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Natural Superdisintegrants in Fast Dissolving Tablet Emphasis on Banana Peel Powder as a Sustainable Pharmaceutical Excipient - A Review

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Abstract: ***Fast-dissolving tablets (FDTs) represent an advanced oral drug delivery system designed to disintegrate rapidly in the oral cavity, improving patient compliance and therapeutic onset. The efficiency of FDTs is primarily governed by the type and performance of super-disintegrants incorporated into the formulation. Conventional synthetic super-disintegrants, such as croscarmellose sodium, sodium starch glycolate, and crospovidone, are effective but are often associated with higher costs, limited biodegradability, and environmental concerns. Consequently, natural super-disintegrants derived from plant and agro-waste sources have emerged as promising alternatives. Banana peel powder, an abundant agricultural waste, has gained attention due to its high cellulose and mucilage content, which impart excellent swelling and wicking properties. This review comprehensively discusses the fundamentals of fast-dissolving tablets, the mechanisms and classification of super-disintegrants, and the growing importance of natural excipients. Special emphasis is placed on banana peel powder as a sustainable natural super-disintegrant, including its physicochemical properties, comparative performance with synthetic agents, applications in diclofenac sodium and other drugs, and prospects. The review highlights banana peel powder as a viable, eco-friendly, and cost-effective excipient for modern pharmaceutical formulation development***.

Keywords: Fast-dissolving tablets; Natural super-disintegrants; Banana peel powder; Diclofenac sodium; Sustainable excipients

1. Introduction

Oral solid dosage forms remain the most preferred drug delivery systems due to their convenience, stability, accurate dosing, and ease of manufacturing. Tablets constitute a major portion of these dosage forms; however, conventional tablets often suffer from delayed onset of action owing to prolonged disintegration and dissolution times. Additionally, difficulty in swallowing conventional tablets poses challenges for pediatric, geriatric, and dysphagic patients, thereby reducing compliance.

Fast-dissolving tablets were developed to overcome these limitations by disintegrating rapidly in the oral cavity without the need for water. These dosage forms provide rapid drug release, faster absorption, and improved bioavailability. The formulation of FDTs requires careful selection of excipients to ensure rapid disintegration while maintaining mechanical strength and stability. (Pradhan D et al, 2021)

Super-disintegrants play a pivotal role in the performance of FDTs. While synthetic super-disintegrants are widely used, the growing emphasis on green pharmacy and sustainable development has encouraged the exploration of natural alternatives. Banana peel powder, derived from agro-waste, has emerged as a promising natural super-disintegrant due to its biodegradability, non-toxicity, low cost, and favorable pharmaceutical properties.

2. Literature Survey

S. No	Title	Author	Year	Research
1	An overview on FDA-approved natural super disintegrants efficacy in a fast-dissolving drug delivery system	Pradhan D, Chakraborty P, Halder S, Bagchi A	2021	For fast-dissolving drug delivery systems, DA-approved natural super-disintegrants offer a sustainable, safe, and efficient substitute. They can function as dependable excipients that combine regulatory compliance with enhanced therapeutic performance and environmental responsibility if they are properly standardized and quality controlled.
2	Formulation and evaluation of a mouth dissolving tablet of meloxicam using natural superdisintegrants	Pawar CV, Mutha SS, Bhise SV, Borawake PD	2020	The study's overall findings indicate that natural superdisintegrants are efficient, cost-effective, biocompatible, and ecologically benign substitutes for synthetic agents in the production of meloxicam mouth-dissolving tablets.
3	Formulation and evaluation of fast dissolving tablets using dehydrated banana powder as superdisintegrant	Manisha K, Kesharwani P	2025	All things considered, dehydrated banana powder is a sustainable, non-toxic, biodegradable, and reasonably priced natural superdisintegrant for formulations of fast-dissolving tablets. Its use promotes the creation of environmentally friendly pharmaceuticals while also improving tablet performance. To make commercial application easier, more long-term stability and scale-up research is advised.

4	Formulation of Fast Dissolving Tablet Using Banana Peel Powder	Satish S, Tanwar Y	2020	All things considered, banana peel powder is an economical, environmentally benign, biodegradable, and effective natural superdisintegrant for the creation of rapidly dissolving tablets. By repurposing agricultural waste and preserving acceptable tablet performance, its application promotes sustainable pharmaceutical development. For commercial use, more research on stability, standardization, and large-scale production is advised.
5	Banana-derived excipients: drug release, performance, and stability	Fauzi MF	2025	All things considered, banana peel powder is an economical, environmentally benign, biodegradable, and effective natural superdisintegrant for the creation of rapidly dissolving tablets. By repurposing agricultural waste and preserving acceptable tablet performance, its application promotes sustainable pharmaceutical development. For commercial use, more research on stability, standardization, and large-scale production is advised.

Fast-Dissolving Tablets: Concept and Pharmaceutical Significance

Fast-dissolving tablets are solid oral dosage forms that disintegrate or dissolve within seconds when placed on the tongue. According to pharmacopeial standards, an ideal FDT should release more than 85% of the labeled drug amount within 30 minutes. The rapid disintegration of FDTs leads to faster dissolution and absorption, resulting in quicker onset of therapeutic action.

FDTs offer several advantages, including improved patient compliance, ease of administration without water, rapid onset of action, and suitability for emergency conditions. These dosage forms are particularly beneficial for pediatric and geriatric patients, patients with nausea, motion sickness, or mental disorders, and those who have difficulty swallowing conventional tablets. (pawar CV et al,2020)

Formulation of Fast-Dissolving Tablets:

Fast-dissolving tablets provide a speedy start of action and better patient compliance since they dissolve quickly in the oral cavity without the need for water. An active pharmaceutical ingredient (API), super-disintegrants, diluents, binders, lubricants, and flavoring agents make up the majority of the formulation. Taste, solubility, and dosage are taken into consideration when choosing the API. To encourage quick pill disintegration, super-disintegrants such crospovidone, croscarmellose sodium, sodium starch glycolate, or natural substitutes like powdered banana peel are added. To improve mouthfeel and tablet bulk, diluents like lactose or mannitol are utilized. While lubricants like magnesium stearate enhance flow and avoid sticking during compression, binders like polyvinylpyrrolidone (PVP) offer mechanical strength. To cover up an unpleasant taste, flavors and sweeteners are added. Depending on the characteristics of the medicine, the formulation is often made by sublimation, wet granulation, or direct compression. The most popular method is direct compression because of its affordability and ease of use. A tablet press is used to precisely weigh, combine, and compress all contents into tablets. To guarantee quality and effectiveness, the produced tablets are then assessed for characteristics such hardness, friability, wetting time, disintegration time, and drug release. (Satish S et al,2020)

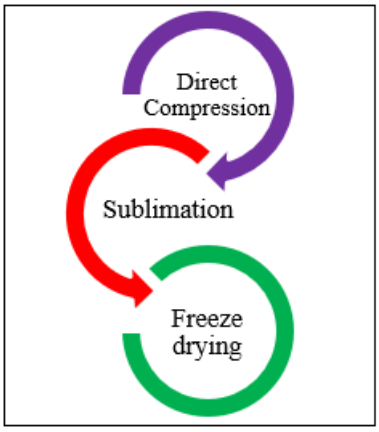

Figure 1: Formulation of fast dissolving tablets

Evaluation of Fast Dissolving Tablets

- Hardness
- Friability
- Weight variation
- Disintegration time
- Wetting time
- In vitro dissolution studies

Super-Disintegrants: Role and Mechanisms

Super-disintegrants are excipients incorporated into tablet formulations to facilitate rapid disintegration upon contact with saliva or gastrointestinal fluids. They are typically used at concentrations of 1–10% w/w and function through various mechanisms. (Rathore P et al, 2025).

3.1 Mechanisms of Action

- Swelling: Super-disintegrants absorb water and swell, generating internal pressure that causes tablet rupture.
- Wicking: Capillary action draws liquid into the tablet matrix, weakening inter-particulate bonds.
- Deformation recovery: Particles expand to their original shape upon wetting, leading to tablet breakup.
- Enzymatic action: Enzymes degrade tablet components, aiding disintegration. (Nandhini M et al,2024)

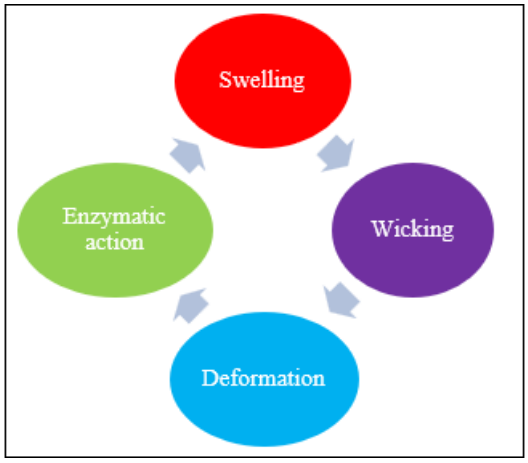

Figure 2: Mechanism of fast dissolving tablets

3.2 Classification of Super-Disintegrants

Super-disintegrants are classified into synthetic and natural categories. Synthetic agents include croscarmellose sodium, sodium starch glycolate, and crospovidone. Natural super-disintegrants are derived from plant sources such as gums, mucilages, and agricultural by-products. (Sharma R et al, 2020)

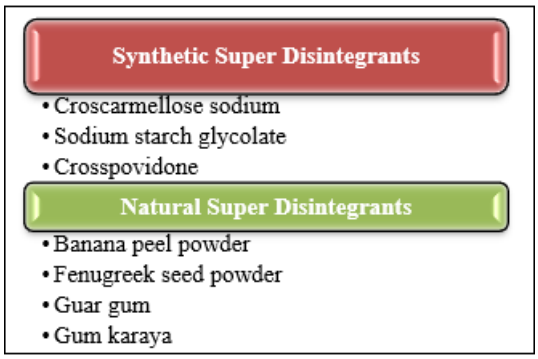

Figure 3: Classification of super disintegrants

Natural Super-Disintegrants: Banana Peel Powder
Banana peel powder is obtained from the dried outer covering of ripe bananas. It is rich in cellulose, hemicellulose, pectin, and mucilage, which contribute to its excellent swelling and water absorption properties. The utilization of banana peel powder not only enhances tablet performance but also promotes waste valorization and environmental sustainability.

Several studies have demonstrated that banana peel powder exhibits comparable or superior disintegration efficiency when compared with synthetic super-disintegrants. Its non-toxic, biodegradable, and cost-effective nature further supports its application in pharmaceutical formulations. (Fauzi MF et al,2025)

Preparation of Banana Peel Powder:
Ripe, healthy bananas are used to gather fresh banana peels, which are then properly cleaned under running water to get rid of any dirt or contaminants. To ensure even drying, the peels are next chopped into small pieces and washed with distilled water. The peels are dried using either oven drying or shade drying at a regulated temperature of 40 to 50 °C until they are entirely dry. After drying, the peels are ground into a fine powder using a mortar and pestle or grinder. To guarantee consistent particle size, the powder is run through an appropriate sieve (such as #60 or #80). Before being used as a natural super-disintegrant or pharmaceutical excipient, the produced banana peel powder is kept at room temperature in an airtight container to prevent contamination and moisture. (Jani RK et al,2025)

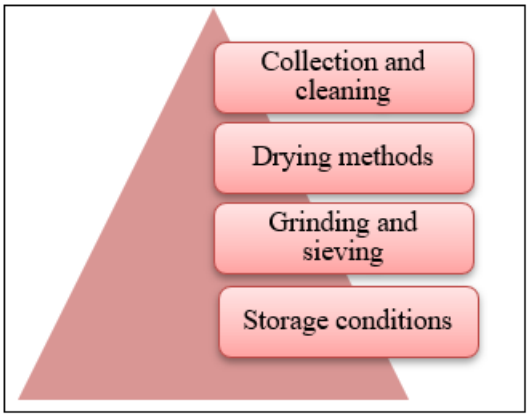

Figure 4: Preparation method of super disintegrants

Role Of Banana Peel Powder in Fast Dissolving Tablets:
When fast-dissolving tablets come into touch with saliva, banana peel powder functions as a natural super-disintegrant, accelerating pill breakage. Dietary fibers including cellulose, hemicellulose, and pectin, which have a high capacity for swelling and water absorption, are abundant in it. Banana peel powder rapidly absorbs moisture, swells, and generates internal pressure inside the tablet matrix when added to FDTs, resulting in speedy disintegration without the need for water. Banana peel powder not only disintegrates tablets but also increases their wettability, which shortens the wetting time and promotes drug solubility. It is a sustainable substitute for artificial super-disintegrants since it is an inexpensive, natural, biodegradable, and non-toxic excipient. By employing agricultural waste, it also promotes environmentally friendly pharmaceutical formulation. Therefore, in fast-dissolving drug delivery systems, banana peel powder promotes quick disintegration, better patient compliance, and sustainable tablet formulation. (kumara N et al, 2024

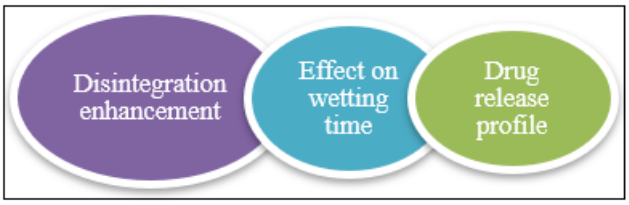

Figure 5: Role of banana peel in fast dissolving tablets

Comparative Performance: Natural Vs Synthetic Super-Disintegrants
Because of their high fiber and polysaccharide content, natural super-disintegrants including banana peel powder, plant gums, and starch derivatives break down tablets mainly by swelling and wicking mechanisms. They are appealing substitutes for synthetic excipients because they are non-toxic, biodegradable, economical, and environmentally sustainable. However, if they are not adequately standardized, their performance may exhibit batch-to-batch variability,

moisture sensitivity, and relatively slower or less uniform disintegration. On the other hand, synthetic super-disintegrants such sodium starch glycolate, crospovidone, and croscarmellose sodium are very effective and offer quick, reliable, and consistent disintegration even at low doses. They are appropriate for large-scale industrial production because they have superior flow characteristics, stability, and regulatory approval. Synthetic super-disintegrants, on the other hand, need chemical processing, are more expensive to produce, and are less environmentally sustainable. Overall, natural super-disintegrants offer a sustainable and affordable alternative to synthetic super-disintegrants, especially for fast-dissolving tablets when properly optimized and standardized. Synthetic super-disintegrants, on the other hand, offer superior consistency and speed. (Nabila N et al,2024)

Applications In Diclofenac Sodium and Other Drugs

In the manufacture of fast-dissolving tablets of diclofenac sodium, a non-steroidal anti-inflammatory medication used to treat pain and inflammation, banana peel powder has been investigated as a natural super-disintegrant and functional excipient. Banana peel powder quickly absorbs saliva, swells, and facilitates tablet breakdown due to its high cellulose and pectin content, which speeds up medication dissolution and beginning of action. Diclofenac sodium, which needs quick relief in acute pain situations and could otherwise exhibit delayed dissolution due to poor aqueous solubility, benefits most from this. Banana peel powder may be used to make fast-dissolving or immediate-release tablets of various medications, including paracetamol, ibuprofen, aceclofenac, ondansetron, metoclopramide, and antihistamines, in addition to diclofenac sodium. It is appropriate for pediatric and geriatric formulations, where quick disintegration and simplicity of administration are crucial, due to its natural origin, biodegradability, and affordability. All things considered, banana peel powder is an environmentally benign and sustainable excipient that improves patient compliance, solubility, and disintegration of a variety of medications used in fast-dissolving tablet formulations.

3. Sustainability and Environmental Impact

A sustainable and eco-friendly method of pharmaceutical formulation is the use of banana peel powder in fast-dissolving tablets. Banana peels are a common household and agricultural waste, and using them as a pharmaceutical excipient helps to valorize waste, which lessens the impact on the environment and the amount of garbage that ends up in landfills. Green chemistry and the circular economy are in line with turning this biodegradable waste into a product with additional value Compared to synthetic super-disintegrants, which frequently require energy-intensive manufacturing methods and chemical treatments, banana peel powder is a renewable, biodegradable, and non-toxic natural substance, making it safer for the environment. Simple processes like washing, drying, and grinding are used in its preparation, which uses less energy and produces less chemical waste. As a result, the carbon footprint of tablet production is greatly reduced. In terms of sustainability, banana peel powder is affordable and readily available locally, especially in nations that grow bananas, which lessens reliance on imported synthetic excipients. Its application maintains efficient tablet performance, such as quick disintegration and better solubility, while encouraging sustainable pharmaceutical development. In general, adding powdered banana peel to fast-dissolving tablets promotes sustainable medicine delivery system design, resource conservation, and environmental protection.

4. Conclusion

Natural super-disintegrants, particularly banana peel powder, represent a sustainable and effective alternative to synthetic disintegrants in fast-dissolving tablet formulations. Their favorable physicochemical properties, safety profile, and environmental benefits support their potential use in modern pharmaceutical development. In conclusion, because of its efficient swelling and water-uptake qualities, sustainability, and affordability, the use of banana peel powder as a natural super-disintegrant in fast-dissolving tablet formulations shows great promise. Natural substitutes, such as banana peel powder, offer an environmentally benign and biodegradable solution made from agricultural waste, while synthetic super-disintegrants offer faster and more reliable disintegration with established regulatory acceptability. Banana peel powder can function similarly to synthetic super-disintegrants with the right standardization, manufacturing optimization, and quality control. Thus, it represents a promising, sustainable excipient for future fast-dissolving tablet formulations, aligning pharmaceutical development with green and environmentally responsible practices.

5. Challenges and Future Perspectives

Banana peel powder presents significant difficulties when used in fast-dissolving tablets, despite its potential as a natural super-disintegrant. Batch-to-batch variability is a significant drawback since the content of banana peels can change according on variety, age, and growth conditions, which may have an impact on the efficiency of disintegration. Because banana peel is an organic material that needs to be properly dried, sterilized, and stored, microbial infestation is another issue. Large-scale tablet production may be hampered by the powder's poor flow characteristics and increased moisture sensitivity. Furthermore, comprehensive safety, toxicity, and stability studies are necessary for the regulatory adoption of novel natural excipients, which can be expensive and time-consuming. If not adequately masked, any problems with color, odor, or taste may also have an impact on patient acceptability. Banana peel powder in fast-dissolving tablets has very promising future potential. It can perform similarly to synthetic super-disintegrants with the right standardization, purification, and particle size optimization. Its disintegration efficiency and flow properties may be further improved by advances in processing techniques including co-processing with additional excipients, surface modification, or nano-milling. Regulatory acceptability and industrial use are anticipated to be supported by a greater focus on sustainability, natural excipients, and green pharmaceuticals. Banana peel powder can also be used in low-cost medications in underdeveloped nations, pediatric and geriatric dosage forms, and herbal formulations. Banana peel powder may become a dependable, cost-effective, and environmentally friendly super-disintegrant for upcoming fast-dissolving tablet formulations with further study and clinical validation.

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