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Isolation of the Mucilage from Seeds of *Astercantha Longifolia* and Study the Effects of Its Mucilage as Pharmaceutical Excipient

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ABSTRACT: *Astercantha longifolia* is an edible plant rich in mucilage, which belongs to the family Acanthaceae. Although the plant has been used traditionally, there is no report on isolation and characterisation of mucilage from *Astercantha longifolia*. The present work was aimed to isolate and characterise the mucilage from the aerial parts of *Astercantha longifolia*. The isolated mucilage was characterized for physical, chemical and flow properties. Primary studies show that mucilage of *Astercanthta longifolia* is insoluble in organic solvents and dispersible in hot water to form a highly viscous gel such as mucilaginous solution with a broad pH tolerance and bioadhesivity. *Astercantha longifolia* mucilage is non Newtonian and yield higher viscosities than most starches at equivalent concentrations. This has led to its application as stabilizer, thickener gelling agent and binder in pharmaceutical industries. In addition to these, other important properties of *Astercantha longifolia* have been identified such as non carcinogenicity, mucoadhesivity and biocompatibility, high drug holding capacity and high thermal stability. This has led to its application as excipients in hydrophilic drug delivery. The isolated mucilage was optimized evaluated for its physicochemical characteristics. By results of evaluation parameters it was decided that the mucilage has adhesive property so tested for bioadhesive nature; it was found that adhesivity is directly proportional to concentration of *Astercantha longifolia* mucilage and subsequently used to formulate Curcumin bioadhesive tablet for stomach ulcer; and the tablet was evaluated for its bioadhesive potential, where it was observed that mucilage showed good bioadhesive property. The mucilage can be further explored for different uses in pharmaceutical industry safely and successfully

Keywords: *Astercantha longifolia*, mucilage, Curcumin, Bioadhesive tablet.

INTRODUCTION: Nature has provided us a wide variety of materials to improve and sustain the health of all living things either directly or indirectly. In recent years there have been important developments in different dosage forms for existing conventional and novel dosage forms by using natural excipients often need to be used for a variety of purposes. So with the increasing interest in excipients of natural origin, the pharmaceutical world has compliance to use most of them in their formulation. Moreover the tremendous orientation of pharma world towards these naturally derived excipients has become a subject of increasing interest to discover, extract and purify such compounds from the reported origin. [1] Gums and mucilages are widely used natural materials for conventional and novel dosage forms. These natural materials have advantages over synthetic ones since they are chemically inert, nontoxic, less expensive, biodegradable and widely available.

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They can also be modified in different ways to obtain tailor-made materials for drug delivery systems and thus can compete with the available synthetic excipients. The synthetic polymers have certain disadvantages such as high cost, toxicity, environmental pollution during synthesis, non-renewable sources, side effects and poor patient compliance. [2]Due to toxicity and approval from regulatory authorities poses a problem with synthetic excipients, so researchers' shows more interest in herbal excipients. Present day consumers look for natural ingredients in food, drugs, and cosmetics as they believe that anything natural will be more safe and devoid of side effects. The traditional view that excipients are inert and do not exert any therapeutic or biological action or modify the biological action of the drug substance has changed and it is now recognized that excipients can potentially influence the rate and/or extent of absorption of a drug. As herbal excipients are non toxic and compatible, they have a major role to play in pharmaceutical formulation. [3] In accordance with above discussion mucilage was isolated from the *Asteracantha longifolia* (L.) Nees, Acanthaceae, finds mention in Ayurvedic treatise like Sushruta Samhita and Charak Samhita as Rasayan or rejuvenator.

Asteracantha longifolia is described in ayurvedic literature as Ikshura, Ikshugandha, and Kokilasha "having eyes like the Kokila or Indian Cuckoo". They are also constituent of ayurvedic formulation "Striravallabhpugpak" and "Rativardhanyog" described in ancient text as a general tonic.

Turmeric has been used traditionally for many ailments because of its wide spectrum of pharmacological activities. Curcumin has been identified as the active constituent which is potential wound healer so used in peptic ulcer treatment. [4] So, present research work deals with isolation, phytochemical investigation and characterization of mucilage obtained from seeds of Astercantha longifolia (L.), for its binding properties and bioadhesive nature.

MATERIALS AND METHODS

Materials:

Following materials were used for the research work.

Table 1: Materials used in the research work

Sr. No.	Material	Source
1	Curcumin	Nisarg Biotech, Satara
2	Astercantha longifolia seeds	Local market, Satara
3	Methanol	Research Fine Lab., Mumbai
4	Lactose	Research Fine Lab., Mumbai
5	Magnesium Stearate	Research Fine Lab., Mumbai
6	Talc	Research Fine Lab., Mumbai
7	Acetone	S.D. Fine Chemicals, Mumbai
8	Disodium hydrogen phosphate	S.D. Fine Chemicals, Mumbai
9	Sodium hydroxide	Loba Chemie, Mumbai
10	Potassium dihydrogen orthophosphate	S.D. Fine Chemicals, Mumbai

METHOD:

Collection of Astercantha longifolia seeds

Astercantha longifolia seeds Linn was collected from local place in Satara. Collected seeds were cleaned manually by sieving and collection method to remove dirt and debris.

Extraction procedure

Astercantha longifolia seeds were extracted by following methods

1) Normal soaking
2) Stirring
3) Normal soaking and heating
4) Normal soaking with different pH
5) Normal soaking and stirring
6) Normal soaking, stirring and pH changing
7) Stirring without normal soaking
8) Stirring without normal soaking with change in pH
9) Stirring without normal soaking with heating.

1) **Normal soaking:** The seeds of *Astercantha loangifolia* were weighted approximately 2 gms and poured in 1000 ml glass beaker then 200 ml of distilled water was added to it and kept it aside for 24 h. Then this mixture was squeezed through eight folded muslin cloth and also retried to squeeze through Buckner funnel.
2) **Stirring:** The seeds of Astercantha loangifolia were weighted approximately 2 gms and poured in 1000 ml glass beaker then 200 ml of distilled water was added to it and kept it aside for 24 h. Then this mixture was stirred for 1 h and then squeezed through eight folded muslin cloth and also retried to squeeze through Buckner funnel.
3) **Normal soaking and heating:** The seeds of *Astercantha loangifolia* were weighted approximately 2 gms and poured in 1000 ml glass beaker then 200 ml of distilled water was added to it and kept it aside for 24 h. Then this mixture was stirred and heated for 1 h and then squeezed through eight folded muslin cloth and also retried to squeeze through Buckner funnel.
4) **Normal soaking with different pH:** Three batches taken each of 2 gms of seeds of *Astercantha loangifolia* were weighted approximately and poured in 1000 ml glass beaker then 200 ml of distilled water of pH 4, 7.2, 10 was added to it and kept it aside for 24 h. Then this mixture was stirred and heated for 1 h and then squeezed through eight folded muslin cloth and also retried to squeeze through Buckner funnel.
5) **Normal soaking and stirring:** The seeds of *Astercantha loangifolia* were weighted approximately 2 gms and poured in 1000 ml glass beaker then 200 ml of distilled water was added to it and kept it aside for 24 h. Then this mixture was stirred for 1 h and then squeezed through eight folded muslin cloth and also retried to squeeze through Buckner funnel.

6) **Normal soaking, stirring and pH changing:** The seeds of *Astercantha loangifolia* were weighted approximately 2 gms and poured in 1000 ml glass beaker then 200 ml of distilled water was added to it and kept it aside for 24 h. Then this mixture was stirred for 1 h with pH modifying agent and then squeezed through eight folded muslin cloth and also retried to squeeze through Buckner funnel.
7) **Stirring without normal soaking:** The seeds of *Astercantha loangifolia* were weighted approximately 2 gms and poured in 1000 ml glass beaker then 200 ml of distilled water was added to it and stirred for 5-6 h. Then this mixture was squeezed through eight folded muslin cloth and also retried to squeeze through Buckner funnel.
8) **Stirring without normal soaking with change in pH:** The seeds of *Astercantha loangifolia* were weighted approximately 2 gms and poured in 1000 ml glass beaker then 200 ml of distilled water was added to it. Then this mixture was stirred for 5-6 h with pH modifying agent and then squeezed through eight folded muslin cloth and also retried to squeeze through Buckner funnel.
9) **Stirring without normal soaking with heating:** The seeds of *Astercantha loangifolia* were weighted approximately 1 gms and poured in 1000 ml glass beaker then 500 ml of distilled water was added to it and stirred for 5-6 h with constant heating at 50 to 60°C temperature. Then this mixture was squeezed through Buckner funnel.

Evaluation of *Astercantha longifolia* seeds mucilage (ALM) powder

1. Description

The ALM powder was evaluated for color, odour and powder nature.

2. pH of ALM powder solution

1% solution of ALM powder was prepared by adding 1 gm mucilage powder in distilled water. pH of solution was determined with the help of pH meter .

3. Viscosity

Required quantity of ALM powder was mixed in the distilled water. Resulting solution was stirred periodically for 24 h. Finally viscosity of solution was measured using spindle S-62. Polymer concentration was prepared in the range of 0.1-0.5 % w/v.

4. Loss on drying

Two gram of dried ALM powder was weighed and transferred into a Petri dish. Petri dish was kept in hot air oven at 105°C until a constant weight was obtained. It indicates the amount of moisture present in the material that was available to interact with other material.

$$\text{LOD (\%)} = \frac{\text{Initial weight of powder} - \text{Final weight of powder}}{\text{Initial weight of powder}} \times 100$$

5. Swelling ratio [5]

One gram of ALM powder was placed in 100 ml stoppered graduated cylinder and the volume occupied by powder was noted. 100 ml of distilled water was added to yield a uniform dispersion. The sediment volume of the swollen mass was noted after 24 h at room temperature**.** The swelling ratio was calculated by determining the ratio of the swollen volume to the initial bulk volume. The swelling ratio was evaluated in distilled water, simulated gastric fluid (0.1 N HCl) and phosphate buffer (pH 6.8).

6. Determination of Total ash content

Two gram of ALM powder was weighed and evenly distributed in the crucible. Crucibles were kept at100 □ ° C to 105 ° C for 1 h and ignite to constant weight in a muffle furnace at 600 ° C. Allow to crucible to cool in a desiccator. Total ash content was measured by using formula given below:

$$\text{Ash content (\%)} = \frac{\text{Weight (gm) of residue}}{\text{Weight (gm) of sample}} \times 100$$

7. Determination of Acid insoluble ash

Two gram of ALM powder sample was weighed and poured into the petridish. Sample was heated at 400 ± 50 ° C until all the carbon is turned off. Ash value was calculated. The ash was washed with 25 ml of dilute HCl; the ash was washed from the dish used for total ash into a 100 ml beaker. The residue obtained after filtration was washed twice with hot water crucible was ignited in the flame, cool and weighed. Crucible was further heated until vapours cease to be evolved. Cool it. Calculate the percentage of acid insoluble ash with reference to the air-dried substance.

$$\text{Acid insoluble ash (\%)} = \frac{\text{Weight (gm) of residue}}{\text{Weight (gm) of sample}} \times 100$$

8. Chemical Tests

I) Carbohydrate

Molisch's test: 100 mg of dried ALM powder was taken in a test tube. To it alpha napthol solution was added. Concentrated sulphuric acid was added from side of test tube. If violet ring formed at the junction of two liquids carbohydrates are present.

Reduction of Fehling's: ALM powder was taken in a test tube; to it equal quantity of Fehling's solution A and B was added. After heating, if brick red ppt is obtained it confirms the presence of carbohydrates.

II) Steroid

Libermann- Burchard test: ALM powder was treated with few drops of acetic anhydride in a test tube. Solution was boiled and cooled. Concentrated sulphuric acid was added from the side of the test tube, if brown ring is formed at the junction of two layers and upper layer turns green which shows presence of steroids.

Salkowski test: ALM powder was treated with few drops of concentrated sulphuric acid. If red colour appears at lower end of test tube it indicates presence of steroids.

III) Flavonoid

Alkaline reagent test: ALM powder was treated with few drops of sodium hydroxide solution, if intense yellow color is formed which turns to colorless on addition of few drops of dilute acid indicate presence of flavonoids.

Zinc hydroxide test: ALM powder was treated with mixture of zinc dust and concentrated hydrochloric acid. It gives red color after few minutes.

IV) Amino acid

Millon's test: ALM powder was taken in a test tube to it 2 ml of millions reagent was added, white precipitate indicates presence of amino acid.

Ninhydrine test: ALM powder was taken in a test tube to it ninhydrine solution was added and boiled. Violet color indicates presence of amino acid.

V) Tannin

Ferric chloride test: ALM powder was treated with ferric chloride solution; blue color appears if hydrolysable tannins are present blue color is changes into green color.

VI) Ruthenium test: Small quantity of ALM powder was taken on a glass slide .To it ruthenium red solution was added and slide was observed under microscope. If pink color develops mucilage is present in powder sample.

9. Bulk density and Tapped density

Bulk density was determined by pouring preweighed and presieved bulk drug into a graduated cylinder via a large funnel and the volume was measured and recorded as bulk volume. The cylinder was tapped until powder bed volume reached a minimum volume and the volume was recorded as tapped volume. The bulk density and tapped density were calculated as shown below,

$$\text{Bulk density} = \frac{\text{Mass}}{\text{Bulk volume}}$$

$$\text{Tapped density} = \frac{\text{Mass}}{\text{Tapped volume}}$$

10. Carr's Index

It is also one of the simple methods to evaluate flow property of a powder by comparing the bulk density and tapped density. The percentage compressibility of a powder was a direct measure of the potential powder arch or bridge strength and stability. It is also known as Carr's index. It can be calculated by following equation.

$$\text{Carr's index} = \frac{(\text{Tapped Density} - \text{Bulk Density})}{\text{Tapped Density}} \text{ X } 100$$

11. Hausner's Ratio

Hausner found that the ratio tapped density/bulk density was related to inter particle friction as such, and could be used to predict powder flow properties. He showed that the powder with low inter particle friction had ratio of approximately 1.2, whereas more cohesive less free flowing powders have Hausner's ratio greater than 1.6. Hausner's ratio less than 1.25 indicate good flow.

$$\text{Hausner's Ratio} = \frac{\text{Tapped Density}}{\text{Bulk Density}}$$

Preformulation studies

1. Melting point determination of drug (Curcumin)

It was determined by using microcontroller based melting point apparatus. The required quantity of drug sample was filled in a capillary tube. The capillary was placed in a silicone oil bath. The instrument switch was turned on. The heater knob was turned on so that temperature increased gradually. The temperature at which sample started to melt was noted and melting range was determined.

2. Determination of λmax by UV

10 µg/ml standard solution of curcumin in 0.1 N HCl was prepared and scanned through 400-800 nm range using shimadzu 1700 UV Spectrophotometer.

3. Development of calibration curve for Curcumin

The standard calibration curve of curcumin prepared in0.1 N HCl. Accurately weighed 100 mg of curcumin dissolved in 100 ml of 0.1 N HCl to give stock solution of 1000 µg/ml. From this stock solution further dilutions were made to give concentration in the range of 0 to 10µg/ml. The absorbance was measured at λmax 420 nm using UV-1700 spectrophotometer against the 0.1 N HCl as blank.

4. Compatibility study

The compatibility between drug, excipients and/or carrier material is one of the important requirements for developing a successful dosage form. Chemical interactions are indicated by the appearance of new peaks. The excipient is then probably chemically reactive and incompatible with the drug and should be avoided. The compatibility of the drug and the formulation components under the experimental conditions is an important prerequisite to formulations. It is therefore necessary to confirm that the drug does not react with the formulation components under experimental conditions. With this objective, a study was carried out to assess the compatibility between, curcumin with ALM powder by infrared spectroscopy. The IR spectrum of pure drug and physical mixture of pure drug and ALM powder were analyzed to check compatibility using IR.

Formulation of Curcumin tablets with *Astercantha longifolia* seeds mucilage powder

Table 2: Formulation batches

Batch	Drug (Curcumin)	ALM Powder	Lactose	Magnesium Stearate	Talc
F1	200	25	275	2	2
F2	200	50	250	2	2
F3	200	75	225	2	2
F4	200	100	200	2	2
F5	200	125	175	2	2
F6	200	150	150	2	2
F7	200	175	125	2	2
F8	200	200	100	2	2
F9	200	225	75	2	2
F10	200	250	50	2	2

All quantities are in mg, ALM: *Astercantha longifolia* seeds mucilage powder

Procedure:

All ingredients were passed through a # 80 sieve and weighed. Drug and polymer was transferred into a morter and mixed well. In above mixture lactose was added and mixed. After this talc and magnesium stearate was added into it. In similar way blends for all formulation given in table 7.4 were prepared. Prepared powder blends were evaluated for flow properties. The tablets were prepared by a direct compression method using double rotary tableting machine having die cavity size 9 mm. Total weight of tablet was 500 mg.

Characterization of Powder Blends

The powder blends of formulations shown in table 8.4 were evaluated for flow properties viz. bulk density, tapped density, carr's index, Hausner's ratio, angle of repose.

Evaluation of formulated Tablets containing Curcumin and ALM powder

1. **Uniformity of weight:** Twenty tablets were selected randomly and weighed. Average weight of the tablet was determined. [6]

2. **Dimensions:** Thickness and diameter of tablets was measured using micrometer screw gauge. The study was carried out in a triplicate.[7]

3. **Hardness:** Monsanto hardness tester (Rolex Scientific Engineers Limited) was used to determine hardness of tablet. It is expressed in kg/cm^2. The mean hardness of each formulation was determined. The study was carried out in the replicate of three. [8]

4. **Friability:** Twenty tablets were weighed and placed in the Roche friabilator and apparatus was rotated at 25 rpm for 4 min. After 100 revolutions the tablets were dedusted and weighed again. Percentage friability was calculated from the loss in

weight as given in equation below. The weight loss should not be more than 1 %. [6]

$$\% \text{ Friability} = \frac{\text{Initial weight} - \text{final weight}}{\text{initial weight}} \times 100$$

5. **Uniformity of content** :20 tablets were weighed individually and powdered. The powder equivalent to about 0.12 gm of curcumin was transferred to a 100 ml volumetric flask. Then 75 ml of ethanol (95%) was added, mixed and filtered. 5 ml of filtrate was diluted upto 50 ml with ethanol. Concentration of drug was determined by measuring absorbance at 420 nm by UV spectrophotometer. [6]

6. **Swelling index:** The extent of swelling was measured in terms of % weight gain by tablet. The swelling behavior of formulation was studied. One tablet from each formulation was kept in petriplate containing pH 6.8 phosphate buffer. At the end of 2 hour the tablet was withdrawn, soaked with tissue paper and weighed. The process was continued till the end of 12 hours. The study was carried out in triplicate. % weight gain by tablet was calculated by formula. [9]

$$\text{Swelling index} = \frac{(Mt - Mo)}{Mo} \times 100$$

7. **Tests for bioadhesivity (The modified balance method):** To measure bioadhesion properties isolated sheep stomach tissue was fixed to steel piece with cyanoacrylate adhesive. This was kept in a beaker and then 0.1 N HCl, pre-warmed to 37° C, was added to the beaker to cover the upper surface of the mucosa in order to maintain its viability. The tablet was attached to the upper clamp with adhesive and then the beaker was slowly raised until the substrate came in contact with the tablet. A preload of 50 g was placed on the clamp for 5 min (preload time) so that adhesion can be established. After this, the preload was removed and water was added to the beaker at a constant rate of 100 drops/min. The addition of water was stopped when the bioadhesive system was detached from the mucosa. The weight required to detach the system from the mucosa was noted. The experiment was repeated 6 times with fresh mucosa in an identical manner. [10]

8. ***In-vitro* disintegration time:** Disintegration test was carried out on six tablets using the apparatus specified in IP (Electrolab disintegration apparatus IP). The distilled water at 370C ± 20C was used as a disintegration media and time in second taken for complete disintegration of the tablet with no palpable mass remaining in the apparatus was measured. [11]

9. ***In vitro* dissolution study:** The *in-vitro* dissolution studies of curcumin tablet were carried out using an USP tablet dissolution apparatus-II rotating 50 rpm, 900 ml phosphate buffer pH 6.8 was used as a dissolution medium. A 5 ml sample solution was withdrawn at predetermined time intervals at 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and12 hours and filtered through a whatmann filter paper. Then filtrate was diluted suitably and analyzed spectrophotometrically using a UV-visible double-beam spectrophotometer. An Equal amount of fresh dissolution medium was replaced immediately after withdrawing a test sample. The percentage of drug that dissolved at different time intervals were calculated using a regression equation generated from the standard curve**.** [12, 13]

RESULTS AND DISCUSSION

Evaluation of *Astercantha longifolia* seed mucilage (ALM) powder:

Extraction:

1. **Normal soaking:** The seeds were soaked for 24 h which showed that swelling of seeds with maximum amount of mucilage around the seeds which was then squeezed from muslin cloth and also then by Buckner funnel but the mixture did not get squeezed from muslin cloth or Buckner funnel.
2. **Stirring:** It was observed that there was no significant effect of stirring by overhead stirrer or magnetic stirrer to get separate the swelled mucilage and was then squeezed from muslin cloth and also then by Buckner funnel the mixture did not get squeezed from muslin cloth or Buckner funnel.
3. **Normal soaking and heating:** The number of batches of 24 h soaked seeds were heated at different temperatures that is at 400 to 1000 ° C was then squeezed from muslin cloth and also then by Buckner funnel but the mixture did not get squeezed from muslin cloth or Buckner funnel.
4. **Normal soaking with different pH:** The number of batches of 24 h soaked seeds with different pH that is pH 1 to 10 and was then squeezed from muslin

cloth and also then by Buckner funnel but the mixture did not get squeezed from muslin cloth or Buckner funnel.

5. **Normal soaking and stirring:** The seeds were soaked for 24 h which showed that swelling of seeds which was then stirred for different speeds but it was observed that the mucilage cannot get separated from seeds and also the mixture did not get squeezed from muslin cloth or Buckner funnel.
6. **Normal soaking, stirring and pH changing:** There was no significant combined effect of normal soaking for 24 h for different pH and then stirring observed. These mixtures were then squeezed from muslin cloth and also then by Buckner funnel but the mixture did not get squeezed from muslin cloth or Buckner funnel.
7. **Stirring without normal soaking:** Stirring without normal soaking also have not any effect to get isolate or separate the mucilage from seeds and also then the mixture did not get squeezed from muslin cloth or Buckner funnel.
8. **Stirring without normal soaking with change in pH:** Stirring without normal soaking with change in pH also have not any effect to get isolate or separate the mucilage from seeds The mixture did not get squeezed from muslin cloth or Buckner funnel.
9. **Stirring without normal soaking with heating:** The seeds without normal soaking but directly stirring with magnetic stirrer at 100 rpm with temperature in between 45 to 55 ° C it was observed that the strings of mucilage were get separated from seeds and then the mixture get squeezed from Buckner funnel.

i) The isolated mucilage was then treated with acetone and then dried but it was observed that the dried mucilage has black color and become very hard which was very difficult to size reduce.

ii) So the isolated mucilage was dried at 60 ° C in hot air oven and it was observed that the mucilage was slight brownish color with easily breakable film which was somewhat transparent.

Appearance of extract powder: ALM fresh mucilage was white in color; ALM powder was a brownish in color.

Figure 1: ***Astercantha longifolia*** **seed mucilage (ALM) powder**

pH: pH of 1% w/v solution was found to be in the range 6.3 – 7.

Viscosity

Viscosity of ALM solution was determined at 50 rpm by using spindle S-62. It was observed that as concentration of ALM powder increased from 0.1 to 0.5 % w/v the viscosity of the solution was also found to be increased from 146.81 to 400.13 cps. The results are given in table 3.

Table 3: Viscosity of ALM Solutions

Sr. No.	Concentration (% w/v)	Viscosity (cps)
1	0.1	146.81
2	0.2	195.93
3	0.3	299.50
4	0.4	359.51
5	0.5	400.13

Loss on drying: Loss on drying for ALM powder was found to be 5%. The moisture content of ALM powder was low, suggesting it's suitability in formulations containing moisture sensitive drug.

Swelling ratio

Table 4: Swelling ratio of ALM powder

Sr. No.	Medium	Swelling ratio
1	Distilled water	14 $\pm$ 0.2
2	0.1 N HCl	8.33 $\pm$ 0.52
3	Phosphate buffer 6.8	9.66 $\pm$ 0.34

All values are mean + SD (n = 3)

Ash value and Acid insoluble ash

Table 5: Ash value and Acid insoluble ash of ALM Powder

Sr. No.	Parameter	Value
1	Ash value	2.74 %
2	Acid insoluble ash	1.17%

Chemical test

ALM powder was tested for presence of carbohydrates, steroids, flavonoids, amino acids, tannins. It shows the presence of carbohydrates and mucilage. Steroids, flavonoids, amino acids and tannins were absent (Table 6).

Table 6: Chemical tests of ALM Powder

Sr. No.	Parameter	Result
1	Carbohydrates	+
2	Steroids	-
3	Flavonoids	-
4	Amino acids	-
5	Tannins	-
6	Ruthenium test	+

+ indicates present, - indicate absent

Flow properties of ALM powder

Table 7 Flow properties of ALM powder

Sr. No.	Parameter	Value
1	Bulk density	0.66 ± 0.02 gm/ml
2	Tapped density	0.81 ± 0.05 gm/ml
3	Hausner's ratio	1.25 ± 0.059
4	Carr's index	16.67 ± 0.17%

All values are mean + SD (n = 3)

Melting point: The melting point of the Curcumin was found to be in the range of 121-123^{0}C.

Determination of λ max: Curcumin shows maximum absorbance at 420 nm.

Calibration curve of Curcumin: The calibration curve of Curcumin was constructed in 0.1 N HCl solution at 420 nm using UV visible spectroscopy. Table 8 shows the absorbance of Curcumin solution containing 0-10 µg/ml of Curcumin in 0.1 N HCl. Calibration curve of curcumin with regression value 0.999 and slope 0.100.

Table 8: Absorbance data of Curcumin in 0.1 N HCl

Sr. No.	Concentration (µg/ml)	Absorbance
1	0	0
2	1	0.1186
3	2	0.2024
4	3	0.3146
5	4	0.4067
6	5	0.5138
7	6	0.6097
8	7	0.7209
9	8	0.8167
10	9	0.9147
11	10	1.0987

Compatibility study:

IR Studies

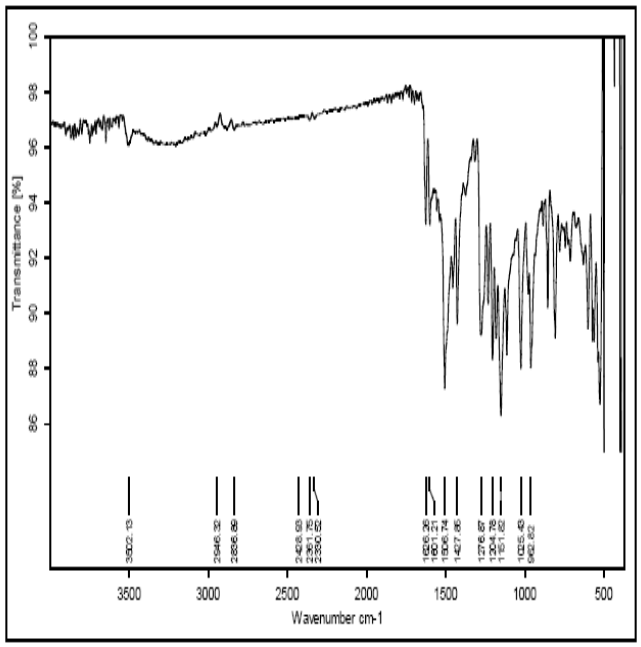

Figure 2: IR Spectra of Drug + ALM powder

Characterization of Powder Blends:

Table 9: Flow properties of powder blends

Batch	Bulk density	Tapped density	Carr's index (%)	Hausner's ratio
F1	0.45± .05	0.52 ± 0.04	13.77± 1.50	1.15± 0.02
F2	0.47± 0.04	0.54 ± 0.04	11.76 ± 0.88	1.13± 0.01
F3	0.44± 0.03	0.51 ± 0.07	12.64± 0.02	1.14 ± 0.01
F4	0.45± 0.04	0.51± 0.07	13.02± 0.35	1.14 ± 0.04
F5	0.48± 0.07	0.56 ± 0.03	13.80 ± 0.77	1.16± 0.01
F6	0.49± 0.04	0.57± 0.07	14.65± 0.28	1.17± 0.03
F7	0.44± 0.16	0.50 ± 0.06	13.4 ± 1.19	1.15± 0.01
F8	0.45± 0.07	0.53± 0.07	15.37± 0.10	1.18 ± 0.01
F9	0.47 ± 0.03	0.53± 0.04	11.39± 0.77	1.12± 0.02
F10	0.44± 0.04	0.50± 0.07	12.49 ± 0.26	1.14± 0.03

All values are mean + SD (n = 3)

The bulk and tapped densities give an insight on packing and arrangement of the particles and compaction profile of a material. The values for bulk density were found to be in the range of 0.44 - 0.49 gm/ml where as the values for tapped density were found in the range of 0.50- 0.56 gm/ml. From the data of bulk density and tapped density, values of Carr's index and Hausner's ratio were calculated and found to be within the permissible limits. The values for Carr's index were found to be in the range of 11.39 to 14.65 which were well within the range specified for Carr's index. The values for Hausner's ratio were found to be less than 1.25. Both these values indicate good flow property and uniform die fill. Angle of repose of all the formulations was found to be less than 25 which indicate good flow property of all the powder blends. Then, from the above discussion it is clear that the powder blends possessed all the characteristics required for direct compression. Hence, direct compression method was employed for compressing the sustained release tablets.

Evaluation of formulated tablets (containing Curcumin + ALM)

Appearance:

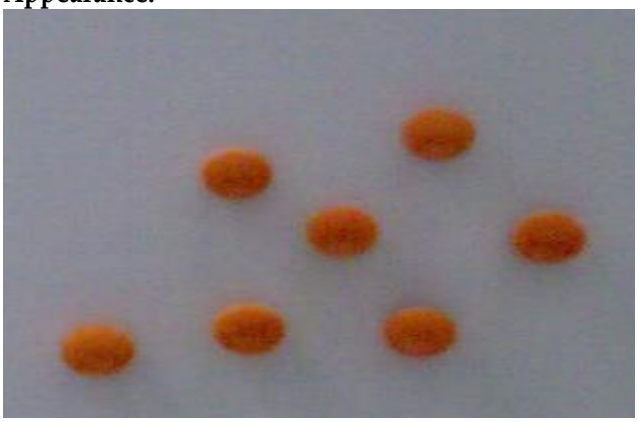

Figure 3: Formulated tablets (containing Curcumin + ALM)

Table 10: Evaluation parameters of formulated tablets

Batch	Hardness (Kg/cm²)	Diameter (mm)	Thickness (mm)	Weight variation	Friability (%)	Drug content (%)
F1	3.52 ± 0.29	9.1± 0.14	3.1± 0.07	Passes	0.34	97.28 + 0.85
F2	3.75± 0.29	9.05± 0.07	3.3± 0.07	Passes	0.38	98.05 + 0.80
F3	4.12± 0.25	9.1 ± 0.1	3.2± 0.07	Passes	0.32	98.42+ 1.01
F4	4.12± 0.25	9.1± 0.0	3.2 ±0.07	Passes	0.36	97.95+ 1.03
F5	3.87 ± 0.25	9 ± 0.07	3.3± 0.0	Passes	0.31	99.48 + 0.52
F6	3.75± 0.29	9 ± 0.0	2.9± 0.07	Passes	0.29	97.72 + 0.72
F7	3.85± 0.29	9± 0.14	3.1± 0.14	Passes	0.36	98.59 + 1.1
F8	3.87± 0.29	9± 0.1	3.3± 0.07	Passes	0.32	98.42 + 1.32
F9	4.5± 0.30	9 ± 0.14	3.4± 0.14	Passes	0.27	98.63 + 1.02
F10	4.5± 0.30	9.1± 0.07	3.2± 0.14	Passes	0.25	98.72 + 0.73

Swelling Index of tablets

Table 11: Swelling Index of formulated tablets:

Time (hr)	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
0	0	0	0	0	0	0	0	0	0	0
2	11.5 ± 0.14	26.4 ± 0.11	33.5 ± 0.02	42.1 ± 0.07	54.1 ± 0.14	59.0 ± 0.52	65.2 ± 0.21	67.23 ± 0.40	68.55 ± 0.20	69.24 ± 0.04
4	15 ± 0.42	29.1 ± 0.25	41.3 ± 0.31	61.2 ± 0.14	63.9 ± 0.14	71.25 ± 0.0	73 ± 0.22	74.6 ± 0.42	74.78 ±0.41	75.15 ±0.50
6	13.1 ± 0.51	34.6 ± 0.22	47.1 ± 0.04	67 ±0.28	69.1 ± 0.28	77.5 ± 0.20	69 ± 0.02	69.08 ± 0.61	66.64 ± 0.36	65.05 ± 0.21
8	10 ± 0.45	33.2 ± 0.01	51.3 ± 0.21	64 ± 0.28	74.1 ± 0.28	76.2 ± 0.25	65.2 ± 0.21	65.58 ± 0.53	62.21 ± 0.31	66.51 ± 0.53
10	20.0 ± 0.21	28.2 ± 0.40	42.2 ± 0.25	62 ± 0.14	71.1 ± 0.03	73.9 ± 0.14	58.5 ± 0.28	55.37 ± 0.29	54.51 ± 0.31	57.23 ± 0.21
12	14 ± 0.15	24 ± 0.58	33.2 ± 0.12	59.6 ± 0.14	64.2 ± 0.05	69.4 ± 0.21	50.1 ± 0.14	49.30 ± 0.13	47.25 ± 0.21	48.6 ± 0.19

In-vitro disintegration time

Table 12: *In-vitro* disintegration time of formulated tablets:

Batch	In-vitro disintegration time (min)
F1	2.25 ± 0.2
F2	3.01± 0.3
F3	3.46± 0.1
F4	4.25± 0.3
F5	5.09 ± 0.5
F6	6.01± 0.1
F7	6.56± 0.2
F8	7.11± 0.1
F9	9.05± 0.3
F10	11.04± 0. 1

Tests for Bioadhesivity:

Table 13: Bioadhesive strength of formulated tablets:

Batch	Bioadhesive strength (g)
F1	32.33 ± 1.52
F2	35.66 ± 1.15
F3	41.66± 0.57
F4	56.66 ± 0.57
F5	64 ± 1
F6	82.33 ±0.57
F7	90.66 ± 0.57
F8	119 ± 1
F9	125.33 ± 0.57
F10	132.33 ± 0.57

In vitro release study:

Table 14: Percentage drug release of formulated tablets:

Time (hr)	F8	F9	F10
1	13.01 ± 0.82	13.26 ± 0.16	8.95 ± 0.27
2	27.85 ± 0.16	24.23 ± 0.40	13.55 ± 0.20
3	35.61 ± 0.41	32.26 ± 0.45	19.3 ± 0.28
4	43.26 ± 0.78	39.6 ± 0.42	27.23 ± 0.41
5	48.71 ± 1.15	45.3 ± 0.40	38.56 ± 0.51
6	52.48 ± 1.47	52.08 ± 0.61	46.64 ±0.36
7	61.48 ± 0.83	58.41 ± 1.04	54.7 ± 0.38
8	65.61 ± 0.61	66.58 ± 0.53	62.21 ± 0.31
9	70.47 ± 0.22	72.01 ± 0.93	70.04 ± 0.38
10	75.81 ± 0.84	81.37 ± 0.29	74.51 ± 0.30
11	87.53 ± 0.20	85.11 ± 0.16	85.12 ± 0.50
12	95.46 ± 0.41	94.3 ± 0.13	93.25 ± 0.21

Formulation F8 to F10 contains ALM powder as a matrix forming agent in the increasing concentration of ALM from 200 mg, 225 mg and 250 mg. It was observed that as the concentration of ALM powder increased % cumulative drug release was decreased. The in vitro drug release of formulations F8 to F10 shows drug release in the range of 95.46 to 93.25 %. It was observed that as the concentration of ALM powder increased from F8 to F10 formulations the swelling index was increased due to formation of gel layer around the tablet core. It has been observed that cumulative % drug release decrease with increasing concentration of ALM powder and swelling index. This is due to slow erosion of gelled layer from the tablets containing higher amount of ALM powder.

CONCLUSIONS:

The present research work was carried out to isolate mucilage from seeds of *Astercantha longifolia* and used as pharmaceutical excipient. The isolation was carried out with the help of different techniques but techniques employing soaking, heating and continuous stirring method were found to be successful method for isolation of mucilage from the seeds of *Astercantha longifolia* with predetermined specification. The isolated mucilage was optimized evaluated for its physicochemical characteristics. By results of evaluation parameters it was decided that the mucilage has adhesive property so tested for bioadhesive nature; it was found that adhesivity is directly proportional to concentration of ALM and subsequently used to formulate Curcumin bioadhesive tablet for stomach ulcer; and the tablet was evaluated for its bioadhesive potential, where it was observed that mucilage showed good bioadhesive property and as it has natural origin it showed no side effects, no toxicity, may reduce cost of preparation so can be used in pharmaceutical industry safely and successfully. Future perspective of the research could be exploring its suitability in other areas of excipient development of ALM powder like gel forming agent, viscosity enhancer and film forming agent etc.

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