A review on plant based superdisintegrants

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***Abstract*- For an oral solid medication to be effective, it is desirable that it breaks down into the individual particles that were used to prepare it. For tablets and capsules requiring quick disintegration, it's essential to include the appropriate disintegrant to achieve the best possible absorption into the body. Disintegrates are compounds that prompt the breakdown of capsules or tablets into finer particles, facilitating faster dissolution. In recent years, a new class of disintegrating agents known as superdisintegrants has emerged, aimed at enhancing the effectiveness of solid dosage forms in very low concentration. These agents work by reducing the disintegration time, leading to a faster drug dissolution rate. A variety of superdisintegrants, including synthetic, natural, and co-processed blends, have been utilized to create efficient orally disintegrating tablets and to address the drawbacks of traditional tablet formulations. Recently, natural superdisintegrants have become increasingly popular due to their widespread availability, cost-effectiveness, non-irritating nature, and lack of toxicity. This study outlines the various natural-origin superdisintegrants utilized in formulations to enhance drug delivery efficacy.**

***Keywords*: Superdisintegrants, Plant based, natural, Fast release, mucilage**

INTRODUCTION

Disintegrants are a type of excipient that are commonly used in pharmaceutical formulations to aid in the dissolution and disintegration of tablets and capsules. They work by absorbing water from the surrounding environment and swelling, which creates pressure within the tablet or capsule and causes it to break apart into smaller pieces [1].When a disintegrant encounters water in the gastrointestinal tract (GIT), it rapidly swells and creates channels or pores within the tablet or capsule, allowing water to penetrate the interior of the dosage form. This process creates a large surface area for the active ingredient to dissolve and become available for absorption, which can enhance bioavailability and improve therapeutic efficacy [2]. Overall, the use of disintegrants in pharmaceutical solid dosage forms, assure rapid and better absorption in the body, which can improve patient outcomes and treatment efficacy[3]. Now a day's different types of disintegrants have been developed which are called as superdisintegrants". Superdisintegrants accelerate disintegration by utilizing the synergistic effect of swelling and water absorption. Additionally, they improve the wetting and dispersion of the system, thereby augmenting both disintegration and dissolution. Superdisintegrant absorbs the fluid and swells, causing a rapid increase in volume and a disruptive change in the tablet structure. This disruptive change creates a greater surface area, which allows for faster dissolution of the tablet's active ingredients. This is particularly important for drugs that have poor solubility or low bioavailability, as increasing their surface area can enhance their absorption and effectiveness. Several types of superdisintegrants that can be used in tablet formulations, including cross linked polymers, different derivatives of starch and microcrystalline cellulose. Proper selection of a disintegrant that meets the specific needs of the formulation and thorough testing to ensure consistent performance is critical steps in the development of tablet formulations. Orally disintegrating tablets (ODTs) have gained increasing popularity in recent years due to their ease of administration, and improved patient compliance. The choice of disintegrant is particularly important in ODTs, as it must facilitate rapid disintegration and/or dissolution in the mouth while also ensuring good mouth feel and taste masking. The choice of superdisintegrant, depends on various factors such as the properties of the drug being formulated and the desired performance characteristics of the tablet. Studies have shown that superdisintegrants are more effective than traditional disintegrants in achieving rapid tablet disintegration and dissolution, even at lower concentrations also. The concentration of superdisintegrants is ranges in between 1-10% by weight to the total weight of the dosage unit. Near about 1 gm of superdisintegrants can absorb 10-40 gm of water of liquid medium. It can help to swell the tablet and break into finer particles very quickly. Different plant based superdisintegrants like polysaccharides hydrocolloids (glucans, gums, plant mucilages) at minimum concentration are shown greater disintegration effect and mechanical strength also. In designing of Fast dissolving tablets (FDTs) quick disintegration in the mouth is required without the need for water or chewing. In order to achieve this, various natural disintegrants like karaya gum, agar and modified starch have been used in the formulation of FDTs. Natural mucilage is mostly preferred over semi processed and processed substances because of its cost effectiveness, availability, nontoxic and no irritability [11-12]. Therefore this study highlights different plant based superdisintegrants employed in the formulations for enhancing the drug delivery.

ADVANTAGES OF SUPERDISINTEGRANTS [4]

1. It involves the rapid breakup of the tablet or capsule into smaller particles or granules, which can dissolve quickly in the mouth and be absorbed into the body.
2. Amicable with a wide range of active therapeutic agents as well as excipients also.
3. Efficacious as both hydrophilic and hydrophobic formulations.
4. It can provide some degree of mechanical strength to FDTs, they are primarily used for their disintegrating properties and are typically used in combination with other excipients to achieve the desired tablet properties..
5. While there are several superdisintegrants available in the market that have been shown to provide superior disintegration properties, researchers are still actively searching for new and improved disintegrants, and exploring the use of modified natural products as potential disintegrants..

DISADVANTAGES OF SUPERDISINTEGRANTS[5]

1. Expensive.
2. Time-consuming and delicate.
3. susceptible and hygroscopic in nature.

TYPES OF SUPERDISINTEGRANTS

Based on their origin and mechanism of action, superdisintegrants can be categorized into different types such as natural, synthetic, modified natural superdisintegrants.

Natural Superdisintegrants

Superdisintegrants derived from natural sources are more desirable than synthetic counterparts due to their affordability, widespread availability, non-irritating and non-toxic properties. Natural materials such as gums and mucilages have been extensively employed in drug delivery due to their environmental friendly nature, soothing properties, non-irritating and non-toxic characteristics, potential for various chemical modifications, biodegradability, and compatibility owing to their natural origin. Some of thethese gums and mucilages are discussed in below section [8].

Synthetic superdisintegrants

Synthetic superdisintegrants are widely used in tablet formulations to facilitate the disintegration of tablets and increase the rate of drug release. Synthetic superdisintegrants, such as croscarmellose sodium, sodium starch glycolate, and crosslinked polyvinylpyrrolidone (PVP), are preferred due to their superior performance over natural superdisintegrants and their ease of manufacturing and quality control [7].

Co-processed superdisintegrants:

Co- processing is an important technique in pharmaceutical formulation as it allows for the creation of excipient products with superior properties, which can improve drug manufacturing processes and the quality of the final drug product [9]. Some example of co processed excipients blends were STARLAC, LUDIPRESS, STARCAP1500,RAN-EXPLO-S,LUDIFLAST etc[10].

NATURAL POLYMERS UTILIZED AS SUPERDISINTEGRANTS

Chitin and chitosan:

Chitosan is a widely recognized natural polysaccharide with diverse applications in the pharmaceutical industry. It is obtained from chitin, a natural polysaccharide found in crab and shrimp shells, consisting of N-acetyl-D-glucosamine (β-1,4). Chitin differs from chitosan in that it contains an acetyl group that is covalently attached to an amino group, whereas chitosan has a free amino group. To produce chitosan on a commercial scale, chitin - the structural component of crustacean exoskeletons and fungal cell walls - undergoes a process called deacetylation. Chitosan's ability to act as a superdisintegrant has been harnessed in the development of a rapidly dissolving oral tablet using a novel processing technique. Like other superdisintegrants, when exposed to aqueous media, chitosan readily absorbs water and ruptures due to capillary action, causing immediate breakdown of the dosage form. As a result, a homogeneous dispersion is formed in the surrounding medium which mimics a true suspension that forms within the body. As a result, the drug is rapidly and completely absorbed, leading to its quick onset of action. Bruscato et al. demonostrated that the addition of chitin to standard tablets resulted in disintegration within 5 to 10 minutes, regardless of the drug's solubility. Olorunsola et al. had extracted chitosan from shells of callinectes gladiator and assessed its superdisintegrant properties and found that callinectes chitosan is a more effective disintegrant than corn starch when used in tablets, making it a suitable superdisintegrant. It appears to be superior to corn starch as disintegrant. They concluded that callinectes chitosan is a viable option for use as a tablet superdisintegrant and is more effective than corn starch in this role. Draksiene et al. utilized medium molecular weight chitosan and the wet granulation technique to fabricated Meloxicam fast disintegrating tablets which exhibited favorable dissolution and disintegration characteristics [13-15].

Guar Gums

Guar gum is a natural extract obtained from the seeds of the guar plant. It mainly contains guaran or galactomannan (about 80% MW:50000-8000000), along with 5-7% protein, 10% moisture, and small traces of heavy metals and ash and oftens employed as stabilser, thickening agent and emulsifying agents. This polymer has a neutral pH, dissolves easily, and free-flowing, making it an ideal food additive. Moreover, it is not affected by changes in pH, moisture content, or the solubility of the tablet matrix. However, guar gum may not always appear white and can have a color range from off-white to tan, and it is prone to discoloration over time in alkaline tablets. Guar gum, marketed under the name Jaguar, has been discovered to outperform common disintegrants like corn starch, celluloses, alginates, and magnesium aluminum silicate in its role as a disintegrant. The disintegration process can be influenced by particle size, as smaller particles tend to have more effective disintegrating properties. Sunitha et al. formulated captopril tablet using guar gum and reported that the prepared tablet exhibited a disintegration time of 50.1 sec and achieved a 99%

drug release, thus making guar gum a better disintegrating agent. Jha et al. formulated glipizide tablets utilizing gum acacia, gum tragacanth, and guar gum. The study revealed that the glipizide tablets incorporating guar gum displayed rapid disintegration upon exposure to water, owing to the generation of sufficient pressure to initiate disintegration before the formation of a gel. Conversely, gum acacia and gum tragacanth exhibited minimal disintegrant action due to their gel-forming properties. Ranganathan et al. developed a mouth dissolving tablet of dexamethasone drug with guar gum and xanthan gum, which resulted in improved drug release and disintegration time compared to the standard dexamethasone tablet [16-18].

Soy polysaccharide

Soy polysaccharide, which is derived from soybeans and consists of high molecular weight polysaccharides, is a naturally occurring superdisintegrant that is free from starch or sugar, making it suitable for use in nutritional products. The effectiveness of soy polysaccharide as a disintegrant produced through direct compression was evaluated by Khalidindi et al. The study employed corn starch and cross-linked sodium carboxy-methyl cellulose as standard disintegrants. The results demonstrated that soy polysaccharide was efficient disintegrant, producing outcomes similar to those obtained using sodium carboxy-methyl cellulose cross-linked. The performance of soy polysaccharide as a disintegrant was analyzed by Amayreh et al. using image analysis and compared to that of commonly used superdisintegrants. Soy polysaccharide exhibits optimal disintegration effects at concentrations ranging from 4% to 8%.Singh et al. formulated mouth dissolving tablets of atorvastatin calcium using soy polysaccharide using direct compression method and revealed that the tablets containing a 10% concentration of Soy Polysaccharide exhibited excellent results in terms of tablet disintegration, wetting time, and dissolution rate, thus concluding that the formulated tablets disintegrate within seconds without the requirement of water [19-21].

Ispaghula Husk Mucilage (Plantago ovata)

Ispaghula or Psyllium husk, from the Plantago ovata plant, contains mucilage in its seeds which can be released by soaking and boiling. This mucilage has binding, disintegrating, and sustaining properties, and a high swelling index, making it a superior disintegrating agent for fast-dissolving tablets in comparision to other superdisintegrants. Compared to crospovidone, the mucilage from Plantago ovata is a new development due to its superior ability to disintegrate rapidly, demonstrating a faster disintegration time. Ghange et al. employed Plantago ovata mucilage to develop Amlodipine Besylate fast disintegrating tablets, with optimized formulation displaying a quick in vitro dissolution rate (16 min) and a shorter disintegration time (11.6 s). Draksiene et al. prepared orodispersible meloxicam tablets by utilizing varying concentrations of psyllium husk via direct compression. They discovered that the use of psyllium husk as a superdisintegrant considerably improved the dissolution rate of meloxicam in the orodispersible tablets[22-26].

Fenugreek seed mucilage

Fenugreek, derived from Trigonella foenum, is a versatile herbaceous plant from leguminous family with applications such as a food ingredient, traditional medicine and food additive worldwide. The seeds of Fenugreek contain a substantial amount of adhesive mucilage, which can serve as a disintegrant in mouth dissolving tablets, characterized by a fast onset of action and reduced disintegration time. Kumar et al. prepared diclofenac sodium tablet via direct compression, employing various concentration of fenugreek gum, as a superdisintegrant, (1%-6%, w/w) and demonstrated that compared to synthetic superdisintegrants, such as croscarmellose sodium and sodium starch glycolate , fenugreek gum at 6% concentration was the optimized formulation with the shortest disintegrating time (21 seconds) and highest drug release rate (93.74% at 25 minutes). Therefore concluding that fenugreek gum is a superior natural alternative for superdisintegrants in fast dissolving formulations [27-29].

Lepidium sativum mucilage

Lepidium sativum, or Asaliyo, is a widely used herbal medicine in India from the Cruciferae family. The plant is easily accessible, cost-effective and different parts of it are used, including leaves, root, oil, and seeds. The seeds have high levels of mucilage and various dimeric and monomeric imidazole alkaloids. The mucilage from Lepidium sativum has multiple properties, including binding, disintegrating, and gelling. Mehta et al., prepared Nimesulide tablets using Lepidium sativum as disintegrating agent and revealed revealed that using 10% mucilage led to higher dissolution rate and in comparison to commonly used superdisintegrants such as Sodium starch glycolate, Ac di sol, and kyron T314, the disintegrating properties of extracted mucilage was superior with disintergartion time of 17 sec. Kanuja et al., formulated domperidone tablets using Lepidium Sativum mucilage by direct compression method and exhibited that Lepidium sativum mucilage had a significant impact on the in vitro drug release, disintegration and wetting time. Thus, suggesting that the natural mucilage potentially serving as a substitute carrier for synthetic superdisintegrants [30-31].

Locust bean gum

Carob bean gum, also referred to as locust bean gum, is a galactomannan vegetable gum obtained from the Carob bean seeds, that serves as a prevalent gelling agent and thickening in the food industry. In addition, it demonstrates bioadhesive qualities and improves solubility. Malik et al developed and assessed nimesulide orodispersible tablets utilizing locust bean gum as a superdisintegrant. The gum displayed favorable powder flow characteristics, a swelling index of 20 seconds indicating its potential as a suitable superdisintegrant. Also, tablets incorporating 10% locust bean gum demonstrated a disintegration time of 13 sec, comparable to the standard superdisintegrant, cross-carmellose sodium [32,33].

Agar

Agar is a gel-like substance derived from red algae, such as Gelidium amansii, Gracilaria, and Pterocadia with a mucilaginous taste and no discernible odor. It comes in various forms, including strips, sheets, flakes, and powder. Agar contains two types of polysaccharides: agarose, which provides gel strength, and agaropectin, which determines viscosity. Agar, with its strong gelling properties, is suitable as a disintegrant for various applications various applications. Sahoo et al. formulated granisetron hydrochloride orodispersible tablets using agar as disintegrant by wet granulation method and demonstrated that the tablets was quickly disintegrated within time range of 19 to 31 secs and exhibited 99.09% drug release in 6 mins [34-36].

Xanthan Gum

Xanthan Gum, which is extracted from Xanthomonas campestris, is recognized by the US Pharmacopeia (USP). It displays remarkable hydrophilicity and minimal tendency to form gels. Although it exhibits low solubility in water, it possesses exceptional swelling properties that enhance its ability to disintegrate quickly [37].

Gellan Gum

Pseudomonas elodea, a type of bacteria, produces a water-soluble polysaccharide known as Gellan gum through fermentation. It is an anionic gum with a high molecular weight that is derived from the exocellular polysaccharide. The gum's repeating unit of tetrasaccharides, which include β-D-glucose (two), β-D-glucuronic acid (one) and α-L-rhamnose (one) residues. Antony et al. investigated the disintegrating properties effectiveness of Gellan gum as a disintegrant, comparing it with conventional options such as avicel, dried corn starch, Kollidon CL, explotab and Ac-di-sol. They found that Gellan gum's high hydrophilic nature and instant swelling upon contact with water led to the rapid disintegration of tablets. As a result, Gellan gum was found to be a superior disintegrant based on its ability to completely dissolve tablets [38,39].

Mango peel pectin

The peel of mango, which makes up around twenty to twenty five percent of mango processing waste, has been discovered to contain high-quality pectin with beneficial properties. This pectin is suitable for creating film and jellies. Pectin is a hydrophilic colloid that consists of complex heteropolysaccharides. Malviya et al. examined the potential of mango peel pectin as a superdisintegrant for fast dispersible tablets. While it may not be as potent as synthetic superdisintegrants, the pectin's high solubility and swelling index make it a viable option for use in such formulations [40].

Cucurbita maxima pulp (CMP) powder

Malviya Rishabha et al conducted a study on the disintegrating characteristics of CMP powder, and prepared Diclofenac sodium dispersible tablets using varying concentrations of both the powder and sodium starch glycolate. The tablets were assessed for their disintegration time and drug dissolution, and showed favorable results with an enhanced drug release characteristics and appealing appearance. The findings suggested that CMP powder has potential as a useful pharmaceutical adjuvant, particularly as a disintegrating agent [41].

Hibiscus rosa sinesis linn.

Hibiscus rosa-sinensis Linn., which belongs to the Malvaceae family, goes by several names such as Chinese hibiscus, shoe flower and Chinese rose. It is widely distributed in in India and the mucilage extracted from it exhibits superdisintegrant properties. The plant contains various compounds including methyl sterculate, cyclopropanoids, 2-hydroxysterculate malvate, methyl-2-hydroxysterculate, and β-rosasterol. Using a direct compression method, Shah et al. prepared Aceclofenac orally disintegrating tablets with the Hibiscus rosa-sinensis mucilage at a 6% w/w, that exhibited a very short disintegration time (20 seconds) [42,43].

Ocimum americanum seed mucilage

Patel et al. investigated the potential of mucilage extracted from the seeds of Ocimum americanum as a disintegrating agent for tablets. They conducted experiments using various concentrations of the mucilage and determined that the most effective concentration was 10%w/w and concluded that the mucilage enabled faster disintegration times compared to starch, with disintegration times of 154 seconds and 269 seconds, respectively [44].

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