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Superdisintegrants and their unavoidable role in oral disintegrating tablets

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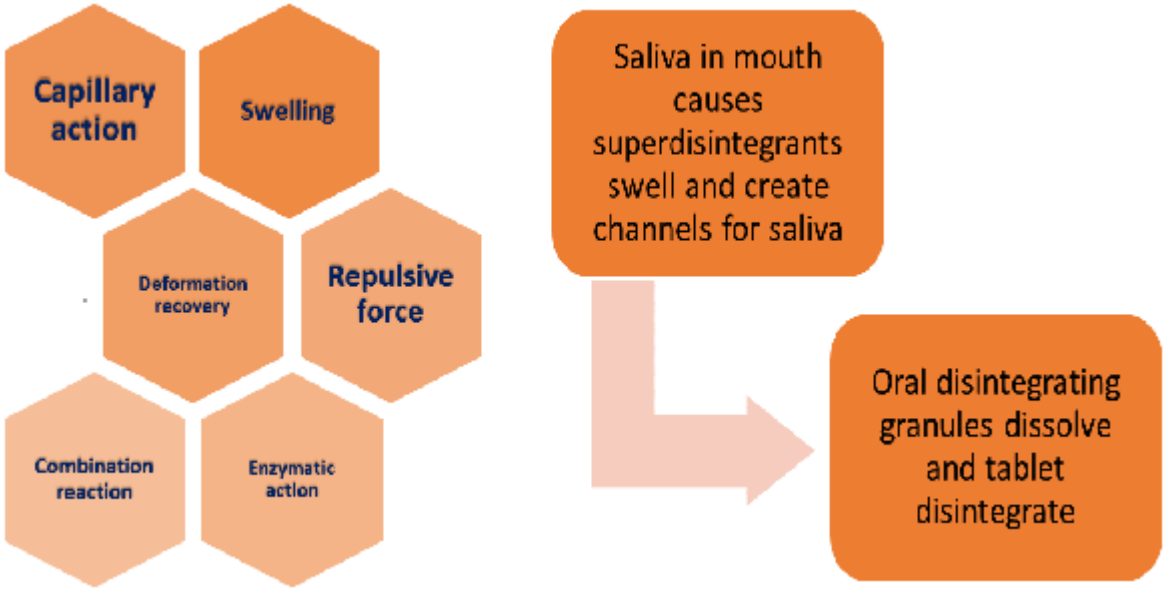
Abstract

Oral disintegrating tablet are generally intended for the route via mouth cavity. The chief excipient used for oral disintegration tablet is superdisintegrant. Many superdisintegrants either natural and synthetic are used in pharmaceutical industry. Among this the natural superdisintegrants offer an additional advantage over the synthetic superdisntegrants. The mechanism of action of superdisintegrants is generally divided into seven basic types such as Capillary action, Swelling, Chemical reaction, Particle repulsive force, Deformation recovery, Enzymatic reaction and Combination reaction. The natural disintegrants such as Ispaghula (Plantago ovata seed mucilage), Lepidium sativum Seed Mucilage, Fenugreek seed mucilage and chitosan agar and starch are mostly used. Synthetic superdisintegrants such as crospovidone. cross carmellose sodium, sodium starch glycolate are commonly used in pharmaceutical industry for oral disintegrating tablets. Superdisintegrants have three basic addition process such as intragranular, extragranlar and partly internal and external depending upon the formulation and nature of API. This article includes all the details for natural and synthetic superdisintegrants.

Keywords – super-disintegrants, dysphagia, biocompatible, biodegradable etc.

Graphical abstract



Introduction

In contrast to other traditional oral solid dosage forms, oral dispersible tablets (ODTs) are an unique oral solid dosage form that quickly dissolves in the mouth (within seconds to minutes of oral administration) without chewing and without the need for water.[1][2] .Solid dose forms are widely used because they are inexpensive, simple to administer, allow for precise dosage self-medication, reduce pain, and most importantly ensure patient compliance. Tablets and capsules are the most often used solid dose forms. Dysphagia, or trouble swallowing, is a significant disadvantage of such dose formulations and is prevalent across all age groups. Size, surface, and taste of pills are frequently cited reasons for swallowing problems.[3][4]

Oral disintegrating tablet are those tablets which are placed upon tongue can be disintegrate in matter of second to min before swallowing without need of water.[5][6]

Disintegrants in the oral disintegrating tablet swell when come in contact with moist mucosal oral cavity and create channel for the saliva passing in between them. When tablet get in contact with saliva disintegrates swell and tablet disintegrate in small molecule and tablet gets dissolve.[7] in oral disintegrating tablet drug release increases and disintegration time decreases in comparison with conventional tablet. This tablet increases bioavailability by enhancing the onset of action. onset of action increases because of of disintegration in saliva and pregastric absorption. pregastric absorption leads to avoid first pass metabolism and this tablet are advantageous for the drug those having great deal with hepatic metabolism.[8][9]

Superdisintegrants are substances that speed up the disintegration process. When compared to the overall weight of the dose units, the superdisintegrants are utilized at very tiny concentrations of 1–10% by weight. In addition to having an absorption characteristic, these substances also have swelling properties. They hardly ever absorb any considerable amounts of water, but they quickly swell. Superdisintegrants are structural weakeners that aid in the dissolution of solid dosage forms. They physically spread and expand inside the dose form when it is exposed to a moist environment.[10][11]

Some factors of superdisintegrants that are increases the disintegration speed of tablet are as follow [12]

- It ought to result in an immediate breakdown.
- It must exhibit acceptable flow and molding characteristics.
- The particle size, hydration capacity, and compressibility index should all be good.
- Its water solubility needs to be low.
- Disintegrating efficiency should be higher and effective at very low concentrations
- It must be compatible with the other excipients and provide favorable tableting qualities.

Mechanism of action of superdisintegrants -

1. Capillary action
2. Swelling
3. Chemical reaction
4. Particle repulsive force
5. Deformation recovery
6. Enzymatic reaction
7. Combination reaction

1.Capillary action –

When we submerge the tablet in a suitable aqueous medium or solution, the air deposited on the particles replaces when the medium penetrates the tablet, weakening the intermolecular connection and causing the tablet to break into small particles. This is the first step in the disintegration process.[13] Water uptake is influenced by tableting circumstances, excipients, and drug hydrophilicity. These kinds of disintegrants are necessary to maintain a porous structure and low interfacial tension toward aqueous fluid, which promotes disintegration by creating a hydrophilic network around the drug particle. Disintegrating agents that do not swell employ mechanisms of porosity and capillary action. [14]

2. Swelling –

Some disintegration substances, like starch, are thought to transmit the dissolving action by swelling. The ability of disintegrants with ionizable substituents to swell in an acidic liquid poses a risk to their effectiveness in accelerating tablet disintegration and the rate of medication dissolution.[15] The adhesiveness of other substances in a tablet is overcome by swelling when in contact with water, causing the tablet to crumble. For instance, deformation, Plantago Ovata, and sodium starch glycolate.[16]

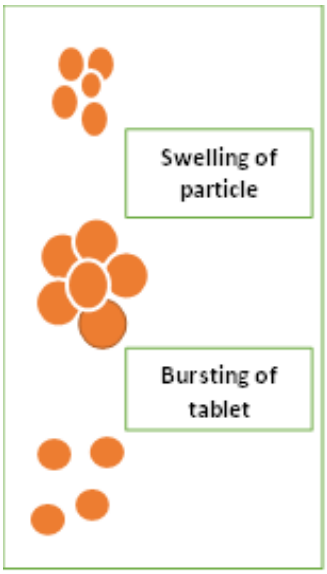


Fig 1. Swelling

3.Chemical reaction-

Due to the interaction of tartaric acid and citric acid (acids) with alkali metal carbonates or bicarbonates (bases) in the presence of water, the tablet swiftly disintegrates via internal CO2 liberation in water.[17] due to liberation of CO_2 gas the pressure can be generated in the tablet and it can be disintegrated. Also, the dissolution profile of active pharmaceutical ingredient increases and taste masking effect improved.

4.Particle repulsive force-

It is reported that there is no single mechanism required for disintegrants actions. But it is believing that there is inter-relation between these mechanisms. Another disintegration process makes an attempt to explain why a tablet manufactured with "nonswellable" disintegrants swells. Based on the finding that **unswollen** particles also contribute to tablet disintegration, Guyot-Hermann proposed the **theory of** particle **repulsion.** The mechanism of disintegration is the electric repulsive interactions between particles, and water is necessary for it.[14]

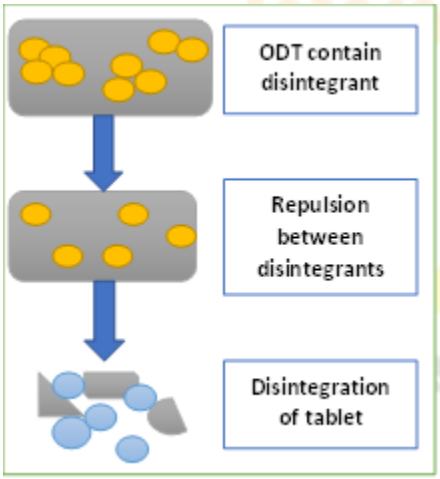


Fig 2. Particle repulsive force

5.Deformation recovery –

This method demonstrated that when fragmented tablet particles are compressed, they deform, and when these distorted particles come into touch with aqueous fluid or water, they return to their original structure. In case of starch i.e., potato starch and starch grains they are elastic in nature in such cases when the tablet gets exposed in the air and the grains gets deformed because of the energy potential causes disintegration.[18]

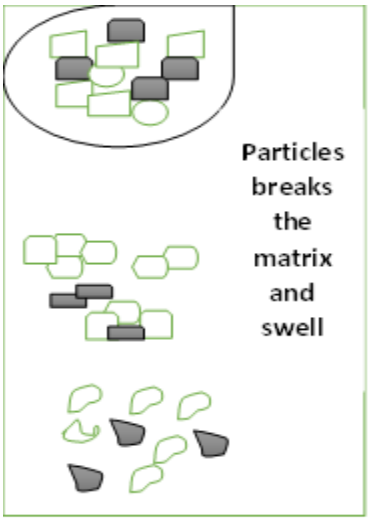


Fig 3. Deformation recovery

6.Enzymatic reaction –

The body's natural enzymes also function as disintegrants. These enzymes aid in disintegration and eliminate the binding action of the binder. The swelling causes pressure to be applied in the tablet's outer direction, which causes it to rupture, or the water's faster absorption generates a huge rise in the number of granules, which encourages disintegration.[19]

7.Combination reaction –

In this, the pill is broken down by the disintegrant through a wicking and swelling action. An example of an agent that works by both swelling and wicking is crosspovidone.

Types of superdisintegrants

There are three types of superdisintegrants used in formulation of oral disintegrating tablets

1.Natural superdisintegrants

2.Synthetic superdisintegrants

3.Co-processed superdisintegrants

1. Natural superdisintegrants –

Various natural chemicals, including gums, mucilages, and other substances of natural origin, are included in the natural superdisintegrants. These substances are more effective at lower concentrations with increased disintegration efficiency and mechanical strength. Natural agents have several benefits over synthetic ones, such as being nontoxic, easily accessible, inexpensive, biocompatible, and biodegradable. The superdisintegrants will speed up drug release while slowing down disintegration time. Some of them are

- **Ispaghula (Plantago ovata seed mucilage) -**

The popular name for several Plantago species whose seeds are used commercially to make mucilage is psyllium, also known as ispaghula. Mucilage from the Plantago ovata has a number of functions, including as binding, dissolving, and maintaining qualities. For the entire release of mucilage into water, Plantago ovata seeds were cooked for a short period of time after being steeped in distilled water for 48 hours. Plantago ovata's mucilage

possesses a variety of characteristics, including binding, dissolving, and supporting properties. Because mucilage has an extremely high swelling index (around 892.2% v/v) compared to other superdisintegrants, it is a super disintegrating agent that is utilized to create fast dissolving tablets. To filter and separate the marc, the substance was forced through muslin cloth. The mucilage was then precipitated by adding an equal volume of acetone to the filtrate. A low-temperature oven was used to dry the separated mucilage.[20][21][22]

- **Lepidium sativum Seed Mucilage -**

As a disintegrating agent and herbal remedy, natural Lepidium sativum (family: Cruciferae), also known as asaliyo, finds extensive use in the pharmaceutical industry. Mucilage, the new monomeric imidazole alkaloids semilepidinoside A and B, and the dimeric imidazole alkaloids lepidine B, C, D, E, and F are all present in higher concentrations in seeds. Different methods can be used to remove the mucilage from seeds, and the yield ranges from 14% to 22%.[23]

In the first technique (method A), 100 g of seeds were steeped in distilled water for 12 hours (1litre). Mucilage was then separated using a vacuum pump. Following that, any leftover particles were sorted by running through muslin fabric. Then acetone was used to treat the isolated transparent substance. to obtain mucilage that has precipitated. Drying took place for 6 hours at 45 °C. The yield was then determined after the powder had been put through an 80 # mesh filter and weighed.[24]

- **Fenugreek seed mucilage -**

Fenugreek is an annual plant in the family **Fabaceae**, with leaves consisting of three small obovate to oblong leaflets. It is cultivated worldwide as a semiarid crop.

Using a mortar and pestle to grind the seeds into a powder, 100 g of the powder was then extracted with hexane to remove lipophilic components. The defatted powder was cooked in ethanol for 20 minutes to get the colors out and deactivate the enzyme. The pH of this treated powder was then brought down to 3.5 using 0.5 M hydrochloric acid after being steeped in 10 liters of water. The mixture was mechanically agitated for 12 hours before being filtered through paper.[25]

- **Chitosan, Agar and Starch –**

The only polycation found in nature, chitosan's charge density is influenced by the media's pH and level of acetylation. The level of acetylation and molecular weight affect how soluble the polymer is. Chitosan oligomers are soluble at a variety of pH levels, including both acidic and basic ones.

Agar is a polymer consisting of galactose sugar monomers that is derived from algae. It is a combination of two substances: agaropectin, a heterogeneous collection of smaller molecules, and the linear polysaccharide agarose.

Amylose and amylopectin are the two primary polysaccharides that make up starch, which is found in nature as water-insoluble granules. Lipids and proteins are minor components that may interact with the polysaccharides.[26][27]

2.Synthetic superdisintegrants[28][29]

In synthetic superdisintegrants three most commonly used superdisintegrants are crospovidone. cross carmellose sodium, sodium starch glycolate.

- **Crospovidone –**

Crospovidone quickly draws saliva into mouth-dissolving formulations to create the hydrostatic pressures and volume expansion required for fast disintegration in the mouth. In contrast to other superdisintegrants, its primary modes of disintegration are swelling and wicking. Crospovidone particles look granular and very porous under a scanning electron microscope. This material's distinctively porous structure speeds up breakdown and makes it

easier for liquid to wick into dosing devices. Crospovidone has a high crosslink density, which causes it to swell more quickly in water without forming a gel than other compounds.

Various brand names of crospovidone is Polyvinyl polypyrrolidone, crospovidone, crospolividone, E1202, Kollidon CL.

- **Cross carmellose sodium –**

It is said that croscarmellose sodium is a cross-linked carboxymethylcellulose polymer. There are differences between the synthetic techniques utilised to change the polymer in addition to the differences between the starch and cellulose polymer backbones. Most significantly, croscarmellose sodium has a greater DS than sodium starch glycolate and uses a distinct crosslinking method. The sodium salt of carboxymethylcellulose is produced through the replacement utilising Williamson's ether synthesis. The fact that some of the carboxymethyl groups themselves are employed to cross-link the cellulose chains, with the task being carried out by dehydration, marks a significant departure from the chemistry of SSG.

Cross carmellose sodium having various brand name like primellose, Ac-Di-Sol etc.

- **Sodium starch glycolate –**

The starch is modified to have spectacular disintegration capabilities and is offered as Explotab and Primogel. It is the oldest and most often used disintegrant. These are granular versions of low substituted carboxy methyl starches. The method involves rapid water absorption, which causes a tremendous rise in the volume of the granules and causes them to disintegrate quickly and uniformly

3.Co-processed superdisintegrants -[30]

Sr.no	Co-processed superdisintegrants	Consist of
1	Ludipress	Lactose monohydrate (93%), Kollidon 30 (3.5%) and Kollidon CL (3.5%).
2	Ludiflash	D-mannitol 82.0-92.0% ,Kollidon 4.0-6.0% , CL-SF, 3.5-6.0% Polyvinyl acetate, 0.5-2.0% water and 0.25-0.60% Povidone.
3	Starlac	Lactose and starch
4	Starlac 1500	Alpha-lactose-monohydrate 85% and white maize starch 15%
5	Ran-Explo-S	Microcrystalline cellulose, silica and sodium starch glycolate

Modes of addition of superdisintegrants[31]

1. Intragranular

2. Extragranular

3. Partly Internal and External

1.Intragranular-

The disintegrant is combined with additional powders in the internal addition procedure before the powder mixtures are moistened with the granulating fluid. As a result, the granules contain the disintegrant.

2.Extragranular –

The disintegrant is added to the sized granulation with mixing in the external addition method before compression.

3.Partly Internal and External –

This technique allows for the addition of some disintegrant both internally and externally. As a result, the tablet is immediately broken up into its previously compacted granules, and the granules' dissolving agent further erodes them back into their original powder form.

Advantages and disadvantages of superdisintegrants[32][33][34]

Advantages-

- Rapid disintegration when wetted; no lumps formed during disintegration; compatible with excipients and routinely used medicinal medicines.
- Does not adhere to the dyes and punches.
- Lower concentrations are effective.
- More effective intragranularly; less impact on compressibility and flow ability.
- Some are biodegradable, while others are anionic and may somewhat bind to cationic medications in vitro.

Disadvantages –

- Instability caused by moisture sensitivity.
- Both lengthy and delicate.

Conclusion –

One of the most popular methods for innovative drug delivery is the orodispersible drug delivery system. Although better and quicker disintegration can be accomplished by including several Superdisintegrants within the orodispersible formulation. The proper disintegrant must be used in tablets and capsules that require quick disintegration in order to achieve maximum bioavailability. The effectiveness of solid dosage forms is increased by the use of superdisintegrants. This can be done by speeding up drug breakdown process by reducing its disintegration time. This study includes a variety of superdisintegrants that deliver medications in a safer and more efficient manner while maintaining patient compliance. This led to the conclusion that orodispersible tablets respond better to natural than to manufactured superdisintegrants.

Reference –

[1] R. Manivannan, "Oral disintegrating tablets : A future compaction," *Int. J. Pharm. Res. Dev.*, vol. 1, no. 10, pp. 1–10, 2016.

[2] A. Maurya, "Orodispersible tablets: An overview of formulation and technology," *WORLD J. Pharm. Pharm. Sci.*, vol. 9, no. 10, pp. 1406–1418, 2020.

[3] A. FB and U. T, "Orally Disintegrating Tablets: A Short Review," *J. Pharm. Drug Dev.*, vol. 3, no. 3, 2015.

[4] R. ANUPAM, "Orodispersible tablets: A review," *asian J. Pharm. Clin. Res.*, vol. 9, no. 1, pp. 19–26, 2016.

[5] J. J. Hirani, D. A. Rathod, and K. R. Vadalia, "Orally disintegrating tablets: A review," *Trop. J. Pharm. Res.*, vol. 8, no. 2, pp. 161–172, 2009.

[6] V. A. S. Pooja Arora, "Orodispersible tablets: A comprehensive review," *Int. J. Res. Dev. Pharm. Life Sci.*, vol. 2, no. 2, pp. 270–284, 2013.

[7] A. Suresh Rewar, "Review Article ORAL DISPERSIBLE TABLETS : AN OVERVIEW ; DEVELOPMENT , TECHNOLOGIES AND EVALUATION," *Int. J. Res. Dev. Pharm. Life Sci.*, vol. 3, no. 6, pp. 1223–1235, 2014.

[8] T. Jesmeen and R. Uddin, "Orodispersible Tablets : A Short Review," *stamford J. Pharm. Sci.*, vol. 4, no. 1, pp. 96–99, 2011.

[9] R. Han, Y. Yang, X. Li, and D. Ouyang, "Predicting oral disintegrating tablet formulations by neural network techniques," *Asian J. Pharm. Sci.*, vol. 13, no. 4, pp. 336–342, 2018, doi: 10.1016/j.ajps.2018.01.003.

[10] P. K. Nagar, "Superdisintegrants- Current Approach," *J. Drug Deliv. Ther.*, vol. 4, no. 3, pp. 37–44, 2014.

[11] Reshma K J, "Superdisintegrants and Their Inevitable Role in Orodispersible Tablet," *Int. J. Res. Rev.*, vol. 7, no. 10, p. 10, 2020.

[12] K. Shobana, L. Subramanian, D. M. Rajesh, and K. Sivaranjani, "A Review on Superdisintegrants," *Int. J. Pharm. Sci. Rev. Res.*, vol. 65, no. 2, pp. 149–154, 2020, doi: 10.47583/ijpsrr.2020.v65i02.023.

[13] A. Bishal, K. A. Ali, B. Bandyopadhyay, R. Bandyopadhyay, and B. Debnath, "Study of different super-disintegrants and their use as a magic ingredient for different immediate-release tablets," *J. Pharm. Negat. Results*, vol. 13, no. 5, pp. 1222–1232, 2022, doi: 10.47750/pnr.2022.13.S05.194.

[14] V. Kaur and N. Mehara, "A Review on: Importance of Superdisintegrants on Immediate Release Tablets," *Int. J. Res. Sci. Innov.*, vol. III, no. Ii, pp. 39–43, 2016, [Online]. Available: www.rsisinternational.org

[15] L. L. A. Na Zhao, "A new era of tablet disintegrants," *AAPS PharmSciTech*, vol. 6, no. 1, pp. E120–E126, 2005.

[16] D. S. K. P. and D. R. I. Jyoti Verma, "An overview on Superdisintegrants:A Review," *Eur. J. Pharm. Med. Res.*, vol. 4, no. 9, pp. 252–260, 2017.

[17] Abha and L. P. Kaur, "Superdisintegrants: an Arising Exemplar in Orodispersible Tablets," *Int. J. Drug Res. Tehnol.*, vol. 5, no. 1, pp. 1–12, 2015, [Online]. Available: http://ijdrt.com/drug-research-and-technology/article/view/superdisintegrants-an-arising-exemplar-in-orodispersible-tablets

[18] Ramakant M. Narke, "superdisintegration: A Review update and application," *Asian J. Pharm. Res. Dev.*, vol. 2, no. 4, pp. 90–100, 2014, [Online]. Available: https://eje.bioscientifica.com/view/journals/eje/171/6/727.xml

[19] P. Giri, "Review on superdisintegrants," *World J. Pharm. Res.*, vol. 11, no. 7, pp. 445–466, 2022, doi: 10.20959/wjpr20227-24317.

[20] S. Kumari M and R. Kaza, "Novel Natural Superdisintegrants: An Updated Review," *Ijppr.Human*, vol. 17, no. 1, pp. 187–210, 2019, [Online]. Available: www.ijppr.humanjournals.comwww.ijppr.humanjournals.com

[21] G. S. S. V Madhulika and B. R. Kuber, "A review on natural and synthetic polymers employed in the formulation of oral disintegrating tablets," vol. 9, no. 2-s, pp. 652–658, 2019.

[22] D. Pradhan, P. Chakraborty, S. Halder, and A. Bagchi, "An overview on FDA-approved natural super disintegrants efficacy in a fast dissolving drug delivery system," *J. Appl. Pharm. Res.*, vol. 9, no. 3, pp. 1–7, 2021, doi: 10.18231/j.joapr.2021.v9.i3.1-7.

[23] R. Pahwa and N. Gupta, "Superdisintegrants in the Development of Orally Disintegrating Tablets: A Review," *Int. J. Pharm. Sci. Res.*, vol. 2, no. 11, pp. 2767–2780, 2011.

[24] N. M. Bhatia *et al.*, "Extraction and characterization of mucilage from Lepidium sativum Linn. Seeds," *Der Pharm. Lett.*, vol. 6, no. 1, pp. 65–70, 2014.

[25] R. Kumar, S. Patil, M. B. Patil, S. R. Patil, and M. S. Paschapur, "Isolation and evaluation of disintegrant properties of fenugreek seed mucilage," *Int. J. PharmTech Res.*, vol. 1, no. 4, pp. 982–996, 2009.

[26] M. T. Alam, N. Parvez, and P. K. Sharma, "FDA-Approved Natural Polymers for Fast Dissolving Tablets,"

J. Pharm., pp. 1–6, 2014, doi: 10.1155/2014/952970.

[27] F. Joseph and K. Premaletha, "Natural Superdisintegrants for the Formulation of Orally Disintegrating Tablets," *Int. J. Res. Rev.*, vol. 8, no. 11, pp. 123–128, 2021, doi: 10.52403/ijrr.20211117.

[28] P. S. Mohanachandran, P. G. Sindhumol, and T. S. Kiran, "Superdisintegrants: An overview," *Int. J. Pharm. Sci. Rev. Res.*, vol. 6, no. 1, pp. 105–109, 2011.

[29] H. Shihora and S. Panda, "Superdisintegrants , Utility in Dosage Forms : A Quick Review," *J. Pharm. Sci. Biosci. Res.*, vol. 1, no. 3, pp. 148–153, 2011.

[30] S. K. Likhith H M, "A Review on Fast Dissolving Tablets by Using Co-Processed Superdisintegrants," *Int. J. Pharm. Pharm. Res.*, vol. 16, no. 3, pp. 149–164, 2019.

[31] K. S. G. Arul Kumaran, J. Sreekanth, and S. Palanisamy, "Formulation development and evaluation of Levodopa-Carbidopa orally disintegration tablets," *J. Chem. Pharm. Res.*, vol. 3, no. 3, pp. 169–175, 2011.

[32] A. S. D. K. Abdul Razak, "Orally disintegrating tablets: A review," *Int. J. pharma Chem. Res.*, vol. 1, no. 1, pp. 25–30, 2015.

[33] R. Santosh Kumar and A. Kumari, "Superdisintegrant: crucial elements for mouth dissolving tablets," *J. Drug Deliv. Ther.*, vol. 9, no. 2, pp. 461–468, 2019, doi: 10.22270/jddt.v9i2.2480.

[34] A. Dalimbe, J. Pawar, S. Bhosale, and N. Shinde, "A REVIEW : NOVEL SUPERDISINTEGRANTS," *Int. J. Creat. Res. thoughts*, vol. 9, no. 7, pp. 31–45, 2021.

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