RESEARCH ARTICLE

Extraction and Characterization of Okra and Almond Gum as a Pharmaceutical Aid

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ABSTRACT

This study centers on the retrieval and analysis of almond gum and okra for their possible use as medicinal additives. Various measures were used to evaluate the extracted gum, including micrometric analyses, flow properties, organoleptic qualities, swelling index, ash value, Carr's index, and Hausner ratio. Extracted okra gum had outstanding flow properties, as shown by its total ash content of 0.56% w/w, Carr's index of 71.10%, and Hausner's ratio of 3.46. The measured pH value was 6.9. Although the gum could not dissolve in organic solvents, it was able to dissolve in warm water. This indicates that the formulation of the chemical may be used without experiencing any negative consequences.

Keywords: Extraction, Characterization, Okra gum, Almond gum, Pharmaceutical aid.

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INTRODUCTION

At the moment, there is a rising tendency all over the world toward the use of natural excipients along with medicines. Due to the extensive variety of medicinal applications that plant-derived polymers may be used for, there has been a recent surge in interest in these materials. These substances have a wide range of uses, including those of a diluent, binder, disintegrant, thickening, protective colloids, gelling agent, and base in many pharmaceutical products. The gum is preferred over synthetic and semi-synthetic additions due to the fact that it is less harmful to the environment, more cost-effective, has relaxing benefits, and does not irritate the skin (Figure 1). In addition to that, it is easily accessible. To what extent do gums perform their duties and what are their characteristics? It is common for gums to be helpful metabolic byproducts that are created either inside the cells of a plant (intracellular production) or without causing any damage to the plant.[1-3]

Numerous tropical and subtropical locations across the world, including India, are responsible for the majority of the cultivation of okra, which is a prominent perennial plant. Vegetable pods that have not yet matured contain a significant amount of resin. Considering that the okra is gathered on a consistent basis, there is no need for a toxicological assessment.[4] The qualities of this chemical that are responsible for tablet binding have been carefully investigated, and it has been shown that it is capable of providing tablets with superior drug release characteristics, resistance to breaking, and structural integrity. When opposed to synthetic materials, natural materials provide a number of advantages, including their abundant availability, low cost, and the lack of any potentially hazardous chemicals. In comparison to the majority of commercially available synthetic polymers, it is non-irritating, biodegradable, biocompatible, chemically inert, and environmentally harmless. These are just some of the numerous advantages it has. The polysaccharides galactose, galacturonic acid, and rhamnose are the components that make up the gum that is extracted from okra beans. Polysaccharides like this produce a solution that has a high viscosity when they are submerged in water by themselves.[5,6]

MATERIALS AND METHODS

Selection and Collection of Raw Material

The following constituents (Table 1) were used in the fabrication procedure of the herbal excipient:

Collection and Authentication of Parts of Plant

Collection of all plant parts was obtained from a botanical garden and local market (Figure 2). The plant was authenticated by a taxonomist.

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Figure 1: Characteristics of excipient

Figure 2: Plant part collected from botanical garden and local market

Extraction Procedure

Okra and almonds were acquired at the nearby market. Following a thorough washing procedure, the collected okra was dried in a shaded area at temperatures ranging from 30 to 40°C for a whole day, or until it reached a consistent weight. The dimension was decreased by using a grinder. The fruit powder was strained using a sieve with a mesh size of #22 and then kept in a safe container for future use. Gum extraction requires two methods.[7-9]

Step 1: Extraction of gum

In order to preserve the crushed fruit, 500 cc of distilled water is used. The mixture should be subjected to a temperature of 60°C for a duration of roughly four hours, with constant stirring. Once the concentrated solution has been strained through muslin cloth, lower its temperature to a range of 4 to 6°C.

Table 1: Raw materials used in herbal excipient formulation

S. No.	*Botanical name*	*Vernacular name*	*Parts used*
1.	*Terminalia catappa*	Almond (Country almond)	Latex gum
2.	*Abelmoschus esculentus*	okra gum	fruits

Figure 3: Extracted okra and almond gum

Step 2: Isolation of gum

he gums that was extracted was separated by using acetone and then filtered through muslin cloth. Muslin fabric was used to filter the substance after it was cleaned with acetone. The gum was dehydrated by subjecting it to a consistent temperature range of 35 to 45°C in a hot air furnace until it reached a stable weight. The solid gum cake was strained using sieve number #22 before being stored in a desiccator for future use (Figure 3).

Physicochemical Description of Gum

The aqueous extract was combined with Molish's reagent before adding sulfuric acid. An observation was made of a violet-colored ring at the polymer. The calculation of surface tension was performed using the equation junction, which indicated the presence of carbohydrates.[10]

Solubility test

According to the standards set by the British Pharmacopoeia, the gum was isolated and its ability to dissolve in water, acetone, chloroform, and ethanol was evaluated.

Swelling index

The volume of each sample was recorded using a 15 mL polypropylene centrifuge tube together with a 1.0 g weight. A 10 mL cylinder containing distilled water was completely filled with 10 mL of water and then closed tightly. The components were mixed using a vortex mixer for a length of two minutes.[11]

Loss on drying

The approach used followed guidelines outlined in B.P. 2004 for acacia. After transferring 1.0 g of sample to a petri plate, it was dried in an oven that had been heated to 105°C until its weight stopped changing. After calculating the percentage of weight lost due to moisture, we divided it by the sample weight to get the moisture content.

Total ash and acid insoluble ash determination

Ash concentration was estimated by measuring the remaining material after it was burned in a furnace set at a temperature of 450°C. Ash produced from total ash determination was immersed in a 2M hydrochloric acid solution and boiled for five minutes. Subsequently, the component that could not be dissolved was separated using filtration, rinsed with heated water, and subjected to combustion, and its mass was measured. The proportion of ash that displayed acid insolubility was computed.[12]

pH determination

The procedure included agitating a 1% weight/volume solution of the sample in water for a duration of 5 minutes, followed by measuring pH using a pH meter.[13]

Angle of repose

The methodology of the fixed funnel and freestanding cone was used to obtain the static angle of repose, θ. A graph paper was affixed to a flat and even surface using a funnel, with tip of the funnel positioned 2 cm above the paper. Granules were added gradually to the funnel, resulting in the formation of a cone (h) where the apex touched tip of funnel. Equation 1 was used to compute the tangent of angle of repose and mean diameters (D) of the powder cone bases.

$$\text{Tan } \theta = 2h / D \quad \text{(Equation 1)}$$

Bulk and tap densities

The weight of each powder sample was 2.0 g, and the volume (Vo) it filled in the 10 mL measuring cylinder without tapping was recorded. It took one hundred table blows to determine occupied volume V100. Bulk and tap densities were determined by calculating the weight to volume ratio.[14]

Hausner index

This was calculated as the ratio of tapped density to bulk density of the samples.

Compressibility index (C%)

The following equation was used to determine this:

$$\text{Compressibility} = (\text{Tapped density} - \text{Bulk density}) / \text{Tapped density} \times 100 \quad \text{(Equation 2)}$$

Thermogravimetric analyses

TG investigations were conducted using TG equipment. The specimen (0.9912 mg) was subjected to a gradual increase in temperature from the ambient level to 200°C, with a heating rate of 10°C per minute. The purge gas used was nitrogen, with a flow rate of 20 mL per minute.[15]

Differential scanning calorimetry analyses

A Netzsch 2.4.11 differential scanning calorimetry (DSC) 204 F1 Phoenix was used to assess the AEG's thermal properties. The nitrogen purge gas was used at a flow rate of 20 mL/min. An aluminum pan was used to hold the crushed particles, which weighed 2.7 mg. From there, it was heated to 400 from 30°C, cooled to 30°C, then heated again at the same rate.

Fourier transform infrared

IR of sample was obtained using an IR spectrometer. Dry potassium bromide (KBr) powder was combined with the material in a ratio of 1:200 before being compacted into discs for analysis.[16]

RESULTS AND DISCUSSION

Isolation Evaluation of Okra and Almond Gum

The gum obtained from okra and almond fruit was extracted and subjected to a series of official and non-official tests for evaluation.

Evaluation of Okra gum

Solubility

Analysis of okra's solubility Benzene, methanol, and acetone were found to be insoluble in gum, whereas cold water showed moderate solubility. Warm water showed high solubility. These results are shown in Table 2.

Physico-chemical characterization of okra gum

The separated gum was subjected to organoleptic examination to assess its attributes including color, odor, taste, fracture, and texture. The ash content of the sample was measured. The results are shown below (Table 3).

Viscosity of okra gum

The results are displayed in Table 4, which demonstrates the viscosity of isolated okra gum as measured using a Brookfield viscometer with spindle no. 64.

FTIR spectra of okra gum

IR of okra exudate was obtained using a Bruker IR spectrophotometer, using KBr pellet approach (Figure 4). Results of a spectrum scan, with a resolution of 4 cm^{-1}, covering a complete frequency range from 4000 to 400 cm^{-1}, are shown in Table 5. The presence of two distinct peaks in the fingerprint area of the spectrum, namely at 700 and 1316 cm^{-1}, may be attributed to the stretching of C-O bond. Band seen at 1604 cm^{1} was conclusively recognized as O-H bending vibration of water. The indication of ester bonds in the 1521.98 cm^{1} area is given by the contribution of the carbonyl stretch. The

Table 2: Solubility behavior of okra gum

Name of solvent	*Solubility parameter*
Cold Water	Slightly soluble
Warm Water	Solubility
Acetone,	
Ethanol,	
Benzene,	Insoluble
Glycerine,	
Paraffin	

Table 3: Physiochemical characterization of okra gum

Parameters	*Observations*
Appearance	Amorphous
Taste	Mucilaginous
Odour	Characteristics
Swelling Index	29.23
pH (1% solution)	6.9
Acid insoluble ash	0.15%
Ash value-Total ash	0.56%
water-insoluble ash	0.13%

Table 4: Viscosity of okra gum

Speed (rpm)	*Spindle used*	*Viscosity (cps)*
10	64	120.3
20	64	116.8
30	63	93.8

Table 5: Interpretation of FTIR spectra of okra gum

Functional group	*Frequency (cm^{-1})*
OH bending of water	1521.98
OH Stretching	3530.65
CO (Carboxylic acid)	1236.82

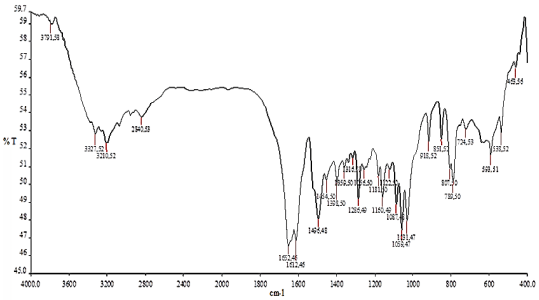

Figure 4: FTIR spectra of okra gum

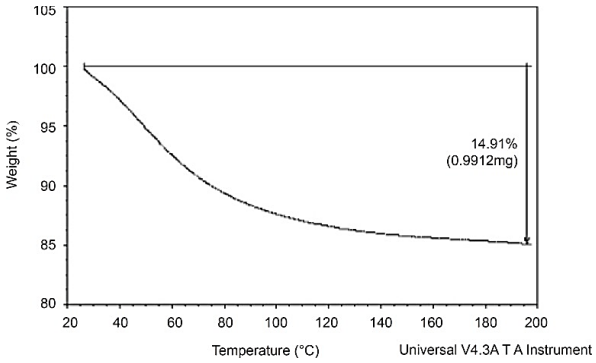

Figure 5: TG curve of okra gum

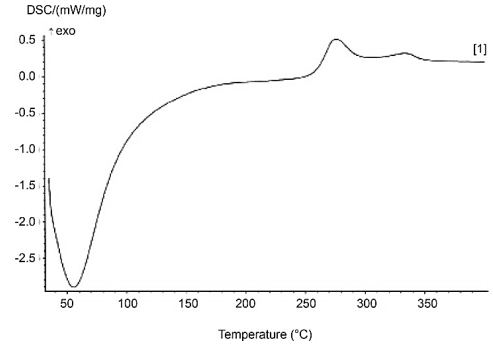

Figure 6: DSC thermogram of okra gum

presence of vulnerable sections in the spectral range of 1650 to 1690 cm^1 indicates that lignin constitutes the majority of this material.

Thermogravimetric analyses

An analysis of TG spectrum was performed in order to determine amount of weight loss that occurred as a consequence of heating the material. The use of TG analysis allows for the identification of transitions that include the transfer of mass. The link between temperature, time, and the transfer of mass may be measured and quantified using this analytical approach. There is a possibility that the evaporation of water that takes place between temperatures of 25 to 195ºC is responsible for the single-step drop in weight that can be seen in the thermogravimetric (TG) curve of the gum (Figure 5).

Differential scanning calorimetry

A technique known as DSC was used in order to determine whether or not an increase in temperature brought about exothermal or endothermal alterations.

Due to its sensitivity and precision, DSC has been used extensively in the investigation of phase transitions of polymers (Figure 6).

Evaluation of Almond Gum

Solubility testing

Despite experimenting with various solvents, the crude latex gum remained insoluble (Table 6).

Determination of swelling index

Gum granule had a starting weight of 2.64 grams, and after that, the weight of the granule was measured every thirty minutes for a period of six hours. 5.28, 6.20, 8.01, and 9.61 grams were the corresponding weights. According to the results of the calculation, the swelling index was 50, 57, 67, and 72.5% (Figure 7).

Table 6: Solubility of latex gum in various solvents

Solvents	*Solubility*
DMSO	Non-dissolvable
HCL	Dissolvable
Water	Partially dissolvable
Acetone	Non-dissolvable
Ethanol	Non-dissolvable
Methanol	Non-dissolvable

Moisture content

Comparison of moisture content of latex gum at different drying times at a temperature of 105ºC. The graph demonstrates the gradual decrease in initial moisture content from 16 to 4%, 2, and 1% at 10-minute intervals over a period of 70 minutes until it achieved a condition of equilibrium. To enhance the desiccation process and achieve a greater reduction in moisture content, one may optimize by augmenting the energy input and using higher temperatures. Hence, the duration required for a material to lose moisture and reach a certain level of dryness is influenced by the temperature.

Fourier transform infrared spectroscopic

The FTIR analysis revealed a signal at 3266 cm^{-1}, indicating the presence of hydrogen crosslinking between water molecules and demonstrating O-H stretching. This peak corresponds

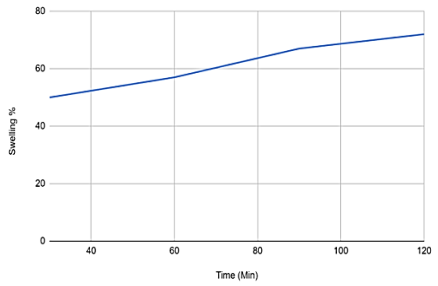

Figure 7: The swelling index percentage as time increases

to the chemical type alcohol and phenols (Figure 8). The presence of a peak at 1721 cm^{-1} suggests the stretching of the -C- bond, which is characteristic of aldehydes and ketones. The presence of a peak at 1601 cm^{-1} indicates the stretching of the carbon-carbon double bond (C=C), characteristic of compounds known as alkenes. The frequency of 1372 cm^{-1} corresponds to the bending motion of the C-H bonds, indicating the presence of an alkane molecule. The presence of a peak at 1241 cm^{-1} suggests the elongation of the C-N bond, indicating the presence of amines in the molecule. Finally, the peak at 1036 cm^{-1} corresponds to the stretching of the C-O bond in a primary alcohol molecule. Samrot *et al.*[20] demonstrated that the gum from *Terminalia catappa* L. exhibited a prominent peak at 3417 cm^{-1}, indicating O-H stretching. Additionally, peaks were seen at 2940 and 1300 to 1450 cm^{-1}, corresponding to alkenes, and at 1725 cm^{-1}, indicating the presence of an aldehyde group.

Phytochemical screening

An analysis was conducted on the gum extract to determine the presence of alkaloids using Wagner's and Hager's tests. A brownish-reddish solid formed during Wanger's test, indicating a positive result; a yellow solid indicated the presence of alkaloids in Hager's test. The good outcomes of the ninhydrin test, which revealed the presence of a blue tint, indicated that the gum extract contained protein and amino acids. Phytosterols were detected in the gum extract using Salkowski's assay, as shown by the presence of a yellow-gold color, suggesting the potential presence of triterpenes. Conversely, no alteration in hue was seen in relation to phenols, flavonoids, saponins, and reducing sugar, all of which had unfavorable outcomes.

DISCUSSION

The solubility of almond and okra mucilage was tested in several solvents including benzene, ether, chloroform, n-butanol, ethanol, acetone, glycerine, and paraffin. It was found that both mucilages were insoluble in these solvents. However, they showed a reasonable level of solubility in tepid water. When water was added, the combination of okra and almond powder underwent an expansion and formed a thick and sticky dispersion. The moderate solubility of almond gum and okra enables the creation of controlled-release formulations by forming a strong matrix polymeric structure via the viscous and expandable dispersion. This structure may regulate the release of drug molecules. Okra and almond gum, which exhibit their highest levels of thickness in the pH range that is neither acidic nor alkaline, may be effectively used as agents that slow down the release of medication in the production of sustained-release tablets.[17] This is because they help to alleviate the consequences of medication molecule release. Uncoated pills are appropriate for a pH that is neither acidic nor basic, and they also cause little discomfort in the gastrointestinal system. The irregular particle size was measured to be 49.50 µm. The mucilage of okra was found to have the following attributes: a brownish color, no discernible smell or flavor, a gritty texture, and an asymmetrical form. To assess the properties of mucilage, we determined the ash values, which were as follows: the total ash content was 0.56%, the acid-insoluble ash content was 0.15%, and the water-soluble ash content was 0.13%. The physical attributes of mucilage include its actual density, total porosity, bulk density, bulkiness, and particle flow behavior. According to the measure of bulkiness, powder has an intrinsic tendency to be "heavy".[18-21]

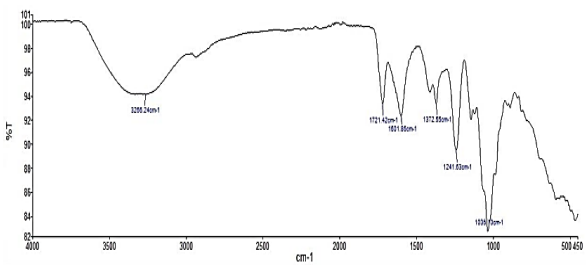

Figure 8: FTIR analysis of the latex gum extract

CONCLUSION

To improve the tablet's solubility, friability, and hardness, almond gum and okra are utilized as binding agents. The investigation's results demonstrate that the fruit polymer of *Abelmoschus esculentus*, often referred to as okra, has dramatically improved binding properties. Natural gums have the potential to serve as a source of biodegradable polymeric compounds. Gums and mucilage have been extensively used in many scientific studies spanning several disciplines, including medicines and food technology. The advantages of mucilage and polysaccharides compared to synthetic materials is readily apparent. Hence, the enduring interest in natural gums and their modifications to create more efficient substances for drug delivery systems will continue in the foreseeable future. The data provided in this context suggests that using *A. esculentus* mucilage as a binder in tablet formulations might enhance their physical characteristics. The substance's ability to bind and form granules for pharmaceutical formulation is shown by the creation of tablets with extended disintegration periods. Okra mucilage shows promise as a pharmaceutical excipient for use in the production of solid oral dosage forms, according to the parameter investigation. Its sensory properties and perfect pH make it ideal for the production of many different dosage forms.

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