Superdisintegrants: An Updated Review

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Abstract
In dosage forms, solid orals gain maximum popularities, about 85%, because of many advantages over others. The therapeutic activity of these formulations is obtained through a typical manner like disintegration followed by dissolution. Hence disintegration has major role for facilitating drug activity and thus gain popularity among other dosage forms. Disintegrants are substances or mixture of substances added to the drug formulation that facilitates the breakup or disintegration of tablet or capsule content into smaller particles that dissolve more rapidly than in the absence of disintegrants. In recent years, several newer agents have been developed known as Superdisintegrants. Superdisintegrants are used to improve the efficacy of solid dosage forms. This is achieved by decreasing the disintegration time which in turn enhances drug dissolution rate. Superdisintegrants are generally used at a low level in the solid dosage form, typically 1 - 10 % by weight relative to the total weight of the dosage unit. The present review comprises the various kinds of Superdisintegrants like natural and synthetic which are being used in the formulation to provide the safer, effective drug delivery with patient's compliance. The various sources of superdisintegrants and their modification to improve disintegration property are also high-lighted.

Key words: Superdisintegrants, disintegration, natural, synthetic, bioavailability, fast release

1. INTRODUCTION
Oral route of drug administration is perhaps the most appealing route for the delivery of drugs. Various dosage forms administered orally, the tablet is one of the most preferred dosage forms amongst them because of its ease of manufacturing, convenience in administration, accurate dosing, and stability compared with oral liquids and because it is more tamperproof than capsules. The bioavailability of drug is dependent on in vivo disintegration, dissolution, and various physiological factors [1].

Tablet disintegration has received considerable attention as an essential step in obtaining fast drug release. The emphasis on the availability of drug highlights the importance of the relatively rapid disintegration of a tablet as a criterion for ensuring uninhibited drug dissolution behaviour [2]. Disintegrants are agents added to tablet (and some encapsulated) formulations to promote the breakup of the tablet (and capsule “slugs”) into smaller fragments in an aqueous environment thereby increasing the available surface area and promoting a more rapid release of the drug substance. They promote moisture penetration and dispersion of the tablet matrix. A disintegrant used in granulated formulation processes can be more effective if used both “intragranularly” and “extragranularly” thereby acting to break the tablet up into granules and having the granules further disintegrate to release the drug substance into solution. Most common tablets are those intended to be swallowed whole and to disintegrate and release their medicaments rapidly in the gastrointestinal tract (GIT). The proper choice of disintegrant and its consistency of performance are of critical importance to the formulation development of such tablets [3].

In more recent years, increasing attention has been paid to formulating not only fast dissolving and/or disintegrating tablets that are swallowed, but also orally disintegrating tablets that are intended to dissolve and/or disintegrate rapidly in the mouth. The task of developing rapidly disintegrating tablets is accomplished by using a suitable superdisintegrants [4]. In recent years several newer agents have been developed known as “Superdisintegrants”. These...
Newer substances are more effective at lower concentrations with greater disintegrating efficiency and mechanical strength.

Water penetration rate and rate of disintegration force development are generally positively related to disintegrant efficiency in nonsoluble matrices. However, such a positive correlation is not always observed between tablet disintegration time and drug dissolution rate. [5]

Superdisintegrants provide quick disintegration due to combined effect of swelling and water absorption by the formulation. Due to swelling of superdisintegrants, the wetted surface of the carrier increases, which promotes the wettability and dispersibility of the system, thus enhancing the disintegration and dissolution. [6] Effective superdisintegrants provide improved compressibility, compatibility and have no negative impact on the mechanical strength of formulations containing high-dose drugs. Number of factors affects the disintegration behaviour of tablets. The optimum concentration of the superdisintegrant can be selected according to critical concentration of disintegrant. The ability to interact strongly with water is essential to disintegrant function. Combinations of swelling and/or wicking and/or deformation are the mechanisms of disintegrant action. The disintegrants have the major function to oppose the efficiency of the tablet binder and the physical forces that act under compression to form the tablet. [7]

2. MECHANISM OF DISINTEGRATIONS BY SUPERDISINTEGRANTS

There are five major mechanisms for tablet disintegration as follows:-

2.1 Swelling
2.2 Porosity and Capillary Action (Wicking)
2.3 Deformation
2.4 Due to disintegrating particle/particle repulsive forces
2.5 Enzymatic reaction

2.1 Swelling

Swelling is considered to be a mechanism in which certain disintegrating agents (such as starch) impart the disintegrating effect. By swelling in contact with water, the adhesiveness of other ingredients in a tablet is overcome causing the tablet to fall apart [8]. E.g. Sodium starch glycolate, PlatagoOvata [9] [10] [4] (Fig.1)

![Fig.1. Mechanism of superdisintegrants by swelling](image)

2.2 Porosity and Capillary Action (Wicking)

Effective disintegrants that do not swell are believed to impart their disintegrating action through porosity and capillary action. Tablet porosity provides pathways for the penetration of fluid into tablets. The disintegrant particles (with low cohesiveness & compressibility) themselves act to enhance porosity and provide these pathways into the tablet. Liquid is drawn up or “wicked” into these pathways through capillary action and rupture the interparticulate bonds causing the tablet to break apart. E.g. Crospovidone, Crosscarmilllose [11]. (Fig.2)

![Fig.2. Disintegration of Tablet by Wicking](image)

2.3 Deformation

Starch grains are generally thought to be “elastic” in nature meaning that grains that are deformed under pressure will return to their original shape when that pressure is removed. But, with the compression forces involved in tableting, these grains are believed to be deformed more permanently and are said to be “energy rich” with this energy being released upon exposure to water. In other words, the ability for starch to swell is higher in “energy rich” starch grains than it is for starch grains that have not been deformed under pressure [7]. (Fig.3)

![Fig.3. Disintegration by Deformation](image)
2.4 Due to disintegrating particle/particle repulsive forces:-
Another mechanism of disintegration attempts to explain the swelling of tablet made with ‘nonswellable’ disintegrants. Guyot-Hermann has proposed a particle repulsion theory based on the observation that nonswelling particle also cause disintegration of tablets. The electric repulsive forces between particles are the mechanism of disintegration and water is required for it. Researchers found that repulsion is secondary to wicking. It is believed that no single mechanism is responsible for the action of most disintegrants. But rather, it is more likely the result of inter-relationships between these major mechanisms. [12] (Fig.4)

2.5 By Enzymatic Reaction:
Enzymes present in the body also act as disintegrants. These enzymes dearth the binding action of binder and helps in disintegration. Due to swelling, pressure is exerted in the outer direction that causes the tablet to burst or the accelerated absorption of water leads to an enormous increase in the volume of granules to promote disintegration. [13] (Fig. 5)

3. Method of Incorporation of superdisintegrants:
The incorporation of superdisintegrants in the dosage forms are mainly of three types:-

3.1 Intragranular or during granulation - In this process the superdisintegrants are blend with other powders and granulation is carried out. Thus the superdisintegrants are incorporated within the granules.

3.2 Extragranular or prior to compression - In this process, the superdisintegrants are mixed with prepared granules before compression.

3.3 Incorporation of superdisintegrants at intra and extra granulation steps- In this process part of superdisintegrants are added to intragranular and a part to extragranules. This method usually produces better results and more complete disintegration than type I and type- II [14].

4. Types of Superdisintegrants:-
The Superdisintegrants can be classified into two categories on the basis of their availability:

4.1 Natural Superdisintegrants
4.2 Synthetic Superdisintegrants.

4.1.1 Natural Superdisintegrants: -These superdisintegrating agents are natural in origin and are preferred over synthetic substances because they are comparatively cheaper, abundantly available, non-irritating and nontoxic in nature. The natural materials like gums and mucilages have been extensively used in the field of drug delivery for their easy availability, cost effectiveness, Eco friendliness, emollient and non-irritant nature, non-toxicity, capable of multitude of chemical modifications, potentially degradable and compatible due to natural origin. There are several gums and mucilages are available which have superdisintegrating activity [15]

4.1.2 Plantago Ovata Seed Mucilage (Isapgula)
Isapghula consists of dried seeds of the plant plantagoovata and it contains mucilage which is present in theepidermis of the seeds. The seeds of Plantagoovatawere soaked in distilled water for 48 hrs and then boiled for few minutes for complete release of mucilage into water. The material was squeezed through muslin cloth for filtering and separating out the marc. Then, an equal volume of acetone was added to the filtrate so as to precipitate the mucilage. The separated mucilage was dried in oven at temperature less than 60°C [16].The mucilage of plantagoovatais a recent innovation for its superdisintegration property when compared with Crospovidone. It shows faster disintegration time than the superdisintegrant,Crosspovidone [17][18].

4.1.3 Lepidiumsativum Mucilage
Lepidiumsativum (family: Cruciferae) is known as asaliyo and is widely used as herbal medicine in India. It is widely available in market and has very low cost. Parts used are leaves, root, oil, seeds etc. Seeds contain higheramount of mucilage, dimeric imidazole alkaloids lepidine B, C, D, E and F and two new monomeric imidazole alkaloids semilepidinosideA and B. Mucilage of Lepidiumsativumhas various characteristic like binding,disintegrating, gelling [19].
<table>
<thead>
<tr>
<th>Name of Drug</th>
<th>Superdisintegrants</th>
<th>Method of Compression</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ondansetron HCl</td>
<td>Plantago Ovata husk</td>
<td>Direct compression</td>
<td>[16]</td>
</tr>
<tr>
<td>Nimesulide</td>
<td>Plantago Ovata husk</td>
<td>Direct compression</td>
<td>[19]</td>
</tr>
<tr>
<td>Granisetron HCl</td>
<td>Plantago Ovata husk</td>
<td>Direct compression</td>
<td>[46]</td>
</tr>
<tr>
<td>Fexofenadine HCl</td>
<td>Plantago ovata mucilage</td>
<td>Direct Compression</td>
<td>[47]</td>
</tr>
<tr>
<td>Famotidine</td>
<td>Locust Bean gum</td>
<td>Solvent Evaporation Method.</td>
<td>[48]</td>
</tr>
<tr>
<td>Ofloxacin</td>
<td>Locust Bean gum</td>
<td>Direct Compression</td>
<td>[49]</td>
</tr>
<tr>
<td>Nimesulide</td>
<td>Locust Bean gum</td>
<td>Direct Compression</td>
<td>[50]</td>
</tr>
<tr>
<td>Piroxicam</td>
<td>Treated Agar</td>
<td>Direct Compression</td>
<td>[51]</td>
</tr>
<tr>
<td>Metoclopramide HCl</td>
<td>Cassia fistula gum</td>
<td>Direct Compression</td>
<td>[28]</td>
</tr>
<tr>
<td>Amlodipine Besylate</td>
<td>Plantago ovata mucilage</td>
<td>Direct Compression</td>
<td>[52]</td>
</tr>
</tbody>
</table>

Table 2 A list of Synthetic Superdisintegrants Used in formulations

<table>
<thead>
<tr>
<th>Drug</th>
<th>Superdisintegrants</th>
<th>Method</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metoclopramide Hydrochloride</td>
<td>Cross Povidone, Cross Carmellose sodium, Ac-Di-Sol Sodium Starch glycolate</td>
<td>Direct Compression</td>
<td>[53]</td>
</tr>
<tr>
<td>Terbutaline Sulphate</td>
<td>Cross Povidone, Crosscarmellose sodium, Sodium Starch glycolate</td>
<td>Direct Compression</td>
<td>[54]</td>
</tr>
<tr>
<td>Carvedilol</td>
<td>Cross Povidone, Cross carmellose sodium, Sodium Starch glycolate</td>
<td>Direct Compression</td>
<td>[55]</td>
</tr>
<tr>
<td>Valsartan</td>
<td>Crospovidone, Ac-Di-Sol Sodium Starch glycolate</td>
<td>Direct Compression</td>
<td>[56]</td>
</tr>
<tr>
<td>Gliclazide</td>
<td>Crospovidone, Ac-Di-Sol Sodium Starch glycolate</td>
<td>Direct Compression (Solid dispersion)</td>
<td>[57]</td>
</tr>
<tr>
<td>Glipizide</td>
<td>Cross Povidone, Cross carmellose sodium, Sodium Starch glycolate</td>
<td>Direct Compression</td>
<td>[58]</td>
</tr>
<tr>
<td>Metoprolol Succinate</td>
<td>Cross carmellose sodium, Sodium Starch glycolate, Sodium Starch glycolate (camphor and Ammonium Bicarbonate Sublimating Agent)</td>
<td>Sublimation</td>
<td>[59]</td>
</tr>
<tr>
<td>Chlorpromazine HCl</td>
<td>Crospovidone, Ac-Di-Sol Sodium Starch glycolate</td>
<td>Direct Compression</td>
<td>[60]</td>
</tr>
<tr>
<td>Zidovudine</td>
<td>B-cyclodextrin, Crosspovidone, Ac-Di-Sol Sodium Starch glycolate</td>
<td>Direct compression</td>
<td>[61]</td>
</tr>
<tr>
<td>Reloxifene HCl</td>
<td>Cross carmellose sodium, Sodium Starch glycolate, Sodium Starch glycolate</td>
<td>Direct Compression</td>
<td>[62]</td>
</tr>
<tr>
<td>Levocetirizine HCl</td>
<td>Citric Acid, Sodium bicarbonate, Sodium Starch glycolate</td>
<td>Direct Compression</td>
<td>[63]</td>
</tr>
<tr>
<td>Ondansetron HCl</td>
<td>Cross carmellose sodium, Sodium Starch glycolate</td>
<td>Direct compression</td>
<td>[64]</td>
</tr>
<tr>
<td>Pioglitazone</td>
<td>Crospovidone, Crosscarmilose, Sodium Starch glycolate</td>
<td>Direct compression</td>
<td>[65]</td>
</tr>
<tr>
<td>Losartan Potassium</td>
<td>Crospovidone, Ac-Di-Sol Sodium Starch glycolate, Sodium Starch glycolate</td>
<td>Direct Compression</td>
<td>[66]</td>
</tr>
<tr>
<td>Felodipine</td>
<td>Crospovidone, Sodium Starch glycolate, Sodium Starch glycolate</td>
<td>Direct Compression</td>
<td>[10]</td>
</tr>
<tr>
<td>Granisetron HCl</td>
<td>Crospovidone, Sodium Starch glycolate</td>
<td>Direct Compression</td>
<td>[67]</td>
</tr>
<tr>
<td>Lisinopril</td>
<td>Ac-Di-Sol, Sodium Starch glycolate, Sodium Starch glycolate</td>
<td>Kneading Technique</td>
<td>[68]</td>
</tr>
<tr>
<td>Ibuprofen</td>
<td>Kollidon CL(K) Explotab(E), Wet Granulation</td>
<td>Wet Granulation</td>
<td>[69]</td>
</tr>
<tr>
<td>Glibenclamide</td>
<td>Crospovidone, Kneading Method</td>
<td>Wet Granulation</td>
<td>[70]</td>
</tr>
<tr>
<td>Fentanyl Citrate</td>
<td>Kollidon CL, Sublingual Method</td>
<td>Wet Granulation</td>
<td>[71]</td>
</tr>
<tr>
<td>Aceclofenac</td>
<td>Ac-Di-Sol, Sodium Starch glycolate, Wet granulation</td>
<td>Wet granulation</td>
<td>[72]</td>
</tr>
<tr>
<td>Disulfiram</td>
<td>Sodium Starch Glycolate (Glycolis-Type A), Dry granulation, Slugging</td>
<td>Wet granulation</td>
<td>[73]</td>
</tr>
</tbody>
</table>
Table 3 Biological source of some natural Superdisintegrants

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Natural Superdisintegrants</th>
<th>Source</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PlantagoOvata Seed Mucilage</td>
<td>Seed of Plantagoovata</td>
<td>[16]</td>
</tr>
<tr>
<td>2</td>
<td>LapidiumSativum mucilage</td>
<td>Seed of LapidiumSativum</td>
<td>[19]</td>
</tr>
<tr>
<td>3</td>
<td>Gum Karaya</td>
<td>Dried exudation of sterculiaUrens tree.</td>
<td>[20]</td>
</tr>
<tr>
<td>4</td>
<td>Fanugreek Seed Mucilage</td>
<td>Seeds of fenugreek, Trigonellafoenum-gracecumL</td>
<td>[24]</td>
</tr>
<tr>
<td>5</td>
<td>Guar gum</td>
<td>Seed of theguar plant, Cyamopsistetragonaloba</td>
<td>[25]</td>
</tr>
<tr>
<td>6</td>
<td>Cassia Fistula gum</td>
<td>Seed of Cassia fistula tree</td>
<td>[28]</td>
</tr>
<tr>
<td>7</td>
<td>Locust Bean Gum</td>
<td>Seed of Carob tree CeretoniaSiliqua</td>
<td>[30]</td>
</tr>
<tr>
<td>8</td>
<td>Hibiscus rosa-sinensis Linn Mucilage</td>
<td>Fresh Leaves of Hibiscus rosa-sinensis Linn</td>
<td>[31]</td>
</tr>
</tbody>
</table>

4.1.4 Gum Karaya
Gum Karaya is a negative colloid and a complex polysaccharide of high molecular weight. On hydrolysis it yields galactose, rhamnose and galacturonic acid. Gum Karaya occurs as a partially acetylated derivative. It is a dried exudation of sterculiaUrens tree (Family-Sterculiaceae). Its synonyms are Karaya, sterculia, Indiantragacanth, Bassoratragacanth, kadaya, Kadira,katila. Gum Karaya is compatible with other plant hydrocolloids as well as proteins and carbohydrates [20]  [21]  [22] (Fig.6)

Fig.6. Structure of Gum Karaya

4.1.5 Fanugreek Seed Mucilage
TrigonellaFoenum-graceum, commonly known as Fenugreek, is an herbaceous plant of the leguminous family. It has found wide applications as a food, a food additive, and as a traditional medicine. The leaves and both the ripe and unripe seeds of TrigonellaFoenum-graceum used as vegetables. Fenugreek has been used in treating colic flatulence, dysentery, diarrhoea, dyspepsia with loss of appetite, chronic cough, dropsy, enlargement of liver and spleen, rickets, gout, and diabetes. It is also used as gastro protective, antiulithiatic, diuretic, antitandruff agent, Anti-inflammatory agent and as antioxidant. The seed is stated to be a tonic [23]. It also is used in post-natal care and to increase lactation in nursing mothers. Fenugreek seeds contain a high percentage of mucilage (a natural gummy substance present in the coatings of many seeds). Although 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 sicc when they are exposed to fluids. The resulting soft mass is not absorbed by the body, but instead passes through the intestines and triggers intestinal muscle contractions [24]

4.1.6 Guar gum
Guar gum is a galactomannan, commonly used in cosmetics, food products and in pharmaceutical formulations. Guar gum is mainly consisting of the high molecular weight (approximately 50,000-8,000,000) polysaccharides composed of galactomannans and is obtained from the endosperm of the seed of the guar plant, Cyamopsistetragonaloba (L) Taub. (Synonym-Cyamopsispsoraleoides). It is used as thickener, stabilizer and emulsifier, and approved in most areas of the world (e.g. EU, USA, Japan, and Australia) [25]. Its synonyms are Galactosol; guar flour; jaguar gum; meprogat; meyprodor. It has also been investigated in the preparation of sustained release matrix tablets in the place of cellulose derivatives such as methylcellulose. In pharmaceuticals, guar gum is used in solid-dosage forms as a binder and disintegrant, and in oral and topical products as a suspending, thickening, and stabilizing agent, and also as a controlled-release carrier. Guar gum has also been examined for use in colonic drug delivery [26]  [27]. (Fig. 7)

Fig.7. Structure of Guar gum

4.1.7 Cassia fistula gum
Seeds of Cassia fistula gum obtained from cassia fistula tree. Gum obtained from the seeds of Cassia fistula comprises β-(1→4) linked d-mannopyranose units with random distribution of _α (1→6) linked d-galactopyranose units as side chain having mannose:galactose ratio of 3.0). Carboxymethylation as well as carbamaylyehylation of Cassia gum is reported to improve cold water solubility, improve
viscosity and increase microbial resistance as compared to native gum. Therefore, an attempt was made to incorporate calcium or sodium salts of carboxymethylated or carbamoyl ethylated C. fistula gum as superdisintegrant in the formulation development of FDT [28].

4.1.8 Locust Bean gum
Locust bean gum is extracted from the endosperm of the seeds of the carob tree Ceretonia siliqua, which grows in Mediterranean countries. It is also called Carob bean gum. Some other familiar polysacharides are starch and cellulose, which are made of long chains of the sugar glucose. In locust bean gum, the ratio of mannose to galactose is higher than in guar gum, giving it slightly different properties, and allowing the two gums to interact synergistically so that together they make a thicker gel than either one alone. It shows as a binder and as a disintegrant property at different concentration. Pharmaceutical application of locust bean gum in various novel drug delivery systems. Locust bean gum has been widely used in food industry as a thickening and gelling agent. Locust bean gum has also been reported to have bioadhesive and solubility enhancement properties. There are various reports that Locust bean gum can be used in pharmaceutical and biotechnological purpose [29] [30] (Fig. 8)

![Fig.8. Structure of locust bean gum](image)

4.1.9 Hibiscus rosa-sinensis Linn. Mucilage
Hibiscus rosa-sinensis Linn of the Malvaceae family is also known as the shoe- flower plant, China rose, and Chinese hibiscus. The plant is available in India in large quantities and its mucilage has been found to act as a superdisintegrant. The plant contains cyclopropanoids, methyl sterulate, methyl- 2- hydroxystereulate, 2- hydroxystereulate malvate and β- rosasterol. The leaves contain carotene (7.34 mg/100 g of fresh material) moisture, protein, fat, carbohydrate, fibers, calcium, and phosphorus. Mucilage of Hibiscus rosa-sinensis contains L- rhamnose, D- galactose, D- galactouronic acid, and D- glucuronic acid.[31]

4.1.10 Mango Peel Pectin
Dried mango peel powder is use for extracting pectin. Rather mango peel pectin cannot be used for promising the behaviour of superdisintegrants, but due to its good swelling index and good solubility in biological fluids it can be used to prepare fast dispersible tablets. [32]

4.2 Synthetic Superdisintegrants
A group of superdisintegrants including croscamelllose sodium (Ac-Di-Sol) sodium starch glycolate (Primogel and Explotab) and crospovidone (Polyplasdone XL) alleviate most of these problems. Use of the superdisintegrants in fast dispersible tablet is possible as tablet shows optimum physical properties. [33]

Advantages of Synthetic Superdisintegrants
- Effective in lower concentrations than starch.
- Less effect on compressibility and flow ability.
- More effective intragranularly[34]

4.2.1 Sodium Starch Glycolate: (Explotab, Primogel)
Sodium starch glycolate is widely used in oral pharmaceuticals as a disintegrant in capsule and tablet formulations. It is recommended to use in tablets prepared by either direct-compression or wet-granulation processes. The recommended concentration in a formulation is 2-8%, with the optimum concentration about 4% although in many cases 2% is sufficient. Disintegration occurs by rapid uptake of water followed by rapid and enormous swelling. The disintegrant efficiency of sodium starch glycolate is unimpaired in the presence of hydrophobic excipients, such as lubricants unlike many other disintegrants. Increasing the tablet compression pressure also appears to have no effect on disintegration time. These are modified starches with dramatic disintegrating properties and are available as explotab and primogel which are low substituted carboxy methyl starches. Explotab consisting of granules that absorb water rapidly and swell. The mechanism by which this action takes place involves rapid absorption of water leading to an enormous increase in volume of granules resulting in rapid and uniform disintegration. The natural predried starches swell in water to the extent of 10-20 percent and the modified starches increase in volume by 200-300 percent in water[26] [35] (Fig. 9)

![Fig.9. Basic Structure of Sodium Starch Glycolate](image)
4.2.2 Cross-linked polyvinylpyrrolidone: (crospovidone, PolyplasdoneXL, XL10)

Crospovidone quickly wicks saliva into the tablet to generate the volume expansion and hydrostatic pressures necessary to provide rapid disintegration in the mouth. Unlike other superdisintegrants, which rely principally on swelling for disintegration, Crospovidone superdisintegrants use a combination of swelling and wicking. When examined under a scanning electron microscope, crospovidone particles appear granular and highly porous. This unique, porous particle morphology facilitates wicking of liquid into the tablet and particles to generate rapid disintegration. Due to its high crosslink density, crospovidone swells rapidly in water without gelling. Other superdisintegrants have a lower crosslink density and, as a result, form gels when fully hydrated, particularly at the higher use levels in ODT formulations. Swells very little and returns to original size after compression but act by capillary action[36] [37] [38]. (Fig. 10)

![Fig. 10. Basic Structure of Crospovidone](image)

Unlike other superdisintegrants, which rely principally on swelling for disintegration, Polyplasdone disintegrants use a combination of mechanisms to provide rapid disintegration. Although Polyplasdone polymers swell by 95% to 120% upon contact with water, swelling is not the only mechanism for tablet disintegration. Swelling or swell volume is mainly a measure of the change in volume of the disintegrant after it is introduced to an aqueous solution and the system has reached equilibrium. However, swell volume does not measure the rate at which a disintegrant absorbs water and swells or the pressure generated by swelling. Polyplasdone polymers, with their porous particle morphology rapidly absorb water (wicking) via capillary action. As the deformed polyplasdone particles come in contact with water that is wicked into the tablet, the polyplasdone particles recover their normal structure and then swell, resulting in rapid volume expansion and high hydrostatic pressures that cause tablet disintegration. [39]

4.2.3 Modified Cellulose (crocarmellosesodium, Ac-Di-Sol)

Crocarmellose sodium is described as a cross-linked polymer of carboxy methyl cellulose (CMC). This polymer is different in synthesis and structure as compared to Sodium starch glycolate. Most importantly, the degree of substitution using Williamson’s ether synthesis of croscarmellose sodium is higher than that of sodium starch glycolate, and the mechanism of crosslinking is also different. The chemistry of SSG is different that of cross carmellose sodium as some of the carboxymethyl groups themselves are used to cross-link the cellulose chains. For example, the cross-linking in Primogel are phosphate ester rather than carboxyl ester links as compare to Cross carmellose sodium [40] [41]
Crocarmellose sodium at concentrations up to 5% w/w may be used as a tablet disintegrant, although normally 2% w/w is used in tablets prepared by direct compression and 3% w/w in tablets prepared by a wet-granulation process[42] (Fig.11)

![Fig. 11. Basic Structure of Croscarmilose Sodium](image)

4.2.4 Resins

Resins although insoluble, have great affinity for water and hence, act as disintegrant. Moreover, because of their smaller particle size the rate of swelling is high making them superdisintegrant. Like conventional disintegrant, they don’t lump but additionally impart strength to the tablets. The use of ion exchange resins into drug delivery systems have been encouraged because of their physico-chemical stability, inert nature, uniform size, spherical shape assisting coating and equilibrium driven reproducible drug release in ionic environment. Ion exchange resins are insoluble polymers that contain acidic or basic functional groups and have the ability to exchange counter-ions within aqueous solutions surrounding them[43]. Drug, molecules attached to the resins are released by appropriate charged ions in the gastrointestinal tract, followed by diffusion of free drug molecules out of the resins as shown below,

\[
\text{Resin} - \text{Drug} + X^+ \rightarrow \text{Resin} - X^- + \text{Drug}^+ \quad (1)
\]

\[
\text{Resin} + \text{Drug} + X^- \rightarrow \text{Resin} + X^- + \text{Drug} \quad (2)
\]

Where, X and Y are ions in the gastrointestinal tract [44] [45] [16].
Conclusion
The innovations in the area of formulating ODTs are aimed at both increasing the performance of the dosage form by decreasing the disintegration time. This article attempted to unveil the strategies that have been used by inventors for improving the performance of Superdisintegrants. The use of Superdisintegrants for achieving these aims is not new. However, with the improvement innovation of superdisintegrating agents, it has become possible to develop ODTs with reduced content of superdisintegrants. Similarly, considerable research towards producing modified microcrystalline cellulose or starch in order to engineer them suitable for direct compression has significantly reduced the product development time for optimizing ODT formulation. Rapidly disintegrating dosage forms have been successfully commercialized by using various kinds of superdisintegrants.

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