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Isolation Of Mucilage From Various Plant Sources and Compare Their Disintegrant Action In Tablet Formulation

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ABSTRACT

The aim of the current study was to isolate mucilage from five different plants, which was done by maceration, followed by incorporating the extracted mucilage into a tablet formulation and to study its disintegrant property. Comparative results were obtained and varying degree of disintegrant action was observed among the five subject plant sources. It was found that *Lepidum sativum* seeds showed the highest yield of 12.5%w/w as compared to the remaining four plant products. Additionally, the disintegration time of tablets formulated from mucilage obtained from *Lepidum sativum* was found to be the least and the tablets disintegrated in 25 seconds. Mucilages are very hydrophilic and are capable of trapping water in their cage-like structures to form a gel. Consequently, when mucilage is mixed with water it swells to many times its original volume as it absorbs water¹. Mucilages find applications in numerous pharmaceutical preparations and perform their role as disintegrants, sustained-release agents, binders, mucoadhesives, to name a few².

Keywords: Mucilage; Paracetamol; disintegrant; swelling ratio; maceration

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INTRODUCTION

Tablet disintegration has received considerable attention as an essential step in obtaining fast drug release. Disintegrating tablets are intended to dissolve or disintegrate rapidly in the mouth for which various natural and synthetic disintegrants are included in the formulation. Recent advances in novel drug delivery system aims to enhance safety and by the formulating a convenient dosage form for administration to achieve the better patient compliance. One such approach is formulation of orally disintegrating tablets, these are useful for pediatric, geriatric and also dysphasia patients, leading to improved patient compliance³. In recent years, plant derived polymers have evoked tremendous interest due to their diverse pharmaceutical applications such as diluent, binder, disintegrants in tablets, thickeners in oral liquids, protective colloids in suspensions, gelling agents in gels and bases in suppositories⁴. Mucilages are pharmaceutical aids in drug formulations which help to modify drug release, improve stability of dosage form, improve bioavailability of active pharmaceutical ingredient, enhance patient acceptability and ensure ease of manufacture. Natural materials are cost effective, non-toxic, stable, easily available with less regulatory issues, eco-friendly, capable of multiple chemical modifications, degradable and compatible⁵. Thus they are preferred in drug delivery. Mucilages of different sources and their derivatives represent a group of polymers widely used in pharmaceutical dosage forms. Mucilage present in plants help to store water and food and also play a role in seed germination and thickening membranes⁶. On one hand, it acts as pharmaceutical adjuvants and on the other hand, mucilages of different sources act as cytoprotective agents. It has been reported that mucilage helps in the treatment of gastric ulcer. It may act by forming a protective layer with increase in mucous secretion from the superficial epithelial cells against the ulcer inducer and thus prevent the penetration of necrotizing agent into the gastric mucosa⁷.

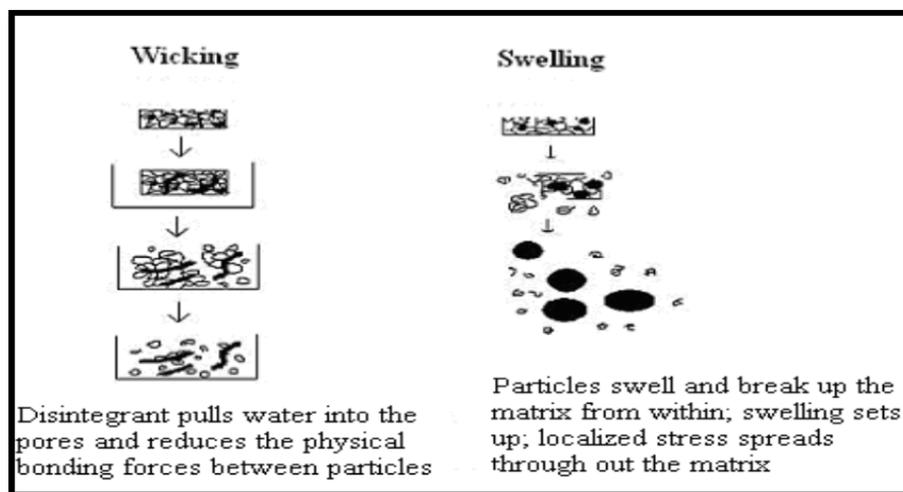


Figure 1: Mechanism of Disintegrant Action

There are two classes of disintegrants: traditional disintegrants, such as starch, and super disintegrants, which include croscarmellose sodium, crospovidone, and sodium starch glycolate. Currently, these three super disintegrants are the most popular disintegrants. In capsule formulations, super disintegrants are typically used at levels from 4% to 8%, which is about twice that used in a typical tablet formulation. The reason for this is that when a disintegrate breaks apart the plug, it does so by swelling, and this expansion of the disintegrant particles pushes the adjacent particles apart, but because plugs have a much higher porosity and the particles are not packed as close together, a given amount of expansion does not push the particle apart as much as in a tablet where the particles are much closer together. Sodium starch glycolate is known to swell more than other super disintegrants, which makes it a popular choice for capsule formulations.⁸

A disintegrant is added to most tablet formulations to facilitate a breakup or disintegration of the tablet when it contacts water in the gastrointestinal tract. Disintegrants may function by drawing water into the tablet, swelling and causing the tablet to burst apart. Such tablet fragmentation may be critical to the subsequent dissolution of the drug and to the attainment of satisfactory drug bioavailability.

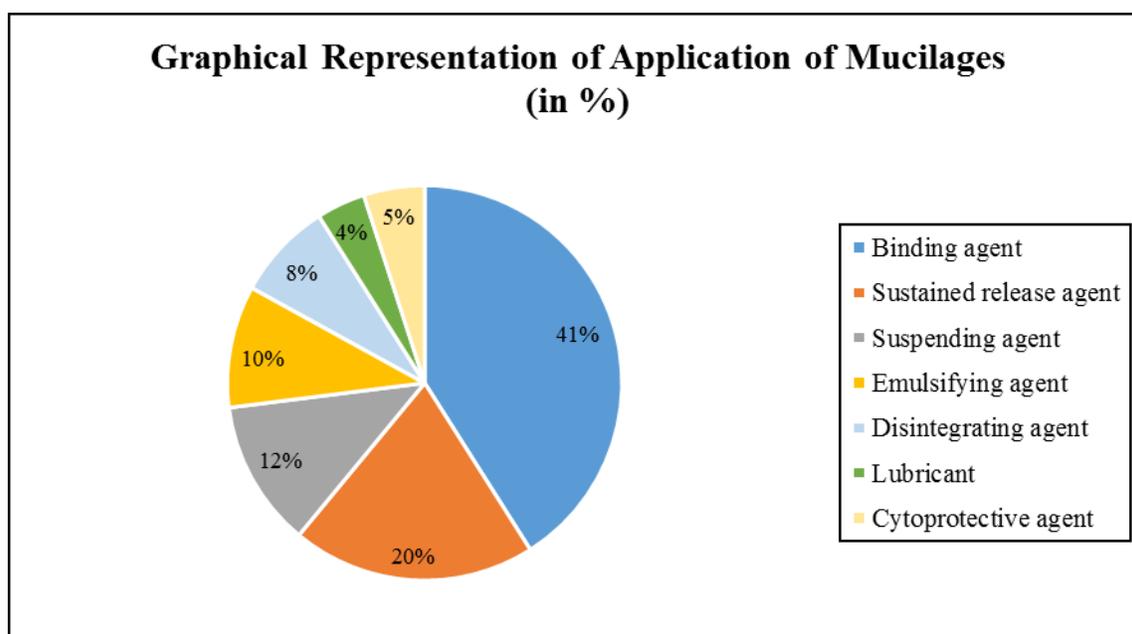


Figure 2: Graphical Representation of Application of Mucilages (in %) ⁶

MATERIALS AND METHOD

The five plants used to isolate the mucilage were *Lepidum sativum*, *Linum usitatissimum*, *Dioscorea alata*, *Solanum tuberosum*, *Hibiscus rosa-sinensis*, all these materials were procured from a local market in Navi Mumbai, India. Paracetamol, ethanol, acetone, talc, magnesium stearate and other chemicals were obtained from Research Lab-Fine Chem Industries, Mumbai.

Disintegration test apparatus, Friability test apparatus, Hardness tester, Hot air oven and Dissolution test apparatus were some of the equipment used.

Method of Extraction

Maceration:

The process is intended to break and soften the plant's cell wall to release the soluble phytochemicals⁹. The mature plant part was cut or ground into small pieces and was subjected to overnight soaking in water. The materials were then filtered through a muslin cloth which yielded a plant residue. The residue was allowed to precipitate by addition of ethanol or solvent. The choice of solvent depended on the type of plant used. The precipitate thus obtained was later washed with acetone and dried in hot air oven at 60°C and dried mucilage powder was collected and subjected to various physicochemical characterization tests.

Physicochemical characterization of mucilage

Swelling index:

Accurately weighed (1g) powdered mucilage was taken in a 25 ml measuring cylinder, 25ml of fresh distilled water was added and mixture was shaken thoroughly every 10 minutes for 1 hour and allowed to stand for 3 hours at room temperature. Swelling index can be calculated using the formula-

$$\text{Swelling index} = \frac{X_t - X_o}{X_o} \times 100$$

Where, X_o = initial height of the powder in graduated cylinder and X_t = height occupied by swollen gum after 24 hours.

pH of mucilage:

The mucilage was weighed and dissolved in water separately to get a 1% w/v solution. The pH of solution was determined by using digital pH meter.

Loss on drying:

Moisture content of mucilage can be determined by loss on drying method. Accurately weighed 1g sample was heated at 105°C to get a constant weight in a hot air oven and percent loss of moisture on drying was calculated using following formula-

$$\text{LOD (\%)} = \frac{\text{Weight of water in sample}}{\text{Weight of dry sample}} \times 100$$

Solubility of mucilage:

One part of dry mucilage powder was shaken with different solvents such as methanol, ethanol, hot water, cold water for the determination of solubility behavior of the mucilage.

Molisch's test:

Small quantity of mucilage powder was mixed with Molisch reagent and conc. H₂SO₄ was added

from sides of test tube. Violet green colour observed at junction of two layers confirms presence of mucilage.

Ruthenium red test:

A small quantity of dried mucilage was dissolved in 2ml distilled water, mixed with a few drops of Ruthenium red solution. Observed pink colour indicates the presence of gums and mucilage.

Bulk density:

It is measured by putting the accurately weighed powder into a graduated cylinder and the volume was calculated using following formula-

Bulk density = Weight of powder/ Volume occupied by powder

Tapped density: The tapped density can be determined by three tap method. Weighed quantity of powder was carefully introduced into a 10 ml graduated cylinder and was dropped on hard wood surface on tiles three times from height of 2.5 cm. It was calculated by using formula.

Tapped density = Weight of powder/ Final volume after tapping

Compressibility index:

It is indirectly related to the relative flow rate, cohesiveness and particle size of the powdered mucilage. It is fast, simple and popular method of predicting powder flow characteristics. It was calculated by following formula:

Compressibility index = $\frac{\text{Tapped density} - \text{Bulk density}}{\text{Tapped density}} \times 100$

Hausner's ratio:

It is an index which shows the ease of powder flow; it was determined by using the following formula²:

Hausner's ratio = $\frac{\text{Tapped density}}{\text{Bulk density}} \times 100$

Formulation of tablets containing extracted mucilage as disintegrant

The granules of Paracetamol were prepared by wet granulation method using the extracted mucilage and starch paste (10% w/w) as a binder.

Wet granulation method: Paracetamol and other ingredients were passed through 80 mesh and required quantity was weighed. Extracted mucilage was mixed with it in the mortar. Starch paste was prepared and small quantities were added to get a dough like a mass. The wet mass was sieved through 10 mesh sieve. Granules were collected and dried at 60°C for 15 minutes. Dried granules were sieved through 20 mesh and retained on 40 mesh. Granules retained on 40 mesh were collected. The granules were weighed and 10% fines of granules (below 40 mesh) were added. This was followed by addition of lubricant and extra granular disintegrant. The mixture was mixed properly and compressed into tablets.

Evaluation of tablets

Thickness:

Thickness of tablet was measured by vernier caliper.

Hardness test:

The hardness of a tablet is an indication of its strength. The force was measured in kilograms.

Friability test:

This in process quality control test is performed to ensure the ability of tablets to withstand the shocks during processing, handling, transportation, and shipment. Permitted friability limit is 1.0 %.

Weight uniformity test:

The percentage weight deviation of each tablet from average weight was calculated using the following formula. Deviation within the IP permissible limit of 5% is allowed as the tablet weighs 300 mg.

$$\% \text{ Deviation} = \frac{\text{Average weight} - \text{Individual weight}}{\text{Average weight}} \times 100$$

In- vitro dissolution time:

In vitro drug release of the samples was carried out using USP – type II dissolution apparatus (paddle type). The dissolution medium, 900 ml of phosphate buffer (pH 6.8) solution, was placed into the dissolution flask maintaining the temperature of $37 \pm 0.5^\circ\text{C}$ and rpm of 50. One tablet was placed in each flask of dissolution apparatus. The apparatus was allowed to run for 10 min. Samples measuring 5 ml were withdrawn after every 2, 4, 6, 8 and 10 min. Samples were filtered through 10 μm filter. The fresh dissolution medium was replaced every time to maintain sink condition. The collected samples were analyzed at 249.60 nm using dissolution medium as blank. The cumulative percentage drug release was calculated.¹⁰

Disintegration time:

One tablet was introduced into each tube of the disintegration apparatus. Suspend the assembly in the beaker containing the medium and operate the apparatus for the specified time. Remove the assembly from the liquid. The tablets pass the test if all of them have disintegrated. If one or two tablets fail to disintegrate, repeat the test on 12 additional tablets; not less than 16 of the total 18 tablets tested disintegrate. The preparation complies with the test if all the tablets in the repeat test disintegrate.¹¹

RESULTS AND DISCUSSION

Method of Extraction of Mucilage:

The seeds of *Lepidum sativum* contain the mucilage around the outer layer. The major problem in

isolation of mucilage is that it swells but does not separate from the seeds. Because of this, general methods of separation are not applicable to separate the seed mucilage and hence, different procedures were studied and the present method was accepted ¹². In the present project, ethanol and acetone were used as solvents for precipitation of mucilage from plant part. This method was found to be uncomplicated with minimum steps of extraction. It is a cost-effective method as it consumes less volatile solvent because acetone increases the rate of precipitation. Acetone being more volatile in nature was completely removed and no traces of solvent were found in the dried mucilage. The mucilage was dried at 60°C which reduced the time for extraction. The drying temperature did not affect the mucilage stability.

Physicochemical characterization

Organoleptic properties:

The mucilages obtained from the five different plant sources demonstrate a spectrum of organoleptic properties. The mucilage was observed for their colour, odour and appearance. The solubility of the mucilage were examined under different solutions. All the mucilages were found to be soluble in water to some extent, while showing varied solubility in solvents like ethanol, acetone and chloroform. The results of organoleptic parameters are shown in Table 1.

Table 1. Organoleptic parameters

Sr. No	Parameters	Observations				
		<i>Lepidum sativum</i>	<i>Linum usitatissimum</i>	<i>Dioscorea alata</i>	<i>Solanum tuberosum</i>	<i>Hibiscus rosa-sinensis</i>
1.	Colour	Light brown	Brown	Light brown	White	Creamy brown
2.	Odour	Characteristic	Odourless	Characteristic	Odourless	Characteristic
3.	Appearance	Non-lustrous	Crystalline	Amorphous	Crystalline	Amorphous
4.	Solubility	Forms colloidal solution, soluble in lukewarm water, practically insoluble in ethanol and chloroform	Mucilage is soluble in water and insoluble in alcohol	Soluble in water, insoluble in alcohol and acetone	Soluble in warm water	Swells to form a gel in cold water, soluble in hot water, insoluble in acetone, chloroform and ethanol



Figure 3. *Lepidium sativum* mucilage powder **Figure 4. Precipitation of mucilage by acetone**

Physicochemical characterization of mucilage:

The extracted mucilage was evaluated for various physicochemical parameters such as Molisch and Ruthenium Red test, pH, swelling ratio, loss on drying, bulk density, tap density, compressibility index and Hausner's ratio. All the five different types of mucilages were found to pass the common identification test of mucilage owing to the appearance of purple and pink colour in Molisch and Ruthenium red test, respectively. The pH of the mucilages were found to be near the neutral range. The swelling ratio of the mucilage were calculated in solutions of different pH ranges, ranging from acidic, basic to neutral. The particle size of the mucilage was reduced by passing it through 80 mesh sieve, due to which each particle was found to swell at a greater extent resulting in a higher swelling index. The weight loss on drying was calculated and it was observed that mucilage extracted from *Dioscorea alata* showed highest weight loss on drying of 12.01% compared to the other mucilages which indicated that more amount of moisture was present in the material which would be available to interact with other material in the formulation. The bulk and tapped density along with compressibility and Hausner ratio were calculated and the values obtained showed that the mucilage possesses good flow properties.

The results of the physicochemical characterization of the dried mucilage is shown in Table 2.

Table 2. Physico-chemical characterization of dried mucilage

Sr. No.	Parameters	Observations				
		<i>Lepidium sativum</i>	<i>Linum usitatissimum</i>	<i>Dioscorea alata</i>	<i>Solanum tuberosum</i>	<i>Hibiscus rosa-sinensis</i>
1.	Identification: Ruthenium red test Molisch test	Mucilage present Mucilage confirmed				
3.	pH	5.8	6.6	6.35	6.7	7.1

4.	Swelling ratio					
	In 0.1 N HCl	6.1	5.9	5.9	5.1	4.1
	Phosphate buffer pH 7.4	3.3	4.3	3.6	4.2	5.9
	Distilled water	64	43	47	50	27
5.	Loss on drying	1%	0.9%	12.01%	5.1%	0.9
6.	Bulk density	0.62	0.58	0.46	0.48	0.46
7.	Tapped density	0.78	0.75	0.72	0.55	0.72
8.	Compressibility index	19.55%	18.05%	17.96%	19.09%	17.96%
9.	Hausner's ratio	1.09	1.29	1.02	1.21	1.02

Tablet formulation:

After considerable evaluation of the pre-compression parameters of the dried mucilage obtained from the five different plants, the next step was formulation of tablets by wet granulation method. Paracetamol was chosen as the active pharmaceutical ingredient which is a common analgesic and anti-pyretic. Tablets were formulated by incorporating the extracted and dried mucilage as a disintegrant. Starch paste performed the function of a binding agent. The wet mass was successfully prepared and care was taken that the dough was not too sticky or too dry, or else the tablets would not have been compressed effectively. After granulation process, extracted mucilage was added again as a disintegrant followed by talc which acted as a lubricant and glidant. Magnesium stearate was also added for an extra lubricant action.

The formula used for tablet formulation is shown in Table 3.

Table 3. Formulation of Paracetamol tablets

Sr. No.	Ingredients	Quantity taken (For 10 tablets)
1.	<u>BEFORE GRANULATION:</u> Paracetamol I.P.	3 gms.
2.	Mucilage (extracted from plant)	0.075 gms.
3.	Starch paste 10% w/w	0.13 gms.
4.	<u>AFTER GRANULATION:</u> Mucilage(extracted from plant)	0.06 gms.
5.	Talc I.P.	0.02387 gms.
6.	Magnesium stearate	0.0119 gms.

Evaluation of Tablets:

The results of pre-compression parameters indicated good free-flowing properties as shown in Table 2. The weights of the prepared tablets were within the permissible limits according to the Indian Pharmacopoeia. The thickness of the tablets were within a range of 2 to 2.1 mm, whereas hardness of the tablets was found to be in the range of 4 to 4.5 kg. Since all the tablets prepared from different mucilages showed friability of 0.67 to 0.68%, which was less than 1%, which stipulates that the tablets had a good mechanical resistance. The tablets were found to pass the

weight uniformity criteria. The drug release rate of all the tablets was found to be excellent showing that natural disintegrants showed rapid action and the tablet containing *Lepidum sativum* mucilage exhibits the highest release rate of 95.7%, as compared to the rest of the tablets. Disintegration time of tablets obtained from *Lepidum sativum* was found to be the least, which demonstrates that the tablets have a rapid onset of action, owing to the high swelling property of the mucilage.

The results of evaluation of tablets is shown in Table 4.

Table 4. Evaluation of tablets

Sr. no.	Tests	Observations				
		<i>Lepidum sativum</i>	<i>Linum usitatissimum</i>	<i>Dioscorea alata</i>	<i>Solanum tuberosum</i>	<i>Hibiscus rosa-sinensis</i>
1.	Thickness	2.1 mm	2mm	2.2 mm	2 mm	2 mm
2.	Hardness	4.5 kg	4 kg	4 kg	4.1 kg	4.2 kg
3.	Friability	0.67	0.67	0.68	0.67	0.68
4.	Weight uniformity	Passes	Passes	Passes	Passes	Passes
5.	Cumulative drug release at 30 minutes.	95.7%	93.7%	92.45%	93.48%	95.35%
6.	Disintegration time	25 seconds	30 seconds	35 seconds	40 seconds	39 seconds

Table 5. Percentage yield of Mucilage

S. no.	Plant source	Percentage yield (%w/w)
1.	<i>Lepidum sativum</i> Linn.	12.5%
2.	<i>Linum usitatissimum</i>	4%
3.	<i>Dioscorea alata</i>	3.3%
4.	<i>Solanum tuberosum</i>	2.5%
5.	<i>Hibiscus rosa-sinensis</i>	4.1%

DISCUSSION

In the present study, the aim was to isolate the mucilage from various plant sources and study their disintegrant property by incorporating them in a suitable tablet formulation. For isolation of mucilage, maceration technique was followed as it is the most convenient and economical as compared to other methods of extraction. The next step was physicochemical characterization of the mucilage powder. Here, certain tests were carried out to assess the physicochemical nature of the mucilage obtained and to study its properties as a disintegrant. This was done by calculating the swelling ratios of each plant mucilage. As the mucilage swells up to a greater extent in water, it can be used as an effective disintegrant as well as superdisintegrant in pharmaceutical formulations. Further, tablets were formulated using Paracetamol as active ingredient following the wet granulation method and finally compression into tablets. The tablets were evaluated for quality

and disintegration time was found out. The tablets containing the mucilage with the fastest disintegration time proves to be a better natural disintegrant.

CONCLUSION

From the present study, it can be concluded that natural substances, i.e. plant sources which yield mucilage show good disintegrating properties and can be used in tablet formulations as a disintegrating agent in certain concentrations. As natural substances are cheap, biocompatible, biodegradable and easy to manufacture, they can be used as superdisintegrants in place of currently marketed synthetic super-disintegrating agents. There are large numbers of natural polymers which have been used in pharmaceutical preparations. Natural substances like gums, mucilages, and also dried fruits can be used as a binding agent. They have showed good potential as a disintegrating agent as well as they possess some other properties like fillers, binders, sustained releasing agent. Natural polymers showed good binding property in wet granulation, granules are stable and less friable in comparison with other binders. The present study forms a preliminary basis for research into modified mucilages, for example gum arabic.

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REFERENCES

1. Kerry Bone and Simon E. Mills. Principles and Practice of Phytotherapy: Modern Herbal Medicine, 2nd ed., Churchill Livingstone; 2013: 17-82.
2. Archana Chaudhary, Amit Sharma and Rinu Rana. Mucilage: Isolation, Characterization and Sources. International Journal of Phytopharmacy Research 2014; 5(3): 139-143.
3. Khinchi et al., Studies on the Disintegrant Properties of Seed Powder, Husk Powder and Mucilage of Plantago Ovata By Formulation Of Orally Disintegrating Tablet. IJPSR, 2011; 2(1): 145-152.
4. Rishabh Malviya, Pranati Srivastava and G.T. Kulkarni, Applications of Mucilages in Drug Delivery- A Review. Advan. Biol. Res. 2011; 5(1): 01-07.
5. Vipul D. Prajapati , Girish K. Jani, Naresh G. Moradiya, Narayan P. Randeria,

- Pharmaceutical applications of various natural gums, mucilages and their modified forms, Carbohydrate polymers. 2013: 1685-1699.
6. Moumita Chowdhury, Abhjit Sengupta, Lopamudra Dutta, Sumana Chatterjee, Role of mucilage as pharmaceutical additives and cytoprotective agent. JIPBS 2017; 4(2): 46-52.
 7. Galati E M., S. Pergolizzi, N Miceli, M.T. Monforte, et al. Study on the increment of the production of gastric mucus in rats treated with *Opuntia ficus indica* (L.) Mill. Cladodes Journal of Ethanopharmacology 2002; 8(3): 229-233.
 8. S.W. Hoag. Developing Solid Oral Dosage Forms, 2nd ed. 2017: 723-747.
 9. Waghmare Deepak Harishchandra, Deshmukh Arti Madhukar. Extraction Methods for Preparation of Bio Active Plant Extracts. BioTech Articles. 2017
 10. Rita N. Wadetwar et al. Development of orodispersible tablet using *Lepidum sativum* seed mucilage as natural super disintegrant. International Journal of ChemTech Research 2017; 10(6): 605-616.
 11. Ankur Chaudhary. Disintegration test and apparatus. Pharmaceutical Guidelines. 2011 www.pharmaguideline.com
 12. Sachin S. Salunkhe, et al. Extraction and Characterization of Mucilage from *Lepidum sativum* Linn. seeds. Der Pharmacia Lettre 2014; 6(1): 65-70.

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