Review Article

An Overview on Application of *Dillenia indica*, *Abelmoschus esculentus*, *Oryza sativa* and *Plantago ovata* as Pharmaceutical Excipients

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ABSTRACT

The present review is based on the utilisation of natural substances like mucilaginous extract of *Dillenia indica* and *Abelmoschus esculentus*, *Plantago ovata* and *Oryza sativa* as pharmaceutical excipients. The medicinal as well as the nutritive values of these plants influence its applicability as pharmaceutical excipients. Moreover use of these natural substances is advantageous over synthetic pharmaceutical excipients as they are biodegradable, biocompatible, easily accessible, economic, and nontoxic. The advantages as well as the wide range of utility of these natural substances highlight good future prospect as pharmaceutical excipients in drug delivery.

Keywords: Mucilaginous extract of *Dillenia indica, Abelmoschus esculentus*, Pectin, *Oryza sativa*, *Plantago ovata*, Pharmaceutical excipients.

INTRODUCTION

Dillenia indica

Dillenia indica (family Dillinacea), commonly known as elephant apple (a deciduous tree growing up to 10 meters or more in height), Indian catmon in English, Ou tenga in Assamese, Lisora in Hindi and Bahubar in Sanskrit, occurs in India, Siam, and Malaya. In India, its tree is found in evergreen forests of sub-Himalayan region from Kumaon to Garhwal, eastern region to Assam and Bengal and southern region to Central and Southern India. The fresh ripen fruit is found to have the following composition: moisture 86.40 percent, alcoholic extracts 3.00 percent, water extract 0.37 percent and insolubles 10.23 percent [1]

Abelmoschus esculentus

The plant *Abelmoschus esculentus* (family Malvaceae), commonly known as bhindi in India, krajiab kheaw in Thailand, okra plant, kopi arab, kacang bendi, and bhindi in Southeast Asia, is a tropical to subtropical plant that is widely distributed across Africa to Asia, Southern Europe, and America. Okra plays a significant part in the human diet by supplying fat, protein, carbohydrate, minerals, and vitamins[2]. Moreover, the okra mucilage which is isolated from the fresh fruits contains polysaccharide suitable for certain medical and industrial applications.

Dillenia indica and *Abelmoschus esculentus* source of pectin

It is reported that the mucilages isolated from the seed and the fruit of *Dillenia indica* and *Abelmoschus esculentus* is a good source of pectin. Pectin as such is a polysaccharide and is one of the major constituents of fruits like Apple, Lemon, Bannana, *Dillenia indica*, *Abelmoschus esculentus*. The presence of pectin in the natural mucilaginous extract from the fruit of *Dillenia indica* and *Abelmoschus esculentus* was reported and also the quantity of pectin was determined by Carbazole test. The Pectin was extracted by Acetone precipitation technique[3]. It is an important functional fruit ingredient available in markets in the form of white to light brown powders and is used as a gelling agents in several marketed products in jam, gellies etc. It is one of the major dietery supplements to our body[3]. The pure synthetic pectin available in the market has much application in terms of drug delivery as pharmaceutical excipients. This synthetic pure pectin is costly, not easily accessible. On the other hand, natural mucilaginous substance isolated from fruits like *Dillenia indica, Abelmoschus esculentus* contain a good percentage of pectin which in turn have remarkable swelling capacity and high viscosity, biodegradability, non toxicity, easily accessible and available. Instead of using synthetic pectin, if natural pectin isolated from fruits like Apple, Lemon, Banana, *Dillenia indica* and *Abelmoschus esculentus* is used as a pharmaceutical excipient in Drug delivery systems, it is expected to have more physiological compatibility.

Oryza sativa

Oryza sativa commonly known as Bora rice, a variety of glutinous rice is found in Assam, northeast India. Assam is known to be a origin of rice and is gifted with remarkable prosperous rice diversity[4]. The Bora rice contains starch which is composed of mainly amylopectin (a highly branched polymer) and only traces of amylase (a linear polymer). The desintegration property of starch in Bora rice is due to the presence of amylose, on the other hand amylopectin is probably responsible for reducing the rate of degradation. The higher concentration of amylopectin (>98%) increases its resistance to the gastric fluid of the

upper gastrointestinal tract (GIT) and also causes easy degradation in the colon. Bora rice is a common food stuff, generally classified as 'GRAS' (Generally regarded as safe) and a major source of carbohydrate having many nutrient values[4]. This natural substance contains starch (a polysaccharide) and its applicability as foodstuff makes it a potential pharmaceutical excipient to be used in food or pharmaceutical for regulatory purpose. Its natural originality makes its application extensive in the field of drug delivery as they are easily available, cost-effective, eco-friendly, capable of chemical modifications, biodegradable and biocompatible[5]. As a pharmaceutical excipient, it is primarily used as diluents, binders, desintegrants, adhesives, glidants and sweeteners in conventional dosage forms like tablets and capsules. Now a days, its mucoadhesive potential and the property of influencing the rate and extent of absorption of a drug increases its applicability in pharmaceutical drug carrier systems[6].

Plantago ovata

The biological name of Isabgol is *Plantago ovata* (Family-Plantaginaceae). *Plantago ovata* seed husks, also known as Ispaghula, Isabgol, are portions of the seeds of the plant *Plantago ovata*, (genus Plantago).The seed and husk of the Isabgol contain mucilage which is present in the epidermis of the seed. The mucilage of Isabgol consists of pentosan and aldobionic acid which on hydrolysis yield arabinose, galactose, galactouronic acid and rhamnose. The gel forming ability of the mucilage of *Plantago ovata* husk contains alkali extractable polysaccharides which are due to the presence of arabinose, xylose and traces of other sugars[7]. Traditionally it has found its applicability as laxative , demulcent, emollient, as an adjunct to dietary and drug therapy on lipid and glucose levels, constipation, treatment of diarrhea, inflammation of bowel, colon cancer, obesity in children and adolescents high cholesterol and diabetes. The characteristics of mucilage of *Plantago ovata* husk like binding, gelling, granulating, film former, disintegrating, suspending, and sustaining properties influences its utility for the preparation of pharmaceutical dosage forms like tablets, suspensions, gel and for sustained drug release system[8].

APPLICATION OF *DILLENIA INDICA*, *ABELMOSCHUS ESCULENTUS*, *ORYZA SATIVA* AND *PLANTAGO OVATA*

Dillenia indica

Till now several researchers have done great research by using natural mucilaginous extract of *Dillenia indica* as pharmaceutical excipient in drug delivery system. The application of *Dillenia indica* as pharmaceutical excipients in drug delivery are summarised in Table 1.It is reported that the natural mucilaginous substances isolated from the seeds of *Dillenia indica* have high swelling capacities alongwith appreciable mucoadhesive strength when characterised [by Fourier Transformation Infrared spectroscopy (FTIR), Thermogravimetric analysis (TGA) and X-ray diffraction techniques (XRD), zeta potential][9].

The natural mucilages isolated from the fruit of *Dillenia indica* was evaluated for preparing mucoadhesive nasal gels for the delivery of Felodipine[1]. The natural mucilaginous substances isolated from *Dillenia indica* fruits has proved to be a better mucoadhesive agent than the synthetic polymers like HPMC. The gels prepared from natural mucilaginous substance of *Dillenia indica* exhibited favourable mucoadhesive properties that caused their adherance to the nasal mucosa for a long time and hence enhance the absorption of drugs administered intranasally when the permeation study was carried out using excised goat nasal mucosa.

The natural mucilaginous substances isolated from the fruit of *Dillenia indica* was reported to be used in preparing Ofloxacin mucoadhesive microspheres. The microspheres showed good mucoadhesion when tested *in vivo* and also showed extended drug release[10].

The mucilaginous extract from the fruit of *Dillenia indica* was reported to prepare Pantoprazole loaded microbeads.The microbeads were found to be spherical in shape with sufficient swelling, mucoadhesive property and acid resistance. This may be considered as significant for its use in mucoadhesive drug delivery, particularly for controlled release.[11]

The evaluation of delivery of low bioavailable drugs to the buccal cavity by natural mucoadhesive substance isolated from the fruit of *Dillenia indica* has been reported [12].

Table 1: The application of *Dillenia indica* as drug delivery

Application in drug delivery	Drugs	References
Mucoadhesive gels	Felodipine	1
Controlled release Mucoadhesive Microspheres	Metformin HCl	3
Mucoadhesive Microspheres	Ofloxacin	10
Controlled release Mucoadhesive Microbeads	Pantoprazole	11

Abelmoschus esculentus

The applications are summarised in Table 2. The mucilage isolated from the pods of *Abelmoschus esculentus* was evaluated for its safety and suitability as suspending agent. It is reported that okra mucilage was a good suspending agent for Acetaminophen pediatric suspension. Okra mucilage was a good suspending agent even at low concentration than suspending agents like sodium CMC and tragacanth for ZnO suspension[13]. The extracted mucilage from Okra was found to be nontoxic and was used for formulation of Paracetamol suspension[13]. Mucilage was also evaluated for its disintegrating property. Various concentrations of the mucilage were used and batches of tablets were formulated and evaluated for dissolution, wetting time, and disintegration time. The study revealed that *Abelmoschus esculentus* mucilage powder was effective as a desintegrant in low concentrations (4%) [14]. Okra mucilage was proved to be a good binder for

Acetaminophen tablet[15]. In one of the study for the development of a gastric floating dosage form, the gum of *Abelmoschus esculentus* was used as a polymer. In this study tablet batches were prepared using *Abelmoschus esculentus* mucilage and HPMC E15 in different combinations. It was seen that formulation containing *Abelmoschus esculentus* mucilage had poor floating capacity but showed sustained release, whereas formulation containing HPMC had better floating capacity but showed poor sustained release of the drug, so in all it was seen that formulation containing *Abelmoschus esculentus* mucilage with HPMC gave better floating property as well as better sustained release of the drug[16]. Okra polysaccharide is considered as a microbially triggered material for colon targeted tablet formulation and also as the carrier. From this observation, it can be concluded that the Okra polysaccharide under investigation has the potential to carry the drug in a unchanged form to the targeted site, that is, colon where it is degraded in the presence of anaerobic microbes. It has been reported that Okra mucilage could efficiently target Ibuprofen to colon in the form of colon targeted tablet[17]. As a coating material, Okra mucilage or crosslinked Okra mucilage in combination with HPMC K15M gave extended release for fast disintegrating core tablets of model drug Diclofenac sodium[18]. Okra mucilage prepared mucoadhesive microspheres efficiently delivered Rizatriptan benzoate to nasal cavity[3].

Table 2: The application of *Abelmoschus esculentus* in drug delivery

Application in drug delivery	Drugs	References
Mucoadhesive microspheres	Rizatriptan benzoate	3
Suspending agent in Suspension	Acetaminophen	13
Suspending agent in Suspension	Paracetamol	13
Binder for Tablet	Acetaminophen	15
Binder for Tablet	Ibuprofen	17
Extended release coating material	Diclofenac sodium	18

Oryza sativa

As represented in Table 3, the Bora rice was evaluated as a natural biopolymeric matrix for microfabricated controlled drug delivery system of Ibuprofen[4].It is reported that Assam Bora rice is a useful excipient for preparation of Ketotifen fumarate tablets by direct compression. The tablets showed good tensile strength; friability, drug content, disintegration and dissolution profiles[6]. Pectin-Bora rice microspheres were investigated for colon targeted delivery of Glipizide. Small particle sized, discrete, spherical, free flowing microbeads having entrapment efficiency of 68% was prepared. The microbeads were found to have controlled release and *in vivo* gamma scintigraphy study of optimized Pectin-Bora rice beads demonstrated degradation of beads whenever they reached to the colon[19].Bora rice microspheres were reported for the controlled release of Metformin HCl. The Bora rice not only provided spherical microspheres with significant swelling and mucoadhesivity when tested on the surface of intestinal mucosa of pig skin but also showed controlled release of drug for 7 hours[3].The Bora rice is established as a better pharmaceutical excipients for sustained drug release in colon targeting, mucoadhesive nanoparticulate drug delivery, nasal drug delivery etc for better efficacy of drug because of considerable viscosity and good mucoadhesion property, satisfactory pH, solubility, flow property, bulk density etc[20].

Table 3: The application of *Oryza sativa* in drug delivery

Application in drug delivery	Drugs	References
Polymer for Microbeads	Metformin HCl	3
Polymer for Microparticles	Ibuprofen	4
Binder for Tablet	Ketotifen fumarate	6
Polymer for Microbeads	Glipizide	19

Plantago ovata

As shown in Table 4, *Plantago ovata* or Isabgol seed husk has been successfully evaluated as binder, desintegrant, release retardant, hydrogels, gastroretentive agent, microparticles. Dried Isabgol mucilage in the tablet was found to be suitable for fast desintegration of Diclofenac sodium in the mouth[21]. Isabgol mucilage was reported to have a significant influence on the floating behaviour of the gastroretentive tablets[22]. Isabgol mucilage was a good superdesintegrant for fast dissolving tablet of Telmisartan[23]. Isabgol husk mucilage was found to be better desintegrants than Crosspovidone for fast disintegrating tablets of Metformin Hcl in the oral cavity with enhanced dissolution rate[24]. The Isabgol mucilage was reported to be a superdesintegrant at low concentration when evaluated by preparing dispersible tablet of Nimesulide using wet granulation technique. Further, the results showed that desintegrant property of Isabgol mucilage is similar to Ac-Di-Sol but more than Sodium starch glycolate .In another study, it was observed that Isabgol mucilage had better desintegrating property and higher swelling index over the Ac-Di-Sol and Sodium starch glycolate, for Acelofenac tablet prepared by direct compression method[25].Isabgol husk in combination with HPMC K4M was reported to have sustained release effect for Amoxicillin Trihydrate capsules. The incorporation of HPMC K4M into Psyllium husk granule was observed to reduce the immediate swelling of the matrix and thus reduce its release[26]. Isabgol husk was reported to be a good suspending agent for Nimesulide suspension in comparision to synthetic suspending agent[27]. Isabgol husk was proved to be a good desintegrant than maize starch due to good flow, swelling

capacity as well as water retention capacity[28]. Isabgol mucilage as a binder for Paracetamol tablets was observed to be more suitable than Polyvinylpyrolidene and Tragacanth[8]. Isabgol husk was investigated to have superdesintegrant property for Hydroxyzine hydrochloride tablets prepared by direct compression method[29]. Isabgol husk powder at a concentration of 5% was reported to have good disintegrating property for Ciprofloxacin hydrochloride tablet[30]. Isabgol husk in combination with Hydroxy Propyl Methylcellulose was reported to be a good pharmaceutical excipient for preparing Domperidone matrix tablets[31]. Isabgol husk was reported to be used as superdesintegrant for the formulation of fast disintegrating tablet of Amlodipine Besylate[32].

Table 4: The application of *Plantago ovata* in drug delivery

Application in drug delivery	Drugs	References
Binder for Tablet	Paracetamol	8
Desintegrant for Tablet	Diclofenac sodium	21
Superdesintegrant for Tablet	Temisartan	23
Desintegrant for Tablet	Metformin HCl	24
Desintegrant for Tablet	Nimesulide	25
Desintegrant for Tablet	Accelofenac	25
Polymer for sustained release effect	Amoxicillin Trihydrate	26
Suspending agent in Suspension	Nimesulide	27
Superdesintegrant for Tablet	Hydroxyzine hydrochloride	29
Desintegrant for Tablet	Ciprofloxacin hydrochloride	30
Desintegrant for Tablet	Domperidone	31
Superdesintegrant for Tablet	Amlodipine Besylate	32

CONCLUSION

From the present review, it can be concluded that mucilaginous extract of *Dillenia indica* and *Abelmoschus esculentus*; *Oryza sativa*; *Plantago ovata* husk mucilage have good future prospect in drug delivery as pharmaceutical excipients.

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