be evaluated for its efficacy to sustain the drug release.

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