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FDA-Approved Natural Disintegrant for Fast Dissolving Tablets

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Abstract

Orally disintegrating tablets (ODTs) are an emerging trend in novel drug delivery system and have received ever-increasing demand during the last few decades. ODTs are solid unit dosage forms, which disintegrate or dissolve rapidly in the mouth without chewing and water. This type of property in dosage form can be attained by addition of different excipients, in which disintegrants are the key adjuvant. In recent years, several newer agents have been developed known as super-disintegrants. Super-disintegrants are used to improve the efficacy of solid dosage form and influence the release rate of dosage form. Diverse categories of super-disintegrants are such as synthetic, semi-synthetic, natural, and co-processed blends. These have been employed to develop effectual ODTs and to overcome the limitations of conventional tablet dosage forms. The plant-derived natural super disintegrants comply with many requirements of pharmaceutical excipients as they are non-toxic, stable, easily available, associated with less regulatory issues as compared to their synthetic counterpart, and inexpensive; also these can be easily modified into more polar form. This review discusses about the development of various kinds of natural super-disintegrating agents, along with their role in the tablet disintegration and as potent candidate to be used in ODTs, which are being used in the formulation to provide the safer, effective drug delivery with patient compliance.

Keywords: Gums, Mucilages, Oral-disintegrants tablets

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Introduction

Of all the dosage forms administered orally, the tablet is one of the most preferred dosage forms. Disintegrants are agents integrated to tablet and some encapsulated formulations to promote the breakup of the tablet and capsule "slugs" into more small fragments in an aqueous environment thereby incrementing the available surface area and promoting a more rapid release of the drug substance. They promote moisture penetration and dispersion of the tablet matrix. Tablet disintegration has received considerable attention as an essential step in obtaining fast drug release. The accentuation on the availability of drug highlights the importance of the relatively rapid disintegration of a tablet as a criterion for ascertaining uninhibited drug dissolution behavior. Number of factors affects the disintegration replace of tablets. The disintegrants have the major function to oppose the efficiency of the tablet binder and the physical forces that act under compression to compose the tablet. The more strong the binder, the more efficacious must be the disintegrating agents in order for the tablet to release its medication. Ideally, it should cause the tablet to disrupt, not only into the granules from which it was compressed but additionally into powder particles from which the granulation was yare. Disintegrants are an essential component to tablet formulations. The ability to interact strongly with water is essential to disintegrate function. Combination of swelling and/or wicking and/or deformation are the mechanisms of disintegrant action. A disintegrant utilized in granulated formulation processes can be more efficacious if utilized both "intra-granularly" and "extra-granularly" thereby acting to break the tablet up into granules and having the granules further disintegrate to release the drug substance into solution. However, the portion of disintegrant integrated intra- granularly (in wet granulation processes) is conventionally not as efficacious as that integrated extra-granularly due to the fact that it is exposed to wetting and drying (as a component of the granulation process), which reduces the activity of the disintegrant. Since a compaction process does not involve its exposure to wetting and drying, the disintegrant used intra-granularly inclines to retain good disintegration activity.[1,2] The polymers obtained from the natural inchoation are more efficacious and safe. They are facilely available in natural regions around the world therefore they are preferred over synthetic polymer.

Natural polymers are utilized in most of the preparation and are more propitious over synthetic polymers as they are economical, and they have low cost and are facilely available in the sufficient quantity. Natural polymers are nontoxic; they do not have any adverse effects on the body. Natural polymers are environmentally friendly as they are biodegradable in nature they do not cause any pollution. Natural polymers are devoid of side effects as they are obtained from the natural source. Natural polymers are mainly preferred by the patients as they are more safe and efficacious as compared to the synthetic polymers and have more patient compliance. Natural polymers provide nutritional supplements and are renewable as they are utilized again and again in different reactions.[3] Conceptual diagram of FDTs is shown in Figure 1.

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Ideal Properties of Fast-dissolving Tablets (FDT)

a. They should be disintegrated within seconds when placed in the mouth
b. They should not require water to dissolve

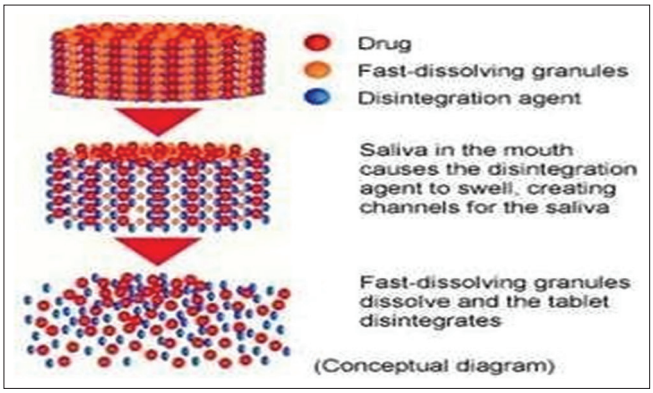

Figure 1: Conceptual diagram of FDTs[4]

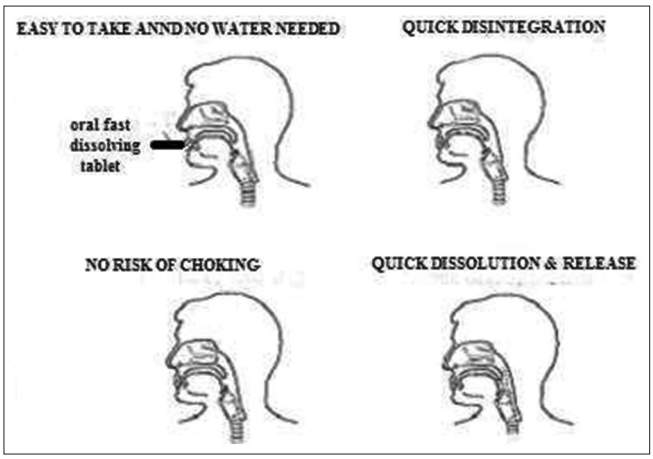

Figure 2: Advantages of FDT[8]

c. Being unit dosage forms, they should provide precise dosing
d. Quick dissolution and absorption in the oral cavity
e. Easy to convey
f. Tablets are manufactured with conventional equipment with low cost
g. Less sensitive to environmental conditions such as humidity and temperature
h. They should be less fragile and should maintain its hardness.[5]

Advantages of FDT

a. FDTs are solid unit dosage form, so they provide precise dosing, and high drug loading is sanctioned in it, and it is an ideal dosage in case of geriatric and pediatric patients, and additionally it is an ideal alternative of conventional tablet
b. It has fast action, as it is taken by the patient, it commences melting when it comes in contact with saliva, it rapidly absorbed in the oral cavity, and it rapidly melts and produces fast action
c. Due to pregastric absorption, the bioavailability of the drugs is amended, and fewer doses are required, which amends the patient compliance, clinical reports are also amended
d. FDTs do not require water to swallow, and also they can be taken anywhere at any time, and they are a convenient option for traveling patients and diligent peoples who do not have immediate access of water; hence, patient compliance is amended
e. They are very facile and convenient to administer as they are a solid unit dosage form, and they are mainly convenient for geriatric, pediatric, uncooperative patients, and dysphagic patients
f. FDTs are very safe and facile to swallow because there is no peril of suffocation in the airways due to physical obstruction during swallowing
g. FDTs contain minimal leaves, and they thoroughly dissolve in the mouth; no residue is left, so they provide good mouth feeling and hence improved palatability of the tablet
h. FDTs are less sensitive to environmental conditions; hence, they are very stable
i. FDTs are packed in simple blister packaging, and there is no need of special and costly packaging, so they are economical
j. FDTs provide incipient business avenues as product differentiation, product promotion, line extension, uniqueness, and life cycle management
k. FDTs are cost efficacious; they do not require costly ingredients. Natural polymers, when utilized as excipient, are available facilely and at low cost, and withal they do not require special packaging material, they can be packed in simple blister packs
l. They are a multifarious technology, as they are utilized in the development of over-the-counter (OTC) medicines, Rx medicines, and veterinary medicines
m. They are facilely portable as they are a solid dosage form and less sensitive to environmental condition and do not require water to swallow the dosage form [Figure 2].[6,7]

Natural Polymers used in FDTs

The utilization of natural polymers is valuably predicated on proven biocompatibility and safety. Natural gums are among the most popular hydrophilic polymers because of their cost-efficacy and regulatory acceptance. Polymers are generally employed in floating drug distribution systems so as to target the distribution of drug to a concrete region in the gastrointestinal tract, that is, the stomach. Moreover, these polymers are safe, non-toxic, and capable of chemical modification and gel formation[9] [Table 1].

Advantages of Natural Polymers

The various advantages of natural plant-based materials include the following.

- Biodegradable

Biodegradable as they are naturally available, and they are produced by all living organisms.

- Biocompatible and non-toxic

Basically, all of these plant materials are reiterating sugar polysaccharides.

- Low cost

They are cheaper to utilize as natural sources. The production cost is less compared with the synthetic material. India and many other developing countries are dependent on agriculture, and there are substantial amounts of money investment on agriculture.

- Environmental-friendly processing

There are many types of natural compounds obtained from different plant sources which are widely utilized in the pharmaceutical industry and collected in immensely large

Table 1: Natural polymers used in fast dissolving tablets

S. No.	Natural polymer	Marketed drug	Disintegration time	Concentrat ion used
1	Chitin and chitosan	Cinnarizine	60 s	3% w/w
2	Guar gum	Glipizide	30 s	1% w/w
3	Gum karaya	Amlodipine, Granisetron Hydrochloride	17.10 s	4% w/w
4	Agar and treated agar	Theophylline	20 s	1-2% w/w
5	Fenugreek seed mucilage	Metformin Hydrochloride	15.6 s	4% w/w
6	Soy polysaccharide	Lornoxicam	12 s	8% w/w
7	Gellan gum	Metronidazole	155 s	4% w/w
8	Mango peel pectin	Aceclofenac	11.59 s	0.1–4% w/w
9	*Lepidium sativum* mucilage	Nimesulide	17 s	5–15% w/w
10	*Plantago ovata* seed mucilage	Granisetron HCl	17.10 s	5% w/w
11	*Aegle marmelos* gum	Aceclofenac	8–18 min	6% w/w
12	Locust bean gum	Nimesulide	13 s	10% w/w
13	*Lepidium sativum*	Nimesulide	17 s	10% w/w
14	*Mangifera indica* gum	Metformin HCL, Paracetamol	3–8 min	6% w/w
15	*Hibiscus rosa-sinenses* mucilage	Aceclofenac	20 s	6% w/w
16	Dehydrated banana powder	Ondansetron HCl/Propranolol, Gabapentin	15–36 s	6% w/w

Table 2 : Some FDT products in global market

S. No.	Trade Name	Active Drug	Manufacturer
1.	Alavert	Loratadine	Wyeth, U.S
2.	Aricept ODT	Donepezil	Eisai Co, Japan
3.	Allegra ODT	Fexofenadine	Sanofi Aventis, France
4.	Clonazepam ODT	Clonazepam	Par Pharmaceutical, U.S
5.	Dolib MD	Rofecoxib	Panacea
6.	Domray MD	Domperidone	Ray Remedies, Ahmedabad
7.	Febrectol	Paracetamol	Prographarm, Chateauneuf, France
8.	Feldene Fast Melt	Piroxicam	Pfizer Inc., NY, U.S.A
9.	Insure-MD	Nimesulide	SuzenPharma, Hyderabad India
10.	Mirtazapine ODT	Mirtazapine	Teva Pharmaceuticals
11.	Maxalt MLT	Rizatriptan	Merck and Co., NJ, U.S.A
12.	Mosid-MT	Mosapride citrate	Torrent Pharmaceuticals, Ahmedabad, India
13.	Niravam	Alprazolam	Schwarz Pharma
14.	Nimulid-MD	Nimesulide	Panacea Biotech, New Delhi, India
15.	Orapred ODT	Predinisolone	Sciele pharma, Atlanta U.S
16.	OlanexInstab	Olanzapine	Ranbaxy Labs Ltd., New Delhi, India
17.	Pepcid RPD	Famotidine	Merck and Co., NJ, U.S.A
18.	Rofaday MT	Rofecoxib	Lupin
19.	Romilast	Montelukast	Ranbaxy Labs Ltd., New Delhi, India
20.	Valus	Valdecoxib	Glenmark
21.	Zelapar TM	Selegiline	Amarin Corp., London , UK
22.	Zofran ODT	Ondansetron	GlaxoWellcome, Middlesex, UK
23.	Zotacet MD	Cetirizine HCl	ZotaPharma

ODTs: Orally disintegrating tablets

quantities due to the simple production processes involved.

- Local availability (especially in developing countries)

In India and homogeneous developing countries, there is a promotion for the production of plants as pharmaceutical excipients being done by government, and it withal provides the facilities for bulk production, such as gum and mucilage's because of their wide applications in industries.

- Patient tolerance as well as public acceptance: There is less chance of side and adverse effects with natural materials compared with synthetic one.[10] FDT products in global market are depicted in Table 2.

Classification of Polymers Used in the FDT

a. Natural polymer
b. Synthetic polymer
c. Semi-synthetic polymer

Natural Polymer

These are various plant-based materials. Plant-based material serves as an alternative to synthetic products because of the following reasons:

i. Local accessibility
ii. Eco-friendliness
iii. Bio-acceptability
iv. Having renewable source and low price as compared to synthetic products.

Natural Polymers used in FDTs: Chitin and Chitosan

Chitin (β-(1→4)-N-acetyl-D- glucosamine) is a natural polysaccharide obtained from crab and shrimp shells. It possesses amino group covalently linked to the acetyl group as compared to liberate amino group in chitosan. Chitosan is produced commercially by deacetylation of chitin, which is the structural element in the exoskeleton of crustaceans (such as crabs and shrimp) and cell walls of fungi. Bruscato and Danti, 1978, reported that when chitin was included in the conventional tablets, the tablets disintegrated within 5–10 min irrespective of the solubility of the drug. The disintegration time in the oral cavity, as well as wetting time, could be analyzed by surface free energy. Chitosan is the best kenned natural polysaccharide utilized for its multifarious applications in the pharmaceutical industry.[11]

Guar Gum

Guar gum is mainly consisting of the high molecular weight (approximately 50,000–8,000,000) poly- saccharides composed of galactomannans and is obtained from the endosperm of the seed of the guar plant, *Cyamopsis tetragonoloba* (L) Taub. (Syn. *Cyamopsis psoralioides*). It is utilized as thickener, stabilizer, and emulsifier and approved in most areas of the world (e.g. EU, USA, Japan, and Australia). It is naturally occurring gum (marketed under the trade name Jaguar). It is free-flowing, consummately soluble, neutral polymer composed of sugar units and is approved for use

in food. It is not sensitive to pH, moisture contents, or solubility of the tablet matrix. It is not always pristine white and sometimes varies in color from off-white to tan and inclines to discolor with time in alkaline tablets.[12]

Gum Karaya

Gum karaya is a vegetable gum produced as an exudate by trees of the genus Sterculia. Chemically, gum karaya is an acid polysaccharide composed of the sugars galactose, rhamnose, and galacturonic acid. The high viscosity nature of gum limits its uses as binder and disintegrant in the development of conventional dosage form. Gum karaya has been investigated for its potential as a tablet disintegrant. Different results showed that modified gum karaya produces rapid disintegration of tablets. Gum karaya can be utilized as an alternative super disintegrant to commonly available synthetic and semisynthetic super disintegrants due to its low cost, biocompatibility as well as facil availability.[13]

Agar and Treated Agar

It is the dried gelatinous sub- stance obtained from *Gelidium amansii* (*Gelidiaceae*) and several other species of red algae such as *Gracilaria* (Gracilariaceae) and *Pterocladia* (*Gelidiaceae*). Agar is yellowish-gray or white to proximately colorless, inodorate with mucilaginous taste and is available in the form of divests, sheet flakes, or coarse powder. Agar consists of two polysaccharides, agarose and agar pectin. Agarose is responsible for gel vigor and agar pectin is responsible for the viscosity of agar solutions. High gel vigor of agar makes it a potential candidate as a disintegrants.[14]

Fenugreek Seed Mucilage

Trigonella foenum-graceum commonly kenned as fenugreek, is an herbaceous plant of the leguminous family. Fenugreek seeds contain a high percentage of mucilage (a natural gummy substance present in the coatings of many seeds). Albeit it does not dissolve in water, mucilage forms a viscous tacky mass when exposed to fluids. Like other mucilage-containing substances, fenugreek seeds swell up and become slick when they are exposed to fluids. Hence, the stud revealed that this natural dis-integrant (fenugreek mucilage) showed more preponderant disintegrating property than the most widely used synthetic superdisintegrants such as Ac-di-sol in the formulations of FDTs. Studies betokened that the extracted mucilage is a good pharmaceutical adjuvant and concretely a disintegrating agent.[15]

Soy Polysaccharide

It is a natural super disintegrants that does not contain any starch or sugar so can be utilized in nutritional products. Halakatti *et al*. 2010[16] evaluated soy polysaccharides (a group of high molecular weight polysaccharides obtained from soybeans) as a disintegrant in tablets made by direct compression utilizing lactose and dicalcium phosphate dihydrate as fillers. A cross-linked sodium carboxymethyl cellulose and corn starch were utilized as control disintegrants. Soy polysaccharide performs well as a disintegrating agent in direct compression formulations with results paralleling those of cross-linked CM.[17,18]

Gellan Gum

Gellan gum is a water-soluble polysaccharide produced by *Pseudomonas elodea*, a bacterium. Gellan gum is an anionic, high molecular weight, deacetylated exocellular polysaccharide gum produced as a fermentation product by a pristine culture of *P. elodea* witha tetrasaccharide reiterating unit of one α-L-rhamnose, one β-D-glucuronic acid, and two β-D-glucose residues. Antony and Sanghavi 1997 studied the gellan gum as a disintegrant and the efficiency of gum was compared with other conventional disintegrants such as dried corn starch, Explotab, Avicel (pH 10.2), Ac-di-sol, and Kollidon CL. The disintegration of tablet might be due to the instantaneous swelling characteristics of Gellan gum when it comes in contact with water and owing to its high hydrophilic nature. The consummate disintegration of tablet was has proved itself as superior disintegrant.[18]

Mango Peel Pectin

Mango peel which constitutes 20–25% of the mango processing waste was found to be a good source for the extraction of pectin of good quality, felicitous for the preparation of film, and acceptable jelly. Pectin is an in volute heteropolysaccharide which is a hydrophilic colloid. Malviya *et al*. (2011) investigated and found that mango peel pectin stands as a good candidate as superdisintegrant, though not as more strong than synthetic superdisintegrants, but due to its good solubility and higher swelling index, it may be utilized in the formulation of fast dispersible tablets.[19,20]

Lepidium Sativum Mucilage

L. sativum (family: Cruciferae) is kenned as Asaliyo and is widely utilized as herbal medicine in India. It is widely available in market and has very low cost. Components used are leaves, root, oil, seeds, and so forth. Seeds contain higher amount of mucilage, dimeric imidazole alkaloids lepidine B, C, D, E, and F, and two incipient monomeric imidazole alkaloids, semilepidinoside A and B. Mucilage of *L. sativum* has different characteristics like binding, disintegrating, gelling, and so forth.[21]

Plantago ovata Seed Mucilage

Psyllium or ispaghula is the prevalent name utilized for several members of the plant genus *Plantago* whose seeds are utilized commercially for the production of mucilage. Mucilage of *P. ovata* has different characteristics like binding, disintegrating, and sustaining properties. In an investigation, fast disintegrating tablets of amlodipine besylate were yare by direct compression method utilizing different concentrations of *P. ovata* mucilage as natural superdisintegrants. All formulations were evaluated for weight variation, hardness, friability, disintegration time, drug content, and dissolution. The optimized formulation shows less *in vitro* disintegration time of 11.69 s with rapid *in vitro* dissolution within 16 min. *In vitro* disintegration time decreases with increase in concentration of natural superdisintegrant.[22,23]

Aegle marmelos Gum (AMG)

It is obtained from the fruits of *A. marmelos* belonging to the disintegrated faster and consistently than the croscarmellose

sodium. The ripened fruit pulp is red in color with mucilaginous and astringent taste. The pulp contains carbohydrates, proteins, vitamin C, vitamin A, angelenine, marmeline, dictamine, O- methyl fordinol, and isopentyl halfordinol. AMG is prepared by heat treatment technique. It increases the solubility of poorly soluble drugs. It increases glucose level and glycosylated hemoglobin in diabetic patients decreases plasma insulin and liver glycogen in diabetic patient, decreases lipid peroxidation, stimulates macrophage functioning, and causes significant deviation in the GSH (glutathione) concentration in the liver, kidney, stomach, and intestine. Purified, bael gum polysaccharide contains D-galactose (71%), D- galacturonic acid (7%), L-Rhamnose (6.5%), and L- arabinose (12.5%).[24]

Locust Bean Gum

It is known as carob bean gum. It is a galactomannan vegetable gum extracted from the seeds of the carob tree (*Ceratonia siliqua*) found in the Mediterranean region. Locust bean gum is utilized as gelling and thickening agent in food industry and utilized as bioadhesive, and it enhances the solubility. The gum is a white to yellowish-white, odorless powder. It is insoluble in most organic solvents including ethanol. It is partially soluble in water at ambient temperature and soluble in hot water and needs heating to above 850 for 10 min for complete solubility.[25]

Ficus indica Fruit Mucilage

The mucilage of *F. indica* fruit is utilized as superdisintegrant which is obtained from the pulp of fruit *F. indica*. *F. indica* is an astronomically immense tree up to 3 meters and very fast-growing with spread branches and aerial roots. The fruits of *F. indica* are of the size of cherry. It has nutritional as well as medicinal value. The dried and uncooked *F. indica* fruit gives 230 kcal (963 KJ) of energy per 100 gm or 3.5 oz. (ounce). It is utilized in assuaging fever, pain, inflammation, wound rejuvenating, blood quandaries, and urinary quandaries.[26]

Mangifera indica Gum (MIG)

Mundane name of *M. indica* is mango, and it belongs to *Anacardiaceae* family. It is nontoxic and utilized as disintegrant, binder, suspending agent, and emulsifying agent in different formulations. The gum powder is white to off-white in color, and the powder was soluble in water and virtually insoluble in acetone chloroform, ether, methanol, and ethanol. It is facilely available, and gum is devoid of toxicity, and each and every component of the tree has pharmacological activity such as diuretic, astringent, diabetes, asthma, diarrhea, urethritis, and scabies.[27]

Hibiscus rosa-sinensis

Mucilage and Treated Agar. It is withal called shoe flower plant, China rose, and Chinese hibiscus and belongs to the family Malvaceae. Mucilages are utilized as thickeners, suspending agents, water retention agent, and disintegrants. The plant is facilely available and its leaves contain mucilage and are present in mucilage L-rhamnose, D-galactose, D- galacturonic acid, and D-glucuronic acid. Treated agar is yare by treating it with water for 1 day.[16]

Dehydrated Banana Powder (DBP)

Banana is additionally called plantain. DBP is yare from the variety of bananas called Ethan and nenthran (*Nenthra vazha*) and belongs to the family *Musaceae*. It contains Vitamin A, so it is utilized in the treatment of gastric ulcer and diarrhea. It withal contains vitamin B6, which avails in reducing the stress and solicitousness. It is a very good source of energy due to its high carbohydrate content, and it contains potassium, which is responsible for more preponderant brain functioning.[28]

Current Regulatory Status of These Polymers

All these Polymers are approved by US Food and Drug Administration (FDA). The FDA recognizes these polymers as Generally Recognized as Safe, as listed in the Code of Federal Regulations 21, for example, chitosan, guar gum, Locust, and bean gum. Gum karaya fully meets all specifications as outlined in the Food Chemicals Codex and may be safely used in foods as described in the Federal Register (21 CFR). Gellan gum is approved as a food additive in the European community under the number E 418, with acceptable daily intake confirming its status as a safe food additive. The Gellan gum food grade fully meets the standards and the purity criteria issued in different regions of the world or internationally, such as the Food Chemicals Codex and JECFA, the US Pharmacopoeia/National Formulary, and the European Directives. Hence, these polymers are safe and can be safely used.

Conclusion

Natural disintegrants have more preponderant effects on FDTs than synthetic disintegrants. Natural disintegrants incremented the drug release rate from the tablet and decremented the dissolution and disintegration time, and they are utilized as binder super disintegrant and diluent. Natural disintegrants are preferred over synthetic disintegrants as they are nontoxic, facilely available at low cost, utilized in low concentration, and are naturally extracted to provide nutritional supplement. The disintegrating properties of *P. ovata*, *L. sativum*, gum karaya, Guar gum, Fenugreek seed mucilage, mango peel pectin, and so forth, have been studied in comparison to artificial super disintegrants. Thus, natural disintegrants exhibit faster drug dissolution and increased bioavailability, thereby, availing in efficacious therapy and improved patient compliance. Thus, the natural disintegrant can be efficaciously utilized as disintegrants in tablet formulations.

References

1. Ansel HC, Popvich NG, Allen LV. Pharmaceutical Dosage Forms and Drug Delivery System. 1st ed. United States: Lippincott Williams and Wilkins; 1998.
2. Jain NK, Sharma SN. A Text Book of Professional Pharmacy. 4th ed. New Delhi: Vallabh; 1998.
3. Yadav ND, Pingale PL, Tatane SR. Comparative study on effect of natural and artificial superdisintegrants in the formulation of fast dissolving aspirin tablet. J Pharm Res 2010;3:1594-7.
4. Abdulraheman ZS, Patel MR, Patel KR. A review on immediate release tablet. Int J Univ Pharm Biol Sci 2014;3:93-113.
5. Ratanaparkhi PM, Mohanta GP, Upadhyay L. Review on fast dissolving tablets. J Pharm Res 2009;2:5-12.
6. Pahwa R, Piplani M, Sharma PC, Kaushik D, Nanda S. Orally disintegrating tablets-friendly to pediatrics and geriatrics. Arch Appl

Sci Res 2010;2:35-48.
7. Deshmukh KR, Vidyanand P, Shekhar V, Kumar PA, Dewangan P. A review on mouth dissolving tablet techniques. Int J Res Ayurveda Pharm 2011;2:66-74.
8. Kaur T, Gill B, Kumar S, Gupta GD. Mouth dissolving tablets: A novel approach to drug delivery. Int J Curr Pharm Res 2011;1:1-7.
9. Beneke CE, Viljoen AM, Hamman JH. Polymeric plant-derived excipients in drug delivery. Molecules 2009;14:2602-20.
10. Kumar SA, Vivek D, Vandana A. Role of natural polymers used in floating drug delivery system. J Pharm Sci Innov 2012;1:11-5.
11. Bruscato FN, Danti AG. Pharmaceutical Tablets Containing Chitin or Chitosan as a Disintegrant, US Patent No. 4, 086, 335; 1978.
12. Batham P, Kalichaman SG, Osborne BE. A 52-week oral toxicity study of Gellan gum in the Beagle dog. In: Unpublished Project 81779, WHO by Kelco (Divison of Merck & Co. Inc.), San Diego, Calif, USA. Montreal, Canada: Bio Research Lab. Ltd.; 1986.
13. Shirwaikar A, Shirwaikar A, Prabhu S, Kumar G. Herbal excipients in novel drug delivery systems. Indian J Pharm Sci 2008;70:415-22.
14. Setia A, Goyal N, Kansal S. Formulation and evaluation of ciprofloxacin hydrochloride dispersible tablets using natural substances as disintegrates. Pelagia Res Libr Pharm Sin 2011;2:36-9.
15. Kumar R, Patil S, Patil MB, Patil SR, Paschapur MS. Isolation and evaluation of dis-integrant properties of fenugreek seed mucilage. Int J PharmTech Res 2009;1:982-96.
16. Halakatti KP, Omer S, Gulgannavar SR, Kumar PP. Formulation and evaluation of mouth disintegrating tablets of famotidine by using *Hibiscus ros sinensis* mucilage and treated agar. Int J Res Ayurveda Pharm 2010;1:497-505.
17. Rinaudo M. Chitin and chitosan: Properties and applications. Progress Polym Sci 2006;31:603-32.
18. Antony PJ, Sanghavi NM. A new dis-integrant for pharmaceutical dosage forms. Drug Dev Ind Pharm 1997;23:41-5.
19. Malviya R, Srivastava P, Kulkarni GT. Application of Mucilage's and drug delivery: A review. Adv Biol Res 2011;5:1-7.
20. Liebermann HA, Lachman L, Schawstr JB. Pharmaceutical Dosage Forms Tablets. Vol. 2. New York: Marcel Dekker; 1989.
21. Mehta KK, Patel HH, Patel ND, Vora CN, Patel NJ. Comparative evaluation of natural and synthetic superdisintegrant for promoting nimesulide dissolution for fast dissolving technology. Int J Pharm Pharm Sci 2010;2:102-8.
22. Singh BS. Pysllium as therapeutic and drug delivery agent. Int J Pharm 2007;334:1-14.
23. Ghenge GG, Pande SD, Ahmad A, Jejurkar L, Birari T. Development and characterization of fast disintegrating tablet of amlodipine besylate using mucilage of *Plantago ovata* as a natural superdisintegrant. Int J PharmTech Res 2011;3:938-45.
24. Kulkarni U, Rao NG. Design and development of aceclofenac fast dissolving tablets by amorphous solid dispersion technique using modified *Marmelos gum*. Int J Pharm Res Dev 2011;3:201-10.
25. Malik K, Arora G, Singh I. Locust bean gum as superdisintegrant-formulation and evaluation of nimesulide orodispersible tablets. Polimery Med 2011;41:17-28.
26. Ahad HA, Sreenivsulu R, Reddy KK, Kavitha K, Sumapadmaja B, Reddy VK. Isolation and characterization of *Ficus indica* fruit mucilage. J Pharm Res 2011;4:726-7.
27. Nayak RK, Patil SR, Patil BM, Mahalaxami B. Evaluation of disintegrating properties of *Mangifera indica* gum. RGUHS J Pharm Sci 2011;1:11-21.
28. Prabakaran L, Sendhil D. Formulation development of patient friendly dosage form: All in one natural excipient as binder, diluent and dis-integrant. Int J Pharm Pharm Sci 2011;3 Suppl 2:97-102.