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Extraction and Physiochemical Characterization of Black Gram Mucilage for Potential Use as Pharmaceutical Excipient

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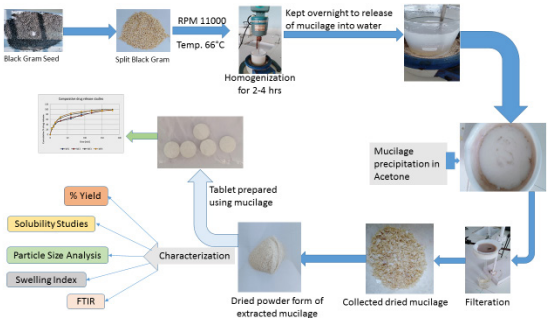
Abstract

Mucilage (polysaccharides) are being frequently used in pharmaceutical dosage forms as pharmaceutical excipient. Mucilage obtained from natural sources, are highly in demand due to of its non-toxic chemical inert, safety properties and are easily available, and most important thing is biodegradable. Hence newer gum and mucilage are investigating regularly in research field. Black gram seed's mucilage one of them which have been less explored. Extraction of mucilage (polysaccharide) from black gram seed and its characterization for potential use in pharmaceutical application. Mucilage from *Vigna mungo* (black gram) seed was isolated by maceration precipitation method. Spilt black gram seeds were converted into Corus powder form after that maceration-precipitation method was employed to extract mucilage from black gram seed. Further it was subjected to characterization of mucilage for potential uses in pharmaceutical application. Mucilage from black gram seed was extracted successfully which % yield was found to be 33.78% and solubility of mucilage was found to be soluble in hot water and insoluble in organic solvent. Other characterization parameters were studied for evaluation of mucilage that found in right direction of mucilage application. Solubility, swelling behavior, viscosity, pH value, flow property had shown its potential use in pharmaceutical application such as gelling agent, as a binder, as a disintegrant, suspending agent. Further it has to be incorporated in sustained release controlled release formulation.



Keywords: Black Gram Mucilage, Polysaccharide, Extraction, Vigna Mungo, Potential use

Introduction

Excipients are a vital component in pharmaceutical formulation production. A pharmaceutical excipient is required to make any dosage form. The pharmaceutical industries use synthetic, semi-synthetic, and natural excipients to create dosage forms (1). Phyto-derived excipients are favored over synthetic, semi-synthetic, and natural excipients (2). Natural excipients like gum and mucilage are gaining popularity in the pharmaceutical industry (3). Mucilage is a polysaccharide

complex carbohydrate containing one or more monosaccharides. Black gram contains galacturonic acid, L-rhamnose, L-arabinose, and protein D galactose (4). Plant-based mucilage and gum have many advantages over synthetics. The pharmaceutical industry relies heavily on natural plant mucilage (5). They are being explored as binding materials, disintegrants, diluent thickeners, viscosity enhancers, and gelling (6). Polysaccharide or mucilage is used as a colloidal suspension and as a foundation for suppository formulations (7). Black gram is a natural source. Despite its nutritional and functional value, black gram is still under-researched for pharmaceutical applications. It is also known as Dhal and is used in food (8). The fabaceae family includes the *vigana mungo* (L.) Hepper genus and species. 10.9 % moisture, 24.0 % protein 1.4 % fat 0.9 % fibre 3.2% minerals 59.6% carbohydrates (9). Long used as an aphrodisiac and demulcent, as well as for hair difficulties, diabetes and CNS disorders (10). Nepal, Korea, Bangladesh, India, the Philippines, and Thailand (11) all are South Asian countries who cultivates this summer pulse crop *vigno mungo*. The agricultural zone must be rainfed (type of forming that depend upon rainfall) to cultivate this crop (12). A promising crop in many nations, but nothing is known about its therapeutic potential (13). No more reported information on black gram pharmacognostic research. Although it is mostly grown in India, there is no additional information available for its pharmaceutical use. Gum and mucilage from black gram seed have been documented, but not as a pharmaceutical excipient (14). While the use of black gram mucilage is not much explored. Hence, this research mainly focused on two objectives viz. extraction of black gram mucilage and its physicochemical & Pharmacognostic characterization in perspective of pharmaceutical excipients such as binding agent, gelling agent, suspending agent, superdisintegrant.

When mucilage from natural source were used as pharmaceutical excipient, have no harmful effects on the body (15). Plant derivatives are readily available, non-toxic, and chemically inert (16). Because black gram mucilage can retain water, it can be employed as a gelling agent (17).

Materials and Methods

Split black gram seeds were purchased from the local market in mathura. Authentication No. NIScPR/RHMD/Consult/2021/3995-96-1 CSIR NISCARE New Delhi. Paracetamol was purchased from Yarrow Chem Products Mumbai. PVP K30, starch, Talc, and Magnesium Stearate were obtained from Central Drug House Pvt. Ltd New Delhi. Other chemicals sodium hydroxide, sulfuric acid, methanol, sodium chloride were procured from (Yarrow chem) Mumbai (AR Grade).

Extraction of the polysaccharide (mucilage)

For maceration and precipitation, 250g split black gram seeds were crushed into powder and sieved through a 60 mesh sieve. A desiccator was used to dry the black gram powder. In a 1 litre beaker, 20 g of black gram powder was suspensed in 800 ml distilled water for 1 hour at 8000 rpm with homogenizer to generate slurry. A homogenizer machine churned this viscous slurry of black gram for two hours at temperatures below 60°C. After that viscous solution was kept for 24 hours for release of mucilage into the water. The filtrate was strained through muslin cloth. Then acetone was added to get precipitate. Precipitates were filtered and dried in a hot air oven at 50°C. The dried mucilage material was crushed and pulverised to achieve powder consistency. Mucilage was sieved through 80 mesh in order to get powdered mucilage uniformity (18, 19).

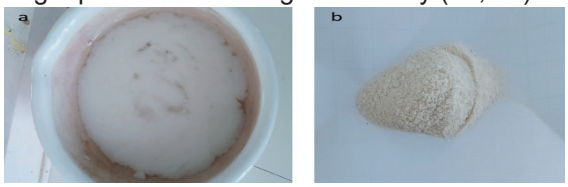


Figure 1: a) precipitated mucilage in mortar, b) dried powdered mucilage of black gram

The yield of extracted mucilage was estimated. Before and after extraction, dried powdered black gram seed and dried powdered mucilage were weighed. Then it was placed for yield calculation to get the percent yield of black gram mucilage (20).

$$\% \text{ yield of mucilage powder} \times 100 = \frac{\textit{weight of} \text{ dried powdered mucilage (g)}}{\text{weight of dried powdered seed of black gram before extraction}}$$

Physicochemical evaluation of mucilage

Molisch's test, Ruthenium red test, and iodine test were used to confirm polysaccharide content in extracted mucilage (21).

Phytochemical composition of mucilage

The phytochemical composition of mucilage was evaluated for glucose, flavonoids, tannins, glycosides, saponin, protein, resins, and alkaloid content (22, 26).

Microbiological study

Using Sabouround's dextrose agar media and nutrition media, fungal and bacterial development in mucilage was detected by boiling all agar media ingredients in a separate vessel and autoclaving at 121°C for 15 minutes. They were maintained in a sterile chamber to solidify. Using the striking method, samples were put to agar. It was incubated for 72 hours at 27°C and 24 hours at 37°C for bacterial and fungal growth (27).

Solubility study

Saturation method was used to test the mucilage's solubility. Separately, 10 ml of each of the following solvents (distilled water, hot water, methanol, acetone, isopropyl alcohol) were added. A small amount of mucilage powder was added to this solvent until it was dissolved (28).

pH

Preparing a 1 percent w/v mixture of isolated mucilage in filtered water and measuring pH with a digital pH meter (Labtronics LT-11, India) (29).

Melting Point

The capillary tube method determined the mucilage powder's melting point (30, 41).

Swelling Index

Pouring 100 mg of powdered black gram mucilage into a 10 ml measuring cylinder determined the swelling behavior. The volume of dry powder mucilage was recorded first (Vo), then 10 ml distilled water was added and allowed to stand for 24 hours. After 24 hours, the mucilage swelled volume (Vs) was calculated using the swelling index formula. So this way the swelling index of black gram powder mucilage was ascertained (31).

Viscosity

A 3 percent, 5 percent solution of extracted mucilage of black gram was produced and tested for viscosity using a Brookfield viscometer and LT spindle 63 at 22°C (32).

Total Ash Value (TAV)

Weighed accurately 1 g of isolated powder mucilage of black gram and transferred into preweighted ashing crucible. Then, heating was given by furnace up to 450° C nearly for 8 hrs until carbon removed. the sample was removed and allowed to cool, kept in desiccator. Then, the sample was weighed for calculation (33, 35).

$$TAV = \frac{\text{total weight of ash}}{\text{total weight of powder mucilage}} X\ 100$$

Acid insoluble ash

About 2 g of extracted powder mucilage was taken into the crucible and weight of it was noted down. Crucible was covered with the lid and it was placed inside a muffle furnace. Sample was burnt in muffle furnace at 550° C for 30 minutes. After 30 minutes of burning crucible, it was taken out from the furnace after cooling

and crucibles lid was removed to check the ash for the Black particles. To check the black particles in crucible, few drop of distilled water was added to the Ash content. Development of black color indicated that the ash had not become free from carbon yet. So it was needed to burn again at 550° C until it become free from carbon. Crucible was placed on hot plate to completely remove the moisture from Ash. After removing the moisture completely, crucible was covered with the lid then crucible was placed inside the furnace to burn at 550° C for 40 minutes. Then crucible was removed from furnace and cooled. Ash was checked carefully for the presence of any black color. Second time, there was no any black particle observed. Few drop of water was added to confirm the black color in crucible. So there was no any black color observed even after adding water. Then it was confirmed that ash became completely free from carbon. Next step was boiling in acid and filtration. In this step 25 ml of 40% hydrochloric acid solution was taken in a measuring cylinder and poured into crucible containing Ash. Then it was placed on hot plate to boil Ash in the acid solution for 5 minutes. Crucible was removed from hot plate using tong. It was filtered through ash less filter paper while it was still warm. Then it was observed that few particles of Ash were trapped on the filter paper which was acid insoluble Ash. Then it was rinsed with hot water for three to four time to ensure that there was no residue of hydrochloric acid was left with filter paper. Next step was crucible preparation, in this step, crucible was dried inside hot air oven at 110° C temperature for 30 minutes. Then it was cooled in desiccator for 10 minutes. This blank crucible was weighed and noted down. Next Step was filtration and incineration, in this step filter paper with insoluble ash was folded carefully to avoid loss of filtrate and placed in the crucible and covered with lid. Then crucible was placed inside furnace at 550° C for 90 minutes. Then it was taken out from furnace and cooled. It was observed that the acid insoluble ash content was present in the crucible. Then, finally crucible containing acid insoluble ash was weighed and noted for calculation using following formula (34, 35, 36).

Water soluble Ash value

For determination of water soluble ash value, same procedure of acid insoluble ash value procedure was followed. Only dilute HCl solution was replaced with water. 25 ml of dil. HCl was replaced with water (36).

Loss on Drying

For determination of loss on dry, an empty dried crucible was weighed and recorded. Then, 1 g of extracted powder mucilage of black gram was weighed in crucible. Then, it was kept inside hot air oven at 105 _+ 2° C for 3 hours. Then, it was taken out from hot air oven with the help of tong carefully. Then, it was kept inside desiccator to cool till room temperature after that it was weighed with crucible and weight was recorded. Procedure was repeated till constant weight was not obtained. Loss on drying was

$$\textit{Loss on drying}\ \% = \frac{\mathbf{Wcs - Wds}}{\mathbf{Wcs - We}}\ \boldsymbol{X\ 100}$$

Where, We = weight of empty crucible, Wcs = weight of crucible with sample before drying,

Wds = weight of crucible with sample after drying.

Fourier Transform Infrared Spectroscopy of Extracted Mucilage

It was then dried in a desiccator to remove any moisture. FTIR spectrometer yielded IR spectra of isolated black gram mucilage (UV-1800 Spectrophotometer, Shimadzu, Japan). Black gram mucilage powder was mixed with dried KBr and exposed to FTIR pellets under mechanical pressure. Then the disc film was scanned between 4000-450 cm^{-1}. A functional group was then identified from the IR spectrum (38).

Particle size analysis

Its particle size was evaluated using Zeta sizer Nano ZS, Malvern Analytical (UK). The mucilage particle was dispersed in deionized water at a concentration of 20mg/20ml for particle size characterization. Particle size at 1969 count rate 230.4 (kcps). The method used to determine particle size was Dynamic Light Scattering (DLS). Particles in suspension were studied.

Preparation of granules of paracetamol (as a model drug) using black gram mucilage

The extracted mucilage of black gram was subjected to evaluate its binding properties in tablet dosage form. Here, Paracetamol drug was selected as a model drug in order to evaluate potency of mucilage in release of drug form dosage form. Formulations containing different concentration of mucilage (4%, 7%, and 10% w/w) were prepared by wet granulation technique (Table 1). PVP K30 was used as standard binder in standard formulation to compare test binder i.e. extracted mucilage from black gram.

Table 1. Formulation table containing black mucilage as a binding agent in comparison with PVP K30 as standard binder.

Ingredients (mg)	MF1 (4%)	MF2 (7%)	MF3 (10%)	MF4 (4%)	MF5 (7%)	MF6 (10%)
Paracetamol	300	300	300	300	300	300
Starch	15	15	15	15	15	15
Black Gram Mucilage	20	35	50	_	_	_
PVP K30	_	_	_	20	35	50
Lactose	150	135	120	150	135	120
Talc	10	10	10	10	10	10
Magnesium Stearate	5	5	5	5	5	5
Total	500	500	500	500	500	500

In the preparation of granules by wet granulation technique for the formulation MF1 to MF6, paracetamol, starch and lactose were mixed thoroughly in mortar pestle. In other hand, solution was prepared of different concentration (4%, 7%, and 10%) w/v of black gram mucilage as binder and PVP K30 by dissolving in suitable solvents like hot water and isopropyl alcohol respectively up to 20 ml.

Prepared viscous solution of mucilage and PVP K30 were added separately to MF1-MF3 and MF4 – MF6 slowly to homogeneous mixture of powder blend of paracetamol, starch, lactose, and lubricant in order to get dough mass of powder blend for 10-minutes and subsequently kneading was performed until formation of enough cohesiveness obtained. Dough mass was passed through sieve no. 12 and dried at 55°C in hot air oven for 6 hours. Dried granules were collected and resieved through sieve no. 20 to get uniform particle size of granules (40).

Prepared granules were subjected to evaluate for %age yield, %age fines, total porosity, bulk density, tapped density, angle of repose, compressibility index, hausner's ratio in terms of flow properties as per reported protocols.

Preparation and evaluation of tablet using mucilage as binding agent

A batch size of 50 Tablets for each formulation was prepared by using single punching machine. Wet granulation technique was adopted in preparation of granules of tablet. Total estimated weight of tablet was 500 mg per tablet taken as weight of individual tablet by using 500 mg die and punch of the machine. Prepared tablets were evaluated for hardness, weight variation, drug content uniformity, disintegrating time and friability. Drug release pattern of formulated tablets were subjected to *Invitro* dissolution studies by using dissolution apparatus paddle type -I as per Indian Pharmacopoeia method (41).

Results

The average yield of recovered powdered black gram mucilage was determined to be 33.78 percent by maceration precipitation. The extracted mucilage powder was white creamy in appearance.

Identification and Phytochemical examination of powder mucilage of black gram

A occurrence of polysaccharide in black gram seed mucilage was confirmed by Molish's rest, Ruthenium red test, and iodine test (39).

Micromeritric properties of the black gram powder mucilage

Powder flow properties are an important characteristic for powder micrometrics (40). The Carr's index, Hausner's ratio, and angle of repose of black gram mucilage were found to be respectively 14.16, 1.16, and 27.05 C. (Table 1) of black gram seed.

Micromeritics Parameters	**Observed value**
Bulk density	0.561 g/cm^3
Tapped density	0.780 g/cm^3
Angle of Repose	24˚ 32'
Carr's Index	14.12
Hausner's ratio	1.39

Table 2: flow properties of the extracted mucilage

Phytochemical evaluation of extracted mucilage from black gram

Various tests were performed to demonstrate the presence of glucose, flavonoids, tannins, saponin, resin, protein, alkaloids, glycosides, mucilage, and steroid in mucilage. Some results were negative, indicating no phytochemicals present. In Table 2.

Table 3: Different phytochemical properties of extracted mucilage from black gram (41)

Phytochemicals	Test	Observation	Result
Carbohydrate,	Iodine test, Molish's test	Reddish brown color,	(+ve) Carbohydrates present
Flavonoids	Shinoda test	Red to Pink color	(+ve) Flavonoid present
Tannins (phenol)	Ferric Chloride test	Clear yellow color Was not changed in deep purple color for +ve result	(-ve) absence of Tannins
Saponin	Forth formation test	Foam was not appeared	(-ve) absence of saponin
Resin	Resin test	With HCl, no pink color formed With FeCl3, no greenish blue color formed	(-ve) absence of resin
Alkaloids	Mayer's test	Cream precipitate was not appeared	(-ve) absence of alkoloid
Glycosides	Baljit test	Yellow to orange color appeared	(+ve) presence of glycoside
Mucilage	Ruthenium red test	Pink color appeared	(+ve) presence of mucilage
Protein	Biuret test	Deep purple color was appeared	(+ve) presence of protein

Microbial load test

The British Pharmacopoeia [42] recommends a limit of 1000-100 colony forming units (CFU) per gram of excipient for bacterial and fungal growth. In this investigation, bacterial growth exhibited 89 CFU per petri plate, while fungus growth showed 8 CFU per petri plate. Thus, total CFU for bacteria was 890 CFU/g and total CFU for fungi was 80 CFU/g of recovered mucilage of black gram. So the microbiological study was judged to be acceptable.

Physicochemical characterization of extracted powdered mucilage of black gram

Various physicochemical features of black gram powder mucilage were characterized according to pharmacopoeia criteria. A total ash value was determined, along with acid insoluble ash, water soluble ash and loss on drying (table

3) A colloidal solution was generated in cold water and insoluble in organic solvents such as methanol, ethanol, acetone, ether and isopropyl alcohol. The pH of extracted black gram mucilage was 6.9 when a digital pH meter was immersed in a 1 percent w/v solution of black gram mucilage. The pH of mucilage was 6.9, which is acceptable for oral formulations that do not irritate the oral cavity or gastric mucus line. [43]. The melting point of black gram mucilage was determined to be 118-220 C. Table 3.

The 3 % and 5 % w/v mucilage of black gram had a viscosity of 1322cP and 1552cP, respectively. This viscosity result indicated mucilage's gelling capabilities, which are exploited in medicinal formulations [44].

The extracted mucilage of black gram has a swelling index of 6.24, indicating that it can be employed as a disintegrants and a binder in medicinal solid dosage forms. The total ash value, acid insoluble ash, water soluble ash, and loss on dry were also studied and recorded (table 3).

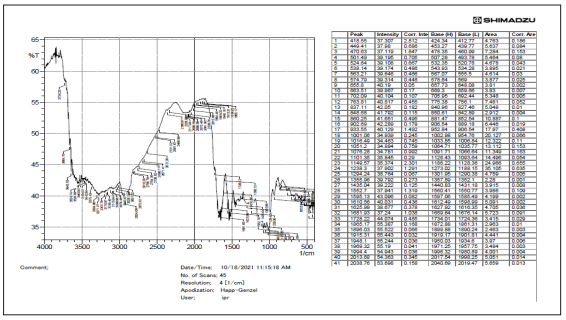
Table 4: Values of physicochemical characterization of extracted mucilage from black gram.

Physicochemical characterization	Observed Value
Melting point [41]	118-220° C
pH	6.9
Viscosity (3% and 5%)	1322cP and 1552 cP
Swelling Index	6.24
Total Ash Value	7.5 ± 0.12(SD)
Acid Insoluble Ash value	1.7 ± 0.14
Water soluble ash valu	5.34 ± 0.13
Loss on drying	2.56 %

IR spectrum of extracted mucilage of black gram

Infrared spectroscopy of powdered mucilage was collected and interpreted for functional group presence. Spectra of mucilage (figure 2.) this can be employed as reference.

Figure 2: FTIR of extracted mucilage of black

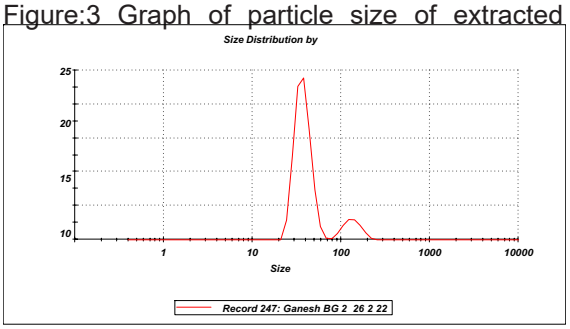


gram seed.

Particle size analysis

The mean particle size of recovered mucilage of black gramme was 1969 nm in diameter, according to the Zeta Sizer graph. Figure 3 depicted graph. So this size is suitable for preparing expient dosage forms.

Figure:3 Graph of particle size of extracted



mucilage from black gram.

Discussion

Mucilage was extracted from black gram seeds and further subjected to various evaluation parameters. In which the %age yield of obtained mucilage was found to be 33.78%. Appearance of the mucilage was white creamy. All mucilage related evaluation parameters were studied previously and found to be within the limit of standard mucilage. Granules were prepared by using extracted mucilage from black gram as binding agent. In which granules were subjected to various evaluation parameters in order to get its suitability in preparation of

formulation like tablet so that it was analyzed for %age of fines, flow properties and particle size (table 5). From the result it was found that the %age of fines were significantly decreased as the %age of concentration were increased. The percentage of fines were higher in granules prepared by concentration of 4% as a binder but mucilage at concentration of 7% may be good when compared with standard binder PVP K 30 at concentration of 10% w/v. furthermore, prepared granules mean particle size was found to be in the range of 0.32 and 0.36 mm which was satisfied with standard result. Angle of repose, bulk density, tapped density, hausner's ratio and carr's index were found to be satisfactory at concentration of 10% mucilage used. Flow property of prepared granules directly related to the angle of propose which was found to be better at 4% concentration of black gram mucilage. As concentration increases angle of propose was increased but comply or below than standard binder pvpk30 which means better than standard binder pvpk 30. Compressibility index of granules were increases with increasing concentration of black gram mucilage although it was found to be better than standard binder which was less than 15% which indicate excellent binding properties. Bulk density was decreases with increasing concentration and at comparison with standard it was found to be better at 10% concentration of mucilage than standard. Tapped density data was decreases with increasing concentration of mucilage and 10% concentration of mucilage were found to be better result and standard. Percentage of fines were decreases with increasing concentration of mucilage due to agglomeration of particles due to higher binding capacity of mucilage hence at 4% concentration of mucilage were found to be better than standard although at 7% concentration of mucilage was also good as standard. Total porosity of granules was found to be increases with increasing concentration of mucilage. In general, less than 26% total porosity indicates particles in powder are of different size. Hence, in mucilage used formulation, total porosity comes in range of 26 to 40% which shows particles are loosely packed and indicated that particles are of not in different size. Since at 10% mucilage as binding agent shows better result in terms of total porosity parameter. From the observation (table 5) all the result were showed satisfactory result for the flow properties of prepared granules by using black gram mucilage as a binder.

Six batches of 50 tablets were prepared by using black muscles as binding agent at concentration of (4%, 7% and 10% w/v) against standard binder PVP 30 and all batches were subjected to evaluate for its hardness weight variation, drug content uniformity and disintegration time, friability and invitro dissolution test (table 6.)

The tablet hardness was increases as concentration of mucilage increases. At 10% concentration of mucilage, hardness of tablet was found to be better than tablets prepared by 10% of PVP K 30 as standard binder. Drug content uniformity of prepared tablets were found to be uniform in all batches but tablets prepared with 10% concentration of mucilage was found to be better drug content that was 98.68% than tablet prepared with standard binder PVP K 30 at 10% concentration. %age friability of tablets was found to be almost constant in all the batches whose result was found to be within the limit that was less than 1%. Tablets prepared with 10% of mucilage were found to be higher in disintegration time compared with 10% standard binder PVP K 30.

From in vitro dissolution study tablets prepared with mucilage at 7% w/v concentration, indicates more than 80% drug was released in uniform manner within 120 minutes. Drug release pattern was found to be decrease with increase in concentration of mucilage of black gram. Tablet prepared with mucilage of black gram at different concentration in (4% 7% 10% w/v) were exhibited drug release more than 85% within 120 minute almost similar with standard binder PVP K30.

Conclusion

Black gram mucilage was isolated and analyzed as per Pharmacopoeia requirements. In this study, the mucilage from black gram seeds was shown to have medicinal applications. The maceration precipitation method of obtaining mucilage from black gram seed worked well. %age yield was found to be in satisfactory limit when compared with other developed mucilage from natural resources. It may be used as a binding agent, gelling agent, disintegrants, suspending agent, and release retardant from its characteristics. Some of excipient properties of extracted mucilage were studied in this research. Microbial growth was shown to be acceptable in extracted mucilage. Results obtained from different studies showed that mucilage obtained from black gram has better binding capacity in preparation of tablet. Hence, it was found to be a better binding agent when compared with standard binding agent PVP K 30. It can be obtained easily and economical when compared with PVP K30. Furthermore, it can be also evaluated for extended release dosage form since in this reason it was found to be mucilage produces sticky film of hydration on the surface which may decrease the drug release hence obtained from black gram can be also evaluated for its efficacy in the extended release dosage form. More research on black gram seed mucilage is still required. It has been concluded from the studies that black gram seed exhibited for the high mucilage content that is 37.78% w/w. So the black gram mucilage may be taken as good natural resources of binder in perspective of pharmaceutical add such as disintegrants and release retardant as economical choice.

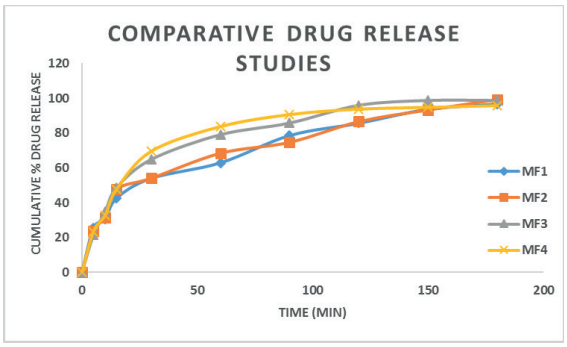
Figure 3. Comparative release of paracetamol from tablet prepared by extracted mucilage and

Table 5. Evaluation result of prepared granules at different concentration of black gram mucilage and PVP K 30 as a binding agent.

Parameters ± SD	**Black Gram Mucilage as a binder**			**PVP K30 as a binder**
	MF-1 (4%)	**MF-2 (7%)**	**MF-3 (10%)**	**MF-4 (10%)**
Angle of Repose	28°	30°	30°	32°
Bulk Density ± SD	0.624±0.043	0.512±0.0301	0.050±0.043	0.487±0.041
Tapped Density ± SD	0.512±0.062	0.508±0.051	0.498±0.034	0.564±0.332
Carr's Index (%) ± SD	8.12±0.862	11.58±0.671	13.52±0.141	13.42±1.022
%age Fines	25.00	19.22	16.52	17.87
Total Porosity (%)	25.23±2.21	38.82±3.26	38.86±3.32	36.45±2.61

Table 6. Evaluation result of prepared tablets at different concentration of black gram mucilage and PVP K 30 as a binding agent.

Evaluation parameters	**MF-1 (4%)**	**MF-2 (7%)**	**MF-3 (10%)**	**MF-4 (10%)**
Hardness (Kg/cm^2)	4.82±0.03	6.81±0.07	7.45±0.08	6.50±0.07
Weight variation	540	504	542	560
Drug Content Uniformity	88.45±0.32	97.21±0.43	98.68±0.034	98.01±0.46
Friability (%)	0.5	0.4	0.2	0.22
Disintegration Time (sec)	218	324	356	248
Thickness	5.5±0.05	5.6±0.04	5.5±0.04	5.5±0.06



PVP K 30 as release retardant.

Conflicts of interest

Authors declared, there is no any conflicts of interest regarding the publication of paper.

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