ORIGINAL ARTICLE

Isolation and physicochemical characterization of *Ficus reticulata* fruit mucilage

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The *Ficus reticulata* fruit mucilage is an edible fruit and its pulp is rich in mucilage. But there are no reports on isolation and characterization of *F. reticulata* fruit mucilage. Hence, the present study was designed to isolate, purify and characterization of *F. reticulata* fruit mucilage. *F. reticulata* fruit mucilage was extracted purified and identified by official methods. The isolated mucilage was characterized for physical, chemical and flow properties. The mucilage was further characterized by Fourier Transform Infrared Spectroscopy (FTIR). The *F. reticulata* fruits gave sufficient quantity of mucilage and it has good physical, chemical, and flow properties. The FTIR spectrum of *F. reticulata* fruit mucilage showed characteristic peaks. It was concluded that the *F. reticulata* fruit mucilage can be used as a binder and excipient in pharmaceutical dosage forms.

Key words: Characterization, *Ficus reticulata*, isolation, mucilage

INTRODUCTION

Ficus reticulata is laticiferous tree grows up to 12.2 m tall with reddish grey bark, alternate leaves, stipules ovate Lanceolate, pubescent, 1.25 to 2.5 cm long, petioles 2.5 to 5.0 cm long. Fruits borne in clusters on the main trunk and leafless short branches, sub globose or pyriform, 2.5 to 5.0 cm in diameter, they become red when ripe.[1] The taxonomical classification of *F. reticulata* was shown in Table 1. The dried uncooked *F. reticulata* fruits give 275kcal (1151.4 kJ) of energy per 100 g (3.5 oz).[2] These fruits were already proved its medicinal values in relieving fever,[3] pain and inflammation,[4] wound healing,[5] blood purifying,[5] and urinary problems.[6] Moreover, the fruits were used in conditions like Impotence and decreased sperm count. The fruit pulp mucilage may also have medicinal values same as fruits. So, it has additive actions with the drug when used in the formulation. Presently, the use of natural gums and mucilages is gaining importance in pharmaceutical formulations as an excipient in dosage forms. Synthetic polymers have certain drawbacks, viz., high cost, non-renewable sources, side effects, toxicity, causing environmental pollution during their synthesis, non-biodegradable (where as biodegradable synthetic polymers are costlier) and less patient compliance[7,8] etc. While natural plant based materials are economical, devoid of side effects, biocompatible, biodegradable, renewable source, environmental friendly processing and better patient compliance.[9-13] Mucilages are polysaccharide complexes formed from sugar and uronic acid units. Mucilages form slimy masses in water, are typically heterogeneous in composition. Upon hydrolysis mucilages gives Arabinose, Galactose, Glucose, Mannose, Xylose and various uronic acids.[14] Mucilages are obtained mainly from fruits have an added advantage of wide acceptability by the patients. The prospects of natural polymers are brighter but even higher extensive testing will be required. In present study, the fruits of *F. reticulata* were selected for the isolation and purification of mucilage. However there are no reports on isolation, purification and characterization of *F. reticulata* fruit mucilage. Hence, the present study was planned to isolate and characterize mucilage of *F. reticulata* fruits. The data so obtained will be a standardizing parameter for future research work.

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Table 1: Taxonomical classification of *F. reticulate*

Kingdom	Plantae
Subkingdom	Tracheobionta
Super division	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Hamamelidae
Order	Rosales
Family	Moraceae
Genus	Ficus L. – fig

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MATERIALS AND METHODS

Materials

The fresh *F. reticulata* fruits were collected from plants growing in and around Anantapur, India. The plant and fruits were authenticated at the Botany Department, Sri Krishnadevaraya University, Anantapur, India. Ethanol (95%), Acetone, trichloro acetic acid, sodium hydroxide and diethyl ether were procured from SD Fine chemicals (Mumbai, India). All other chemicals used were of Analytical Reagent grade and double distilled water was used throughout the experiments.

Extraction of Mucilage

The fresh *F. reticulata* fruits were collected and washed with water. The fruits were opened and seeds were removed. The fruits were crushed and soaked in water for 5–6 hours, boiled for 30 minutes and left to stand for 1 hour to allow complete release of the mucilage into the water. The mucilage was extracted using a multi layer muslin cloth bag to remove the marc from the solution. Acetone (in the volumes of three times to the volume of filtrate) was added to precipitate the mucilage. The precipitated mucilage was separated, dried in an oven at 40±2°C, collected, ground, passed through a #80 sieve and stored in desiccator at 30±2°C and 45±5% relative humidity till use.[15-17]

Purification of the Mucilage

The crude mucilage (1%) was homogenized (Potter S homogenizer, Sartorius AG, Germany) with cold dilute trichloro acetic acid solution (5%). The solution was centrifuged (3500 rpm for 20 min), neutralized with sodium hydroxide by drop wise addition and then dialyzed for 30 hours against distilled water.[18] The mucilage was precipitated with ethanol (in the quantities of three times the volumes) and washed successively with ethanol, acetone and diethyl ether. The mucilage so obtained was dried under vacuum (less than 1 Torr at 25°C for 12 hours). The so obtained mucilage was passed through a # 80 sieve and stored in desiccator at 30±2°C and 45±5% relative humidity till use.[19,20]

Characterization of Mucilage

Physical characterization

The collected mucilage was evaluated for physical characteristics[21,22] viz., appearance, odour, solubility, percentage yield, average particle size, swelling ratio, weight loss on drying, pH, charring, density and bio burden. All these values were tested in triplicate.

Chemical characterization

The extracted mucilage was tested for chemical characteristics for identification, test for carbohydrate, Tannins, chlorides, sulphates and uronic acid. The mucilage was also tested for unwanted chemicals[21,22] viz., foreign matter, heavy metal and arsenic.

Table 2: Chemical characterization of *F. reticulata* fruit mucilage

Chemical properties	Observation
Mounted in 96% ethanol	Transparent angular masses
Mounted in ruthenium red	Particles stained red
Mounted in Iodine solution	Particles stained blue
Mollish test (for Carbohydrates)	+ve
Ferric chloride test (for Tannins)	-ve
Silver-nitrate test (for chlorides)	-ve
Barium chloride test (for Sulphates)	-ve
Test for Uronic acid	+ve
Test for foreign matter (%)	*NMT 0.1
Test for heavy metal (lead)	20 ppm
Test for arsenic	<1 ppm

*NMT – Not more than

Table 3: Flow properties of *F. reticulata* fruit mucilage

Flow properties	Observation
Angle of repose (θ°)	25.77±1.68
Loose bulk density (g/cm^3)	0.53±0.05
Tapped bulk density(g/cm^3)	0.67±0.05
Carr's index (%)	20.8±0.04
Hausner's ratio	1.26±0.03

*All values were expressed as mean± S.D; †Number of trials (*n*)=5

Table 4: Rheological data of *F. reticulata* fruit mucilage compared with sodium carboxy methyl cellulose

Concentration (%w/v)	Viscosity (mPas)	
	F. reticulata fruit mucilage	Sodium carboxy methyl cellulose
0.1	6.26±0.03	5.62±0.01
0.2	7.81±0.07	7.55±0.05
0.3	9.02±0.09	8.95±0.04
0.4	10.95±0.08	9.84±0.06
0.5	11.54±0.05	10.44±0.09

*All values were expressed as mean±S.D; †Number of trials (*n*)=5

Table 5: FTIR spectral data of *F. reticulata* fruit mucilage

Absorption peak value	Absorption range	Specific type of bond
3155.3	2400–3200	N-H bond (ammonium ions)
2935.5	2925	C-H bond (alkyl, methyl)
2885.3	2400–3200	N-H bond (ammonium ions)
2098.4	2140–1990	C-N bond (any)
1635.5	1615–1700	C=N bond (any)
1635.5	1560–1640	N-H bond (primary amine)
1234.4	1220–1260	C-O bond (ethers, aromatic)
1110.9	~1100	C-O bond (alcohols, secondary)
991.3	990	C-H bond (vinyl, mono substituted alkenes)
852.5	800–860	C-H bond (aromatic, para-di substituted Benzene)

Flow properties

The dried *F. reticulata* fruit mucilage was tested for the flow properties[23] viz., angle of repose, bulk densities, compressibility index and hausner's ratio. All these evaluations were carried out as per procedures described in official books. All these experiments were conducted for five times.

Rheological studies

The *F. reticulata* fruit mucilage was tested for Rheological properties (viscosity) by comparing with sodium carboxy methyl cellulose.

Fourier transform infrared spectroscopy

Fourier transform infrared (FTIR) spectrums of dried mucilage were recorded on samples prepared in potassium bromide disks using FTIR spectrophotometer (Shimadzu 1601 PC, Tokyo, Japan). Samples were prepared in KBr disks. The scanning range was 500 to 4000/cm.

RESULTS

Results of Physical Characterization

The extracted mucilage was yellow in colour with a characteristic odour and soluble in water produces yellowish viscous solution. The fruits gave 28±2.457 g of yield per kg. The average particle size of dried mucilage was 159.32±9.543 µm (assessed by microscopy). The average particle size of dried mucilage was found to be uniform. The weight loss on drying was 2.58±0.159 and the percentage of swelling was 47.0±2.575%, which was found to be satisfactory. The dried mucilage was melted and charred at 152±6.851°C. The density of 1.0% w/v solution was 1.058±0.018 and a pH of 7.1±0.111. The mucilage has negligible bio burden.

Results of Chemical Characterization

The mucilage gave positive test for carbohydrates and uronic acid (common for all mucilages) and negative test for tannins, chlorides and sulphates. The amount of foreign matter was negligible. The heavy metal concentration was also found to be within the limits. All these values were shown in Table 2.

Results of Flow Properties

The angle of repose of the dried *F. reticulata* fruit mucilage was 25.77±1.68° indicates an excellent flow properties (25-30°) as per Indian Pharmacopoeia. The Loose bulk density and Tapped bulk density values were 0.53±0.05 and 0.67±0.05 g/cm^3 respectively. These Bulk density values were considered for calculating compressibility index and Hausner's ratio. The compressibility index of the dried mucilage was 20.8±0.04% indicates fair flow properties (18-21%) and Hausner's ratio was found to be 1.26±0.03. These data revealed that *F. reticulata* fruit mucilage can be used as binder in tablet formulations and other pharmaceutical formulations. All these values were shown in Table 3.

Results of Rheological Studies

The viscosity of *F. reticulata* fruit mucilage was slightly better than sodium carboxy methyl cellulose and shown in Table 4.

Results of Fourier Transform Infrared Spectrum

The FTIR spectrum of *F. reticulata* fruit mucilage showed sharp and characteristic peaks indicates the purity of the mucilage. FTIR (KBr) nmax at 3155.3 (NH), 2935.5(CH), 2885.3 (NH), 2098.4 (CN), 1635.5 (NH), 1234.4 (CO), 1110.9 (lactone C=O), 991.3 (CH) and 852.5 (CH) cm^{-1}. The FTIR spectral values and probable bonds present were represented in Table 5 and shown in Figure 1.

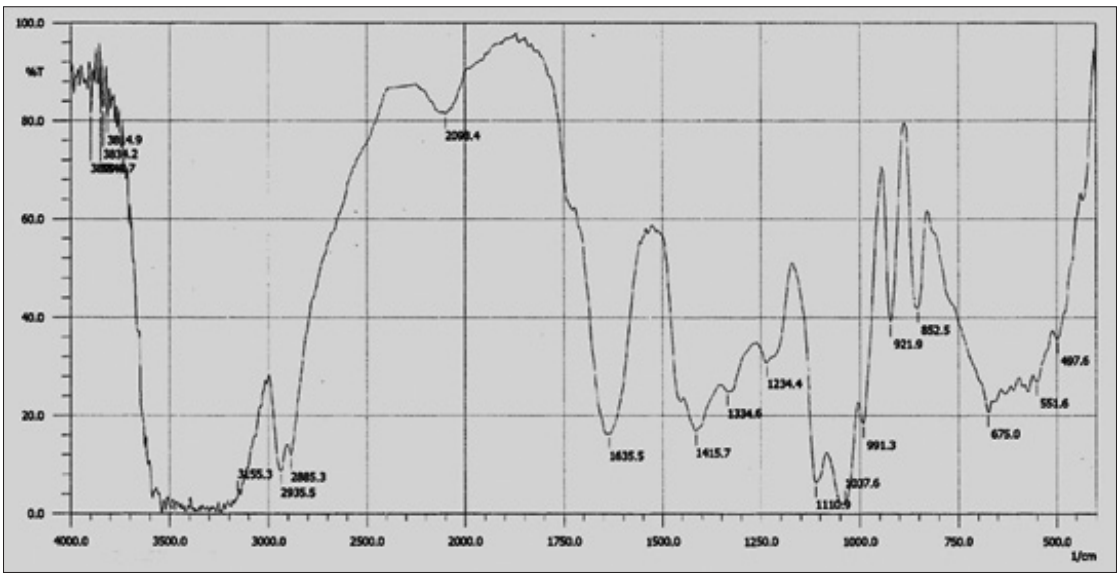

Figure 1: FTIR spectrum of *F. reticulata* fruit mucilage

CONCLUSIONS

This study revealed that *F. reticulata* fruit mucilage has good physicochemical characteristics with good flow properties. The mucilage can be used as viscosity modifying agent in liquid orals and as an excipient in tablet formulations and as matrix forming material in pharmaceutical dosage forms.

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