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An Overview on Isolation and Characterization of Mucilage from Various Species Related to Various Plant Families

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Original Research Article

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Abstract: Mucilage can be extracted from various plants and microorganisms. It is said to be a Polar glycoprotein and exo polysaccharide. In this article we compare different isolation techniques of mucilage and compare their characteristics such as their physical nature, solubility, chemical properties, Total Ash percentage, percentage yield etc. Isolation of mucilage techniques vary from one another with accordance to the presence of mucilage in different parts of a plant such as stem, leaves, fruit, seed etc. After detailed study of these different types of mucilage of various families we could identify that all types of mucilage had presence of carbohydrates in it and all gave positive results to Molisch tests and ruthenium red test. The pH range of all these types of mucilage was found to be in the range of 6.2-6.6.All the types of mucilage have a characteristic odor. All the types of mucilage extracted from the selected plants are edible and also can be utilized as a glue. By detailed study of these plants from various families we can conclude that there are similarities among them with regard to their mucilage and the mucilage extracted from each and every plant has a characteristic utility in pharmaceutical area as it can be used as thickening, binding, disintegrating, suspending, emulsifying, stabilizing and gelling agents. They have also been used as matrices for sustained and controlled release of drugs.

Keywords: Mucilage, isolation, Malvacae, Moraceae, Araceae.

INTRODUCTION

There are several beneficial medicinal uses of *Atrocarpus heterophyllus* plant which belongs to moraceae family such as anti-bacterial, anti-inflammatory, anti-diabetes and anti-pyretic properties. Preclinical studies have shown that along with these effects they also cause a transient decrease in the sexual activity [1]. The leaves of Lepidium *sativum* which belongs to Brassicaceae family are having antiscorbutic, diuretic and stimulant properties. Okra plant belonging to Malvaceae family are rich in mucilage has a very strong demulscent action. The decotion of fresh roots of *Polyalthia suberosa* which belongs to Annonaceae family is said to be having abortifacient properties.

The purpose of this article is to compare different isolation techniques of mucilage and identify the unique characteristics of different types of mucilage of different plants. Mucilage is said to be the main source of polysaccharide in most of the plants. Some of the carnivorous plants like Drosera species utilize it for trapping insects. The common techniques utilized for isolation is Acetone test and the preliminary Confirmatory test for mucilage are Molisch test and Ruthenium Red test. In this article we compared various characteristics of mucilage such as Percentage yield, Total Ash percentage, Bulk density, Physical nature etc. The mucilage of each and every plant has a pharmaceutical use. Some of the mucilage can also be utilized in Anti-Inflammatory drugs.

Mucilage is a thick, gluey substance produced by nearly all plants and some microorganisms. Mucilage in plants plays a role in the storage of water and food, seed germination, and thickening membranes. It is a polar glycoprotein and an exopolysaccharide. Mucilage mixed with water has been used as a glue, especially for bonding paper items such as labels, postage stamps, and envelope flaps. Differing types and varying strengths of mucilage can also be used for other adhesive applications, including gluing labels to metal cans, wood to china, and leather to pasteboard. During the fermentation of nattosoyabeans, extracellular enzymes produced by the bacterium Bacillus natto react with soybean sugars to produce mucilage. The amount and viscosity of the mucilage are important nattō characteristics, contributing to nattō'sunique taste and smell. As in other filamentous or colonial bacteria, the cells of cyanobacteria may join by their walls or by mucilaginous sheaths, but each cell is an independent

unit of life. As true Bacteria, cyanobacteria contain peptidoglycan or murein in their cell walls.

Isolation techniques of mucilage

There are different methods of isolation firstly depending upon the presence of mucilage in a particular part of a plant such as leaves, stem, fruit, seeds etc. In the technique used for isolation from leaves drying process is not performed whereas for extraction of mucilage from other parts of the plant like stem drying process is very much essential. In the case of method used for isolation from fruit of a plant they are made to be directly crushed in a mixer without drying. Although there are differences in the methods followed the chemicals utilized for isolation are mostly the same? The common chemicals used for isolation are Petroleum ether, ethanol, acetone etc.

Different types of mucilage isolated

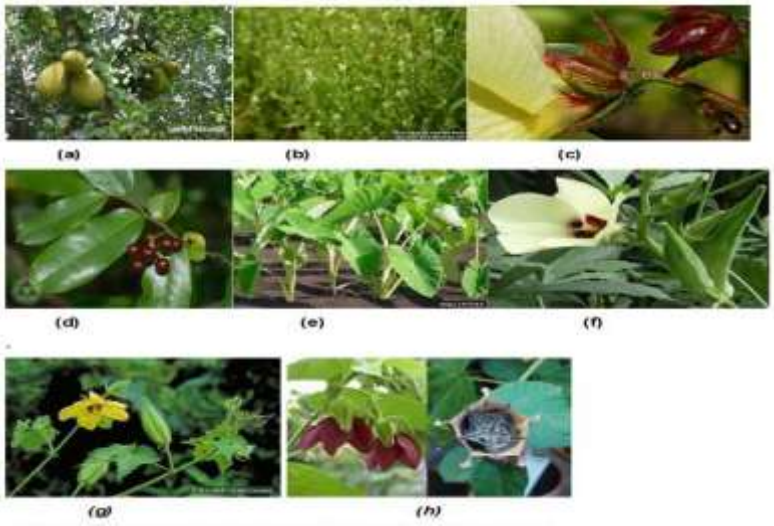

Fig-1: Plants related to various families from which mucilage was isolated
(a)Artocarpus heterophyllus Lam, (b)Lepidium sativum Linn, (c)Abelmoschus esculentus Linn, (d)Polyalthia suberosa, (e)Colocasia esculanata Linn, (f) Hibiscus esculentus Linn, (g) Abelomoschus medic Linn,(h) Abroma augusta L

Mucilage of Artocarpusheterophyllus Lam

In this study Narkhede Sachin,*etal*.:, reported mucilage obtained from *A.heterophyllus Lam.*(family: Moraceae; commonly known as jack tree, jackfruit) which are found in the wild of the forest region. Their fruits are said to be multiple seeded containing mucilage [2]. To isolate mucilage, pulp was removed and then it was macerated with water. After filtering it, acetone precipitation method was used to isolate mucilage from filtrate and was made to dry in a vacuum dryer at 40°C[1]. The methods used to determine the physicochemical characteristics of mucilage such as swelling index, solubility, loss on drying was performed[2].This study was carried out to compare the binding effects of isolated mucilage with starch. Mucilage was made to be isolated from seeds of *A. heterophyllus* by acetone method. Then few portion of the mucilage was taken and transferred it into watch glass with ruthenium red reagent, then after sometime that portion was taken onto a glass slide and was observed in microscope. Firstly 100 gram mucilage containing part was taken from the plant and boiled with 1000 milliliter distilled water for 15 min and then filtered through Buckner funnel without filter paper [2]. The retained residues were made to be boiled with 500 ml distilled water for 15min and the combined liquid was made to be passed through eight folds of muslin cloth. The mucilage was precipitated from the filtrate by adding ethanol. The precipitated mucilage was made to dry in an oven at 45°C till it was completely dried. The mucilage had presence of Carbohydrates and Flavonoids. The test for mucilage with ruthenium red results Positive for this plant. The mucilage is sparingly soluble in cold and hot water. The swelling index is 12.2. The moisture content is 9.05 and pH ranges from 6.2-6.8. The compressibility index values up to 21% result in fair to passable flow properties. The total ash percentage is 8.56%.

Mucilage from Lepidium sativum Linn seeds

In 2010 Divekar Varsha, *et al*., reported mucilage obtained from seeds of *Lepidium sativum Linn*. (Family: Brassicaceae). The research proposal of the author was made to isolate and characterize its morphological characteristics, identification by chemical tests, solubility, melting range, pH, Swelling index, Ash values, presence of foreign organic matter, test for lead and arsenic, Loss on drying, Density, compressibility index and angle of repose which will be standardizing parameter for future scientists. The

mucilage of this plant was collected from seeds. This plant was procured form local market in the form of very small brown seeds [3]. Mucilage was extracted by soaking the seeds of the plant with 10 times of its weight of distilled water and was kept for 24 Hrs [3]. The viscous solution obtained was passed through the muslin cloth. The mucilage was made to precipitate out by addition of 95% ethanol in the ratio of 1:1 by continuous stirring. The coagulated mass was dried in oven at 40 – 45^{0}C, powdered by passing through sieve and was stored in airtight container (yield – 14% w/w).[3]The percentage yield of mucilage was recorded to be 14gm%w/w and it was also soluble in Luke warm water and insoluble in organic solvents. The moisture content of mucilage obtained was 7%.Themucilage decomposes above 200^{0}C which was a characteristic of most of the Polysaccharide. The swelling index was found to be 18.

Mucilage from Abelmoschusesculentus Linn

In 2011 Biren.N.Shah, *et al*. reported mucilage obtained from fruits of *Abelmoschus esculentus Linn*. (Family: Malvaceae Commonly known as: Okra).A microwave assisted extraction technique was developed to optimize the extraction of mucilage from this plant. Microwave extraction at 160 W intensity and 40 min heating duration increased 11.55% in the yield of mucilage when compared to 1 h conventional heating method.[4] The fruits of this plant were used for the isolation of mucilage. The fruits of this plant (5 g) were powdered for 5 min in a mechanical blender and were soaked in distilled water (150 ml) for 24 h in a RB flask. It was boiled for 1h under reflux with occasional stirring and kept aside for 2 h for the release of mucilage into water. The material was made to get filtered through a muslin bag and hot distilled water (25 ml) was added through the sides of the marc and was squeezed well in order to remove the mucilage completely. Equal volume of ethanol was added to the filtrate to precipitate the mucilage and kept inside a refrigerator for one day for effective settling. It had been filtered and dried completely in an incubator till 37º C. Then finally they were powdered and weighed. It was subjected to chemical tests to confirm its identity. The percentage yield of this mucilage is 11.55%.

Mucilage from Polyalthia suberosa

In 2010 Sunil Mistry,*et al*. reported mucilage obtained from leaves of *Polyalthia suberosa* (Family: Annonaceae). This is a medicinal plant which has been traditionally being used as Adaptogenic drug [4]. Present study was done on mucilage, obtained from leaves of *P. suberosa*(PSM). Various physicochemical as well as pharmaceutical properties of mucilage was studied. Dried leaves of this plant were grounded to fine powder [5]. Powder was firstly defatted by using pet.ether and then they were extracted with methanol to remove saponins. Then marc had been soaked in warm water for 3 hours and kept aside for 2 hours. Material was squeezed in a muslin bag to remove marc from filtrate [5]. Filtrate was added slowly to acetone to precipitate the mucilage. The mucilage was then separated and made moisture free with successive precipitation with ethanol. Finally isolated mucilage was dried in an oven at temperature less than 50^{0}C [5]. It was powdered and stored in desiccators until use. Percentage yield of PSM (*P. suberosa* mucilage) was 6.6 %.The mucilage obtained was a pale whitish crystalline powder. The mucilage shows presence of glucose and mannose by Osazone tests. This mucilage obtained was found to have a potential as a suspending agent, binding agent and pharmaceutical adjuvant.

Mucilage from Colocasia esculanata Linn

In 2014 C.A.Alalor, *et al*. reported mucilage obtained from *Colocasia esculenta*(Family Araceae Commonly known as: Taro) This plant was characterized for its morphological characteristics, identification by chemical tests, Solubility, pH, Swelling index, Density, compressibility index and angle of repose *etc*.[6] The isolated mucilage had showed positive results for Molisch's test and Ruthenium red test which indicated presence of carbohydrate and mucilage. Results of physicochemical tests indicated that the mucilage was suitable for tablet dosage form and also as a suspending agent for suspension due to its compressibility, flowability, weakly acidic pH, and swelling and viscous nature. The fresh rhizome of this plant was collected and was washed with water. The tubers were crushed and soaked in water for 6 hours. After boiling for 30 minutes, they were left to stand for 1 hour which would allow complete release of the mucilage into the water. The mucilage was extracted using a muslin cloth bag to remove the marc from the solution. Acetone (in the volumes of three times to the volume of filtrate) was added to precipitate the mucilage. The mucilage was separated, dried in an oven at 40°C, collected, grounded and were made to pass through a #80 sieve and was stored in a desiccator at 30°C & 45% relative humidity till use [6]. The mucilage isolated was a whitish powder with characteristic odour and lustrous in nature. The percentage yield mucilage was found to be 25% [6]. Phytochemical investigation of this mucilage showed the presence of carbohydrates while tannins, alkaloids, proteins, glycosides, flavonoids are absent. The resulting mucilage was found to be always soluble in warm water and insoluble in organic solvents. The moisture content of this mucilage was found to be 7%.The swelling index of mucilage is 18 and pH of mucilage is 6.1.

Mucilage from Hibiscus esculentus Linn

In 2011 Rishabha Malviya,*et al*. reported mucilage obtained from fruit of *Hibiscus esculentus Linn* (Family: Malvaceae Commonly known as: Okra) and further characterized to be used as pharmaceutical excipient. Tablets were prepared using four different concentrations (6.6%, 13.3%, 20%, and 26.66%) of this mucilage and potato starch was used to evaluate binding

properties of mucilage [7]. Results obtained from the micro meritic characterization and flow behavior showed the mucilage obtained was a good candidate to be used as a pharmaceutical excipient [7]. The fruit of this plant was used for isolation of mucilage [7]. Fruit of this plant was firstly washed with water to remove dirt and crushed into a mixer. The crushed fruit material was soaked in warm water for 4 hours, boiled for 2 hours and was kept aside further for 2 hours for release of mucilage into water. The material was squeezed into a muslin bag to remove the mark from the filtrate..Equal volume of ethyl alcohol was added tothe filtrate inorder to precipitate out the mucilage; the mucilage was separated, dried in an oven at about 45°C. Then it was powdered and passed through a sieve at 80^{0}C [7].The powdered mucilage was stored in desicator until further use. The percentage yield of mucilage was found to be 9.17%. Phytochemical investigation of isolated mucilage showed the presence of carbohydrates while gum, tannins, alkaloids and proteins showed negative test. The pH of 1% solution of this plant'smucilage was found to be 6.3 which indicate that this mucilage was less irritating in GIT and suitable for uncoated tablet. Swelling index of mucilage was found to be 11.2 for isolated mucilage. The mucilage is soluble in hot water and insoluble in organic solvents.

Mucilage from Abroma augusta

The study done by Chandrima Chatterjee *et al.* [8] on this plant which belongs to the family Malvaceae showed the methodology involved in isolation and characterization of mucilage. The mucilage was isolated from leaves of the plant. The methodology used in isolation of mucilage of this plant was one of the most commonly used technique in isolation of mucilage from leaves. It involved processes such as collection from a matured plant and they were made to dry firstly with the help of hot air oven until the moisture content reaches to 5%. Then the dried leaves were crushed, powdered and sieved and then allowed to soak in water for 5-6 hours and finally they were made to boil and then mucilage was isolated. The viscosity, pH and sedimentation volume of the isolated mucilage was determined in this study. The mucilage isolated was said to be brown in colour, odourless and sweet in taste. Mucilage of this plant was freely soluble in hot and cold water. It is said to be less soluble in boiling water and sparingly soluble in organic solvents. The viscosity of the mucilage was said to be directly proportional to the concentration of suspension. Swelling index of the isolated mucilage was found to be 23.5. The alcoholic extract of leaf showed presence of saponins, carbohydrates, flavonoids, coumarins, glucosides and reducing sugar. This plant is said to be useful in treatment for jaundice, dermatitis, rheumatic pain, cough, hypertension and diabetes [9, 10].

Table-1: Comparison of all the properties of isolated mucilages from various plants

S.No	Name of the plant	pH range	Percentage Yield(%)	Moisture content(%)	Swelling index
1.	*Artocarpus heterophyllus*	6.2-6.8	8.5	9.05	12.2
2.	*Lepidium sativum*	7	11	7.0	18
3.	*Abelmoschus esculentus*	6.3	11.55	7.2	14
4.	*Polyalthia suberosa.*	5.7	6.6	1.82	4
5.	*Colocasia esculanata*	6.1	25	7.0	18
6.	*Hibiscus esculentus*	6.3	9.17	8.4	11.2
7.	*Abroma augusta*	6.5	12	9.1	23.5

CONCLUSION

The mucilage extracted from various species of different families showed pharmaceutical applications such as thickening, binding, disintegrating, suspending, emulsifying, stabilizing and gelling agents. The mucilage are very easy to isolate and has a slightly acidic pH range i.e 6.2-6.6.The percentage yield of various plants is said to be approximately 18.The moisture content on an average of all the mucilage isolated is under 9.The swelling index on an average of all mucilage is found to be 15.33. There is an alarming need to utilize the mucilage of these various plants for medicinal and pharmaceutical uses. As it is proved that mucilage of various plants are essential for pharmaceutical sector and Thus, there is a need for substantial utilization of plant resources.

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Conflict of interests

The authors declare that there is no conflict of interests regarding the publication of this paper**.**

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