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Extraction and Characterization of *Boswellia Serrata* Gum as Pharmaceutical Excipient

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A – research concept and design; **B** – collection and/or assembly of data; **C** – data analysis and interpretation; **D** – writing the article; **E** – critical revision of the article; **F** – final approval of the article

Abstract

Background. This manuscript deals with the purification and characterization of *Boswellia serrata* gum as a suspending agent. The *Boswellia serrata* gum was purchased as crude material, purified and further characterized in terms of organoleptic properties and further micromeritic studies were carried out to characterize the polymer as a pharmaceutical excipient. The suspending properties of the polymer were also evaluated. The results showed that the extracted gum possesses optimum organoleptic as well as micromeritic and suspending properties.
Objectives. To characterize *Boswellia serrata* gum as a natural excipient.
Material and Methods. *Boswellia serrata* gum, paracetamol, distilled water.
Results. The results showed that the extracted gum possesses optimum organoleptic as well as micromeritic and suspending properties.
Conclusions. It is concluded from the research work that the gum extracted from *Boswellia serrata* shows the presence of carbohydrates after chemical tests. All the organoleptic properties evaluated were found to be acceptable. The pH was found to be slightly acidic. Swelling Index reveals that the gum swells well in water. Total ash value was within the limits. The values of angle of repose and Carr's Index of powdered gum powder showed that the flow property was good. IR spectra confirmed the presence of alcohol, amines, ketones, anhydrides and aromatic rings. The suspending properties of *Boswellia serrata* gum were found to be higher as compared to gum acacia while the flow rate of *Boswellia serrata* gum (1% suspension) was less than gum acacia (1% suspension). The viscosity measurement of both *Boswellia serrata* gum suspension and gum acacia suspension showed approximately similar results **(Polim. Med. 2015, 45, 1, 25–30)**.

Key words: natural polymer, *Boswellia serrata* gum, drug delivery, pharmaceutical excipients, purification.

In the development of novel drug delivery systems, natural polymers and their semi-synthetic derivatives have gained popularity in recent years [1]. Their advantages of being bio-degradable, bio-compatible, easily modified, low cost, readily available, and have non irritant nature and lack of toxicity make them a versatile carrier and thus preferred over the synthetic and semi-synthetic polymers [1–4]. These plant-derived agents such as gums and mucilage can serve in a variety of pharmaceutical formulations such as a diluents, binders, disintegrants, suspending and emulsifying agents, thickeners and gelling and foaming agents [2, 5–7]. As well, they can be used as sustained and controlled release agents [4].

Gums are the pathological products of plants. These are formed when an injury is made on the plant by the breakage of cell walls, a process called as gummosis. Gums are also formed extracellularly in unfavorable conditions like drought [4, 6, 8, 9]. Gums readily dissolve in water while mucilage forms a slimy mass [4, 8, 9]. They offer the advantages of being biocompatible, cheap and easily available, thus their demand is increasing day by day. Also, they are preferred over semi-synthetic and synthetic excipients because of their lack of toxicity, soothing action, low cost and non-irritant nature [2, 5, 10]. Gums and mucilage are widely used for the preparation of conventional and novel drug delivery systems [5, 6].

Natural gums are high molecular weight hydrophilic carbohydrate polymers which, on hydrolysis, yield a mixture of sugars and uronic acids like arabinose, galactose, mannose and glucuronic acid. These hydrocolloidal substances are translucent, amorphous in na-

ture and are the polymers of a monosaccharide or mixed monosaccharides joined by glucosidic bonds, in combination with uronic acids. Gums either solubilize in water or absorb water to swell up but are insoluble in oils and organic solvents. On reacting with cold water, gums form viscous solutions or gels [4, 5, 11]. Gums are used as emulsifying, thickening, suspending, binding, stabilizing, disintegrating and solubilizing agents and also in sustained and controlled release formulations [3, 12].

Material and Methods

Collection, Identification and Purification of Plant Material

Crude plant material (*Boswellia serrata* gum*)* was purchased from a local shop in Greater Noida, India. The collected plant material was identified by the Department of Biotechnology, Gautam Buddha University (State Govt. University), Greater Noida. The plant material was purified as follows:

As described by the author elsewhere, the crude material was soaked in warm water for 4 h, boiled for 2 h and kept aside for 2 h for the release of gum into the water. The material was squeezed in a muslin bag to remove the mark from the filtrate. To isolate the gum, an equal volume of ethyl alcohol was added to the viscous gum solution, the gum was separated, dried in an oven at about 45°C, powdered and passed through a #80 sieve. The powdered gum was stored in desiccators until further use [13].

Physicochemical Characterization of Isolated Gum

Identification tests for carbohydrates, proteins and tannins: As described by the author elsewhere, an aqueous solution (1%) of the extracted gum was used for chemical characterization. Tests for carbohydrates, proteins, starch, fats and tannins were performed according to standard procedures [13].

Solubility: As described by the author elsewhere, the solubility of the gum was identified by taking one part of dry gum powder and shaking it with different solvents and then the solubility was determined [13].

Organoleptic evaluation of isolated gum: As described elsewhere, the isolated gum was characterized for organoleptic properties such as color, odor, taste and fracture [13].

pH of gum: As described by the author elsewhere, the pH of 1% w/v solution of the gum was measured using a digital pH meter [13].

Swelling index of isolated gum: As described by the author elsewhere, the swelling index is the volume (in mL) taken up by the swelling of 1g of test material under specified conditions. The swelling index of the gum was determined by accurately weighing 1 g of gum, which was further introduced into a 25 mL glass-Stoppard measuring cylinder. 25 mL of water was added and the mixture was shaken thoroughly every 10 min for 1 h. It was then allowed to stand for 3 h at room temperature. Then the volume occupied by the gum was measured. The same procedure was repeated thrice and the mean value was calculated [13].

Viscosity of gum: As described elsewhere, the viscosity of 1% w/v solution of the gum was measured using an Ostwald's viscometer [14].

Surface tension of gum: As described elsewhere, the surface tension of 1% w/v solution of the gum was measured using a Stalagmometer [14].

Bulk density and bulkiness: As described by the author, bulkiness is the inverse of bulk density. For the determination of bulk density, an accurately weighed quantity of 5 g was introduced into a graduated measuring cylinder and the cylinder was fixed on the bulk density apparatus. The volume occupied by the powder was noted down. Tapped density was calculated by tapping the powder in a bulk density apparatus until a constant volume was obtained. The final volume was noted [13].

Powder flow property: As described by the author elsewhere, the flow property of the powder was calculated by measuring the angle of repose. Using the formula, the angle of repose was calculated thrice [13].

Powder compressibility: As described by the author elsewhere, the compressibility of the powder is determined using Carr's Index. For this, finely powdered gum (5 g) was transferred into a measuring cylinder and, using the bulk density apparatus, calculations were done [13].

Particle size analysis: As described elsewhere, the particle size was determined using microscopy. Microscopy was done using a Hicon microscope [14].

Ash value: As described by the author elsewhere, the ash value was calculated by weighing 2 gm of *Boswellia serrata* powder in a tared silica crucible. It was then incinerated in a muffle furnace up to 450°C, till the powder completely changes to ash. The crucible was then kept in a desiccator after complete incineration. The weight of the ash was noted and total ash was calculated in terms of a percentage [15].

IR: As described elsewhere, *Boswellia serrata* powder was dried in an oven at 70–80°C for 4 hr and desiccated overnight prior to FTIR analysis. FTIR spectra were recorded at an absorbance mode from 4000 to 400 cm^{-1}. The FTIR analysis was done by ATR, Alpha (Bruker) [16].

Evaluation of Suspending Properties of Gum

Preparation of suspension: As described by the author elsewhere, paracetamol suspensions were prepared by adding the natural polymer (0.1 g) in 3ml of distilled water, triturated with mortar and pestle. The paracetamol was added (1 g), triturated well and transferred to a 10 mL measuring cylinder. The cylinder was filled up to the volume with distilled water and then shaken vigorously for 2 min, thus making 1% w/v of the gum in the preparation. The same procedure was repeated for 2%, 3% and 4% w/v of the natural gum [17].

Sedimentation volume: As described by the author elsewhere, 10 mL of each suspension was stored in a 10 mL measuring cylinder for 7 days at 35ºC. Observations were made at every hr for 7 hr and then every 24 hr for 7 days. The sedimentation volume, F (%), was then calculated by using the following equation [17]:

$$F = 100\ Vu/Vo. \quad (1)$$

where, Vu is the ultimate volume of the sediment and Vo is the original volume of the suspension.

Rheology: As described by the author elsewhere, the time required for each suspension sample to flow through a 5 mL pipette was determined and the apparent viscosity (one gm per cm per sec) was calculated using the equation [17]:

$$\text{Flow rate} = \frac{\text{Volume of pipette (mL)}}{\text{Flow time (s)}}. \quad (2)$$

As described by the author in a previous publication, the viscosity (in poise) of the suspension (in different concentrations) was determined by using an Ostwald viscometer. All the observations were made in triplicate [14].

Results and discussion

After isolating the mucilage from *Boswellia serrata* using ethyl alcohol, the percentage yield of gum was found to be 6.96%. Phytochemical investigation showed the presence of carbohydrates while reducing sugar, glucose, tannins, proteins and polysaccharides were absent. The results of the phytochemical test are summarized in Table1.

The organoleptic properties of the gum were observed and were found to be acceptable. The color of the powdered gum was grayish-brown. The odor and taste were found to be characteristic and agreeable. The fracture was rough. The solubility profile of the gum is shown in Table 2.

Solubility analysis showed that *Boswellia serrata* gum was soluble in hot water, swells and forms a gel with cold water and was insoluble in most of the organic solvents. The different parameters of the gum were evaluated and are shown in Table 3.

Table 1. Chemical characterization of isolated mucilage

Tests	Present/Absent
Carbohydrates	+
Reducing Sugar	–
Glucose	–
Tannins	–
Proteins	–
Polysaccharides (starch)	–
Fats	–
Volatile oils	–

+ Present; – Absent.

Table 2. Solubility profile of gum

Solvents	Solubility
Cold water	Swell to form a gel
Hot water	Soluble
Methanol	Insoluble
Ethanol	Insoluble
Diethyl ether	Insoluble
Petroleum ether	Insoluble
Acetone	Insoluble

Table 3. Parameters of gum

Parameters	Observations
pH (1% w/v solution)	5.60 ± 0.01
Swelling Index (%)	45.45 ± 0.02
Viscosity (1% w/v solution in $N \times sec \times m^{-2}$)	5.78 ± 0.60
Surface tension (1% w/v solution in $gm \times cm \times sec^{-2}$)	51.64 ± 1.77
Bulk density (g/cm^3	0.23 ± 0.01
Tapped density (g/cm^3)	0.27 ± 0.01
Bulkiness (cm^3/g)	4.19 ± 0.19
Hausner's ratio	1.14 ± 0.00
Carr's index (%)	12.91 ± 0.00
Angle of repose (°)	27.46 ± 0.74
Particle size (μm)	41.98 ± 10.75
Total Ash (%)	3.00 ± 0.01

The pH of *Boswellia serrata* gum (1% solution) was found to be 5.6 ± 0.01. Total ash calculated was 3% ± 0.01. Bulk density and tapped density were calculated as 0.23 ± 0.01 g/cm^3 and 0.27 ± 0.01 g/cm^3, respectively. Bulkiness was found to be 4.19 ± 0.19 $cm^{3/}g$. Hausner's ratio and Carr's index calculated were 1.14 ± 0.00 and 12.91 ± 0.00%. The angle of repose of 27.46° ± 0.74 suggested that the powdered gum possess-

es good flow property. The average size of 50 particles calculated was 41.98 μm ± 10.75. The surface tension calculated was 51.64 gm × cm × sec^{-2} ± 1.77 and viscosity was 5.78 N × sec × m^{-2} ± 0.60. The swelling index of the gum was found to be 45.45% ± 0.02, which suggests that the gum has optimum swelling property. Figure 1 shows the IR spectra of the purified gum and is illustrated in Table 4.

The IR spectra of *Boswellia serrata* gum shows the wavenumbers (cm^{-1}) 3744.30, 3607.65, 1793.78, 1740.33, 1515.38, etc., which confirms the presence of alcohol, amines, ketones, anhydrides and aromatic rings.

Sedimentation volume analysis suggests that the Sedimentation Volume (%) of *Boswellia serrata* gum with 1% concentration sediments least after 24 hrs while 2% concentration sediments least after 7 days. The Sedimentation Volume (%) of gum acacia with 1% and 5% concentration sediments least after 24 hrs while 5% concentration sediments least after 7 days. The flow rate of *Boswellia serrata* (1%) gum and gum acacia (1%) was found to be highest among all the others. Table 8 summarizes the effect of different concentrations of polymers on viscosity.

Table 4. IR study of *Boswellia serrata* gum

S. No.	Wavenumbers (cm^{-1})	Group present
1.	3744.30	-NH_2
2.	3607.65	-OH
3.	2920.17	CH_2-CH_2 (asymmetric)
4.	2381.27	CH_2-CH_2 (symmetric)
5.	1793.78	-C=O (ketone)
6.	1740.33	-C=O (Anhydride)
7.	1677.65	-C=C
8.	1515.38	-C-C (Aromatic)
9.	1396.78	-C-NO_2
10.	726.24	-C-H

Tables 5 and 6 illustrate the effect of concentration of the suspending agents on sedimentation volume and flow rate.

It is concluded from the research work that the gum extracted from *Boswellia serrata* shows the presence of carbohydrates after chemical tests. All the organoleptic properties evaluated were found to be

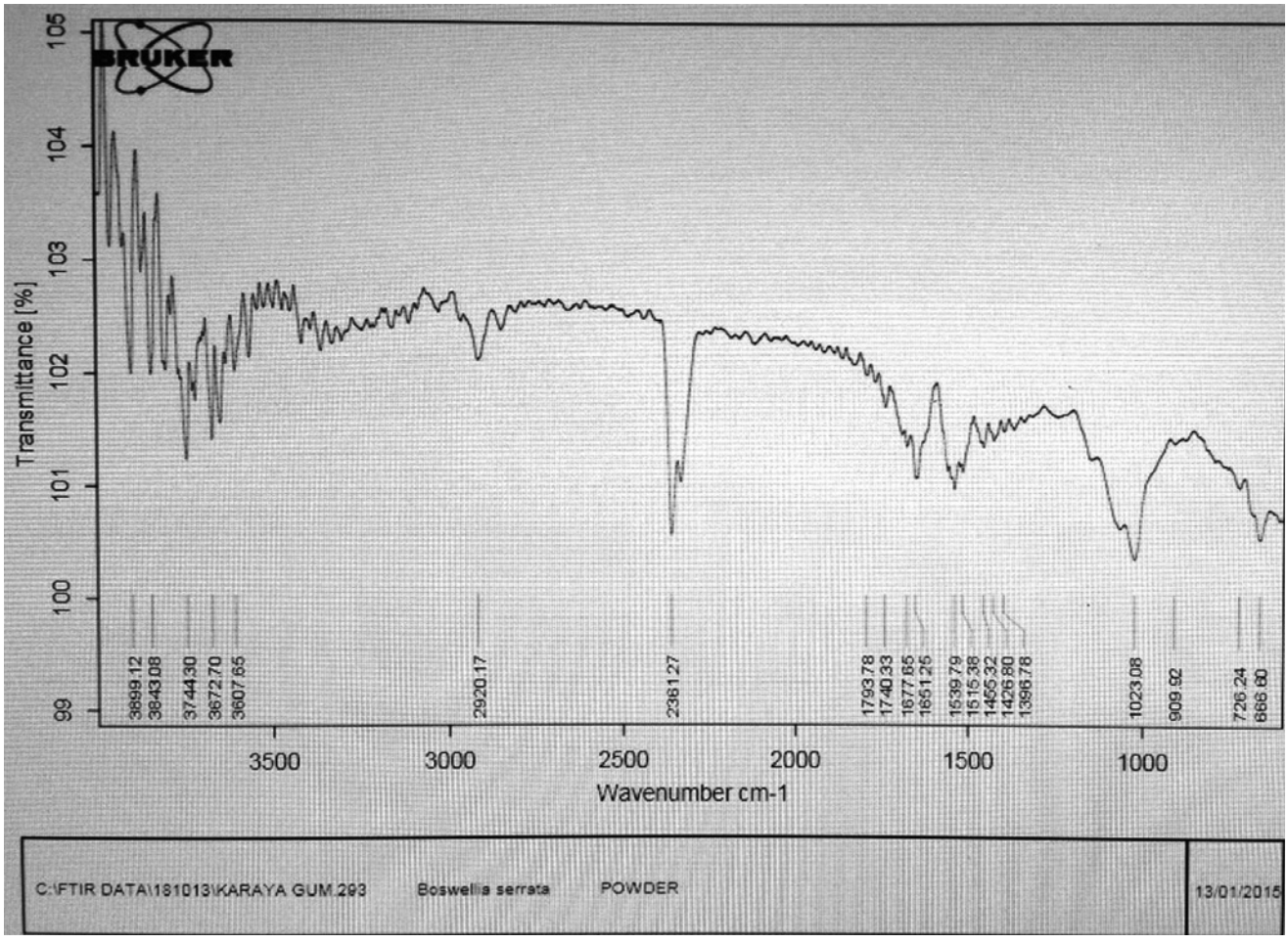

Fig. 1. IR spectra of *Boswellia serrata* gum

Table 5. Values of Sedimentation Volume (%) of suspension using different concentrations of *Boswellia serrata* gum

Sedimentation Volume (%)								
Polymer	Concentration (% w/v)	Time (Days)						
		1	2	3	4	5	6	7
Boswellia serrata gum	1	18.0	18.3	18.5	18.5	19.0	19.5	19.7
	2	20.0	20.4	20.5	20.8	20.8	21.3	21.5
	3	19.0	22.2	22.8	23.0	23.7	24.0	24.0
	4	16.0	18.8	19.4	20.2	21.5	22.0	22.0
	5	21.0	22.8	23.4	24.6	25.2	25.8	25.8

Table 6. Values of Sedimentation Volume (%) of suspension using different concentrations of gum acacia

Sedimentation Volume (%)								
Polymer	Concentration (% w/v)	Time (Days)						
		1	2	3	4	5	6	7
Gum Acacia	1	16.0	16.0	16.4	16.8	16.8	17.0	17.0
	2	16.0	16.2	16.2	16.4	16.7	16.7	16.7
	3	17.3	17.3	17.5	17.5	17.8	17.8	17.8
	4	17.5	17.8	17.8	17.9	17.9	17.9	17.9
	5	17.0	17.0	17.0	17.2	17.2	17.2	17.2

Table 7. Effects of the type and concentration of suspending agents on the flow rate of paracetamol suspensions

Suspending Agents	Conc (% w/v)	Flow Rate (mL s^{-1})
Boswellia serrata Gum	1	2.10
	2	2.06
	3	1.76
	4	1.72
	5	1.67
Gum Acacia	1	3.47
	2	2.42
	3	2.10
	4	1.90
	5	1.76

Table 8. Effect of different concentrations of polymer suspension on viscosity

S. No	Conc. (%)	Viscosity (Poise)	
		Polymer A	Polymer B
1.	1	9.72	9.36
2.	2	12.38	12.17
3.	3	15.16	15.20
4.	4	17.34	17.33
5.	5	20.55	21.30

Polymer A = gum acacia, Polymer B = *Boswellia serrata* gum.

acceptable. The pH was found to be slightly acidic. The Swelling Index reveals that the gum swells well in water. Total ash value was in the limits. The values of angle of repose and Carr's Index of the powdered gum powder show that the flow property was good. IR spectra confirmed the presence of alcohol, amines, ketones, anhydrides and aromatic rings. The suspending properties of *Boswellia serrata* gum were found to be higher as compared to gum acacia while the flow rate of *Boswellia serrata* gum (1% suspension) was less than gum acacia (1% suspension). The viscosity measurement of both *Boswellia serrata* gum suspension and gum acacia suspension showed approximately similar results.

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