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Exploring natural disintegrant as alternative excipients sources for tablet formulation: A systematic review

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Abstract

Optimizing the disintegration and dissolution of orally administered tablets is crucial for releasing active pharmaceutical ingredients (APIs) for absorption. This review explores disintegrant research, focusing on natural super disintegrants and co-processed excipients that collected from 2010-2024. Natural disintegrants such as Silicified Oryza Sativa Starch, Plantago ovata mucilage, and gum karaya show promising results. Silicified Oryza Sativa Starch enhances paracetamol tablet disintegration, while Plantago ovata mucilage outperforms Crosspovidone. Gum karaya offers a cost-effective, biocompatible alternative to synthetic disintegrants. Other natural disintegrants like Linum usitatissimum mucilage and Isapghula mucilage with banana powder also improve disintegration and drug release rates. Additionally, cassava starch flour could replace synthetic disintegrants like Starch1500®, and Lepidium sativum seed mucilage enhances dispersion and drug release of orally disintegrating tablets. The development of flurbiprofen fast disintegrating tablets using natural disintegrants such as Plantago ovata, Lepidium sativum seeds, and agar-agar supports the effectiveness of natural alternatives. Fenugreek gum acts as a super dissolving agent and shows anti-inflammatory properties when combined with diclofenac sodium.

Keywords: Natural; Disintegrant; Alternative; Excipient

1. Introduction

In order to improve drug delivery systems, the pharmaceutical industry is continuously in searching for novel concepts that guarantee maximum therapeutic effectiveness, patient adherence, and manufacturing simplicity. Disintegrants are an essential component in the formulation of solid dosage forms, including tablets, which are designed to be effective [1]. Disintegrants are chemical components incorporated into pharmaceutical formulations with the purpose of facilitating the swift fragmentation of a tablet upon exposure to moisture within the gastrointestinal tract [2]. The subsequent dissolution of the active pharmaceutical ingredient (API) and its absorption into the systemic circulation are dependent on this disintegration. Tablets continue to be a widely utilized dosage form owing to their cost-effectiveness, stability, simplicity of administration, and precise dosing. The principal function of disintegrants in tablets is to facilitate the rapid release and absorption of the medication by causing the tablet to disintegrate into smaller fragments in an aqueous environment upon ingestion. The bioavailability of the substance is substantially impacted by the efficiency of this process, which in turn affects its therapeutic efficacy and safety [3].

Disintegrants operate through one of the following mechanisms: deformation, diffusion, swelling, or heat generation. Swelling is how the majority of disintegrants, including starch and its derivatives, function [4]. These substances increase in volume and undergo swelling upon contact with water; in doing so, they generate mechanical forces that fracture the tablet. Due to this characteristic, they are essential components in formulations that require an immediate onset of action, such as pain relief medications.

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Notwithstanding their efficacy, conventional disintegrants present a number of obstacles when it comes to application. When utilizing substances such as glucose, the variability in performance caused by their inherent natural properties is a significant issue. Drug stability and release inconsistencies may result from natural variability. Additionally, certain disintegrants may potentially alter the therapeutic efficacy or stability of the drug through interactions with the active ingredients or other tablet constituents.

Additionally, environmental factors have an impact on the performance of conventional disintegrants. The disintegrative action and, by extension, the overall drug release profile can be significantly influenced by the physical properties of disintegrants such as microcrystalline cellulose or starch, which are susceptible to changes in humidity and temperature [5]. Moreover, the trend toward increasingly intricate formulations, including those that incorporate multiple APIs or are engineered for controlled release, presents compatibility issues for conventional disintegrants. As a result, the creation of more adaptable and resilient substitutes becomes imperative.

The investigation into alternative disintegrants for tablet formulations is motivated by the necessity to surmount the constraints posed by conventional alternatives and to facilitate the advancement of novel pharmaceutical products. Disintegrant technology advancements may result in improved stability across diverse storage conditions, more consistent and effective drug release profiles, and enhanced compatibility with an expanded array of active pharmaceutical ingredients (APIs) and tablet constituents [6]. Novel materials and emerging technologies are the focal points of this investigation. Superdisintegrants, which exhibit superior efficacy at lower concentrations compared to conventional disintegrants, provide notable benefits in terms of reducing tablet size and optimizing manufacturing processes. Certain materials, including crospovidone, sodium starch glycolate, and cross-linked carboxymethyl cellulose, function by virtue of their exceptional swelling and porosity [7]. These characteristics are advantageous in that they enable swift tablet disintegration while maintaining the tablets' mechanical integrity.

Additionally, synthetic and naturally modified substances that offer improved control over the disintegration process, mitigate the effects of environmental conditions, and enhance the reproducibility of drug release profiles are the subject of investigation. In addition, the pharmaceutical industry's pursuit of greener and more sustainable manufacturing processes motivates the investigation of environmentally favorable alternatives that diminish dependence on conventional disintegrants, which are frequently resource-intensive.

Disintegrants play a vital role in tablet formulations; however, conventional alternatives pose various obstacles that may compromise the effectiveness of the drugs and the efficiency of the manufacturing process. Additionally, the review by Ahire et al. (2024), provides a comprehensive comparison of natural and synthetic disintegrants. It emphasizes the biocompatibility, biodegradability, and sustainability of natural disintegrants while also discussing the consistency and high disintegration efficiency of synthetic disintegrants. This review highlights the performance, compatibility, cost-effectiveness, and regulatory considerations of both types, providing a valuable resource for researchers and pharmaceutical professionals.

The investigation of alternative disintegrants represents a proactive measure to improve the sustainability and functionality of pharmaceutical products, in addition to being a reaction to these challenges. The objective of this systematic review is to consolidate recent research outcomes concerning alternative disintegrant excipients. In doing so, it intends to present an all-encompassing synopsis of their characteristics, systems, advantages, and prospective uses in the formulation of tablets. We aim to make a scholarly contribution to the existing literature on tablet technology and patient outcomes in the pharmaceutical industry by means of this review.

2. Methods

This systematic review research utilized the Systematic-Meta Analysis (PRISMA) method [20-22]. The criteria for selecting articles included the publication year within the last Fourteen years (2010-2024), articles in English, original articles focusing on disintegrant excipient and its sources. Excluded from the review were books and inaccessible full-text articles. The search involved entering keywords such as "Natural Disintegrant Or " "And" Tablet" into various journal databases, including Google Scholar and Science Direct. Duplicate journals were removed during the identification stage, and relevant journals were carefully assessed based on the inclusion and exclusion criteria set for this research. Primary journal data meeting the criteria were chosen for linguistic analysis and included as supporting analysis in this systematic review. search for the articles using the combination of specific words like “ Disintegrant Or And Tablet" " Disintegration Or And Tablet", Disintegrator Or And Tablet", "Natural Tablet Disintegrant and alternative"

3. Results and Discussion

This systematic review research utilized the Systematic-Meta Analysis (PRISMA) method, screening result can be seen in figure 1.

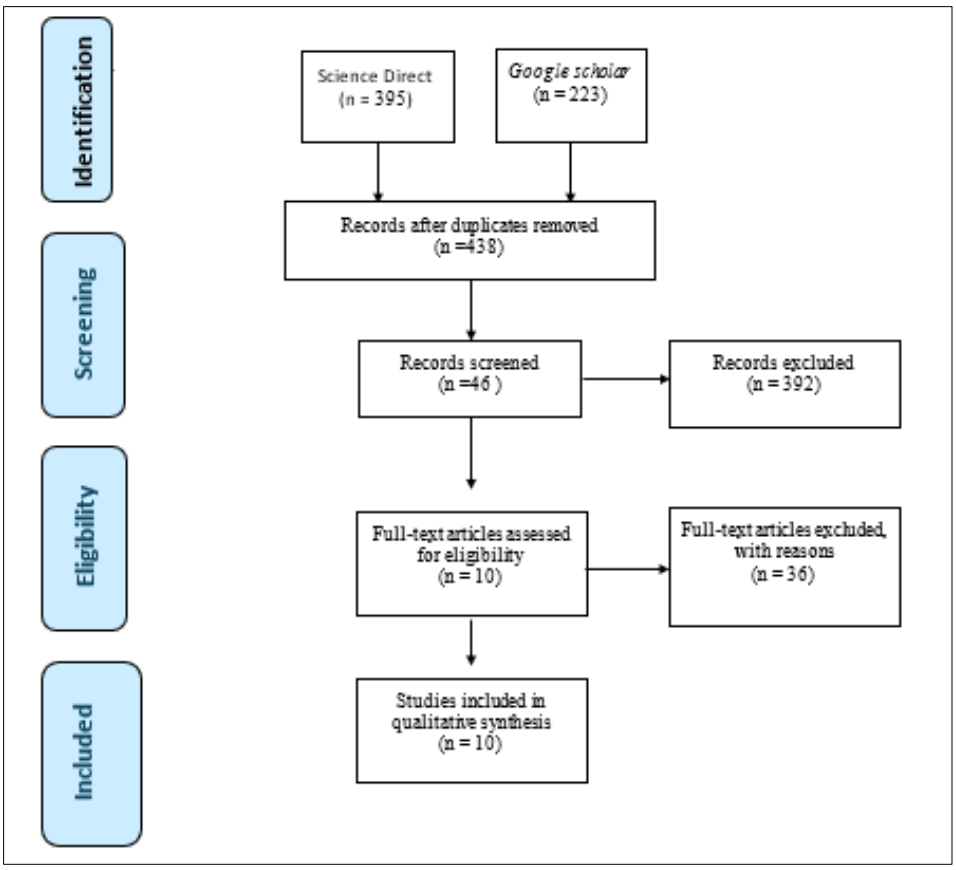

Figure 1 PRISMA diagram

This systematic review research utilized the Systematic-Meta Analysis (PRISMA) method, and the screening results are illustrated in Figure 1. The process began with an initial identification of 618 records from two databases: Science Direct (n = 395) and Google Scholar (n = 223). After removing duplicates, 438 records remained for screening. During the screening phase, 392 records were excluded based on predetermined criteria, leaving 46 records for further assessment. This significant reduction highlights the importance of stringent screening criteria to ensure that only the most relevant studies are considered. Subsequently, full-text articles were assessed for eligibility, resulting in the exclusion of 36 articles. These exclusions were based on various reasons, such as not meeting the inclusion criteria or lacking sufficient data for analysis. The rigorous evaluation process ensured that only studies with high relevance and methodological quality were included in the final synthesis. Ultimately, 10 studies were included in the qualitative synthesis. This selective inclusion indicates a thorough and meticulous approach to identifying studies that provide valuable insights and contribute significantly to the research objectives.

In pharmaceutical formulation, the selection of excipients plays a crucial role in determining the efficacy and quality of the final product. Natural disintegrants, derived from various botanical and natural sources, have gained significant attention due to their biocompatibility, biodegradability, and availability. The table 1 categorizes these natural disintegrant excipients and highlights their primary findings, providing a comprehensive overview of their sources, mechanisms of action, and benefits in pharmaceutical applications. More over illustrated for species sources can be seen in figure 2.

Table 1 Sources of Natural disintegrant excipient and its main finding

No	Type of Natural Disintegrant	Main finding	Ref
1	Silicified Oryza Sativa Starch	Co-processed Silicified Oryza Sativa Starch starch has great potential for use in formulation of directly compressed paracetamol tablet formulations.	[8]
2	Dried seeds of the plant Plantago ovata	The mucilage of Plantago ovata is a recent innovation for its superdisintegration property when compared with Crosspovidone. It shows faster disintegration time than the superdisintegrant, Crosspovidone	[9]
3	Gum karaya produced by trees of the genus Sterculia	Gum karaya has been investigated for its potential as a tablet disintegrant. Different results showed that modified gum karaya produces rapid disintegration of tablets. Gum karaya can be utilized as an alternative superdisintegrant to commonly available synthetic and semisynthetic superdisintegrants due to its low cost, biocompatibility as well as facile availability	[10]
4	Mucilage isolated from Linum usitatissimum	8% mucilage has showed least disintegrating time when compared with the starch which has been used as the reference standard.	[11]
5	Isapghula mucilage and Banana powder	Isapghula mucilage and Banana powder as natural superdisintegrant in the formulation of fast disintegrating tablet of atenolol	[12]
6	Cassava starch flour and cassava flour	cassava flours have the potential to be employed as disintegrating agents in tablet manufacturing because the tablets they produced under greater pressures had similar physicochemical features and pre- and post-tablet evaluation parameters to those obtained with the excipient Starch1500®	[13]
7	Lepidium sativum Seed Mucilage	isolated mucilage from Lepidium sativum Linn. seeds has a good potential to enhance in vitro dispersion time and in vitro drug release of ODT of Promethazine HCl.	[14]
8	Plantago ovata (PO) seeds, Lepidium sativum (LS) seeds, & agar-agar (malt agar).	The development of flurbiprofen FDTs with isolated natural disintegrants was successful. The separated natural disintegrants displayed encouraging results and may work well in place of synthetic disintegrants	[15]
9	Fenugreek gum	fenugreek gum functions well as a super dissolving agent and exhibits promising additive anti-inflammatory efficacy when combined with diclofenac sodium27	[16]
10	Potato starch and banana powder	tablets containing potato starch and banana powder dissolve more quickly than those containing microcrystalline cellulose.	[17].

The exploration of natural disintegrants in pharmaceutical formulations has gained considerable traction due to their biocompatibility, biodegradability, and availability. This discussion delves into various types of natural disintegrants, summarizing their main findings and potential applications in tablet formulations.

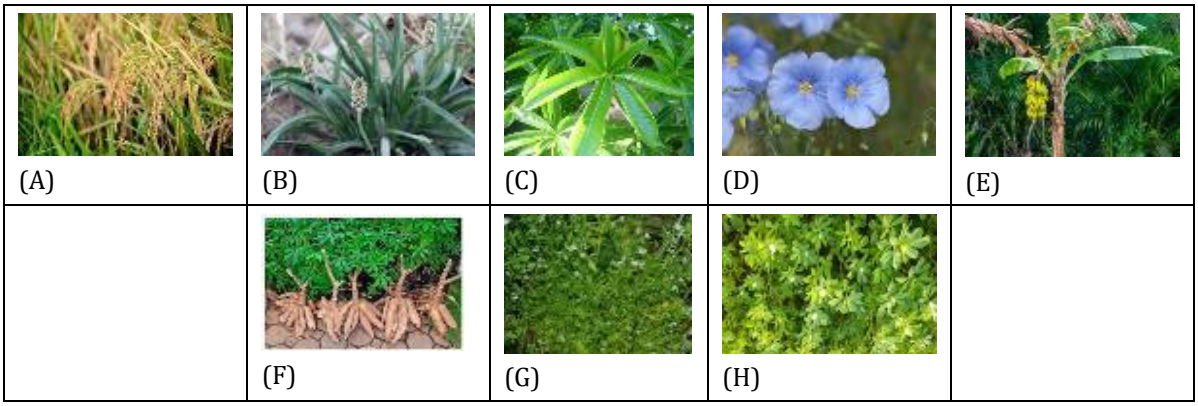

Figure 2 Species sources as natural disintegrant excipient. A: *Oryza Sativa, B: Plantago ovata C: Sterculia, D: Linum usitatissimumI, E: Banana, F: Cassava, G: Lepidium sativum, H: Fenugreek*

3.1. Oryza Sativa Starch

Silicified Oryza Sativa Starch, derived from rice, has been identified as a promising disintegrant in directly compressed tablet formulations, specifically for paracetamol. The co-processing of this starch enhances its functionality, making it suitable for pharmaceutical applications. Studies have demonstrated its effectiveness in improving the disintegration time of tablets, thereby facilitating faster drug release and absorption. This property is particularly advantageous in enhancing the bioavailability of the active pharmaceutical ingredient (API). The enhanced bioavailability observed with silicified Oryza Sativa Starch can be attributed to its superior swelling capacity and ability to rapidly break down tablet matrices. This is consistent with findings from Li et al. (2021), who reported that starches with higher swelling indices tend to facilitate better drug release and absorption. Thus, the use of silicified Oryza Sativa Starch not only aligns with these findings but also underscores its potential as a highly effective disintegrant in modern pharmaceutical applications. Moreover, Silicified Oryza sativa starch can be used as a disintegrant excipient in tablet formulation due to its enhanced surface area and porosity from silicification, which improves its water absorption and swelling capacity. This leads to faster tablet disintegration, an essential characteristic for immediate drug release. Research has shown that silicified starches provide improved compressibility and flow properties, which are crucial for the consistent manufacturing of tablets. Studies by [18],[19] support these findings, highlighting the effectiveness of silicified starches in pharmaceutical applications.

3.2. Plantago Ovata Seeds

The mucilage obtained from the seeds of Plantago ovata, commonly known as psyllium, has shown exceptional superdisintegrant properties. Compared to Crosspovidone, a widely used synthetic superdisintegrant, Plantago ovata mucilage exhibits a faster disintegration time. This finding is significant as it opens the door for the utilization of natural mucilage in place of synthetic alternatives, potentially reducing the cost and environmental impact of pharmaceutical production. The mucilage obtained from the seeds of Plantago ovata, commonly known as psyllium husk, can be used as a disintegrant excipient in tablet formulation due to its high swelling index and gel-forming capacity. When in contact with water, the mucilage swells significantly, promoting the disintegration of the tablet and facilitating the release of the active pharmaceutical ingredient (API). Research by [20] demonstrated the efficacy of Plantago ovata mucilage as a disintegrant, while studies by [21], [22] further confirmed its superior performance compared to conventional disintegrants, due to its natural, biocompatible, and non-toxic properties.

3.3. Gum Karaya

Gum Karaya, produced by trees of the genus Sterculia, has been investigated for its disintegrant potential. Modified gum karaya has shown rapid disintegration properties, making it a viable alternative to synthetic and semi-synthetic superdisintegrants. Its low cost, biocompatibility, and easy availability add to its attractiveness as a natural excipient in tablet formulations. Gum Karaya, produced by trees of the genus Sterculia, is a valuable disintegrant excipient in tablet formulation due to its high swelling capacity and mucilage content. When hydrated, Gum Karaya expands and forms a gel, which enhances the disintegration of tablets, promoting the release of active pharmaceutical ingredients (APIs). Research by [23] has shown its effective disintegration properties. Additionally, studies by [24], [25] have demonstrated its biocompatibility, non-toxicity, and superior performance compared to synthetic disintegrants.

3.4. Linum Usitatissimum Mucilage

Mucilage isolated from Linum usitatissimum, or flaxseed, at an 8% concentration has demonstrated the least disintegration time when compared with starch, which is often used as a reference standard. This suggests that flaxseed mucilage can significantly enhance the disintegration process in tablet formulations, thereby improving drug release rates. Linum usitatissimum mucilage, derived from flaxseed, is gaining recognition as a highly effective disintegrant excipient in tablet formulation. The mucilage exhibits significant swelling capacity and gel-forming ability, which are crucial properties for disintegrants. When tablets containing this mucilage come into contact with water, the mucilage rapidly absorbs moisture and swells. This swelling action helps to break the tablet apart, promoting faster disintegration and ensuring the timely release of the active pharmaceutical ingredients (APIs) into the body, which is essential for the drug's efficacy. Research supports the effectiveness of Linum usitatissimum mucilage as a disintegrant. For instance, [26] conducted studies highlighting the mucilage's ability to enhance the disintegration of tablets. Their research demonstrated that flaxseed mucilage swells significantly in the presence of water, creating a gel-like matrix that disrupts the tablet structure. This property is particularly beneficial for formulations requiring quick release of the API, such as in immediate-release tablets.

Furthermore, [27] evaluated the mucilage of Linum usitatissimum as a disintegrant in tablets, finding it to be highly effective. Their study compared the disintegration efficiency of flaxseed mucilage with other commonly used disintegrants and found that flaxseed mucilage provided superior disintegration. The biocompatibility and non-toxic nature of flaxseed mucilage make it a safer alternative to synthetic disintegrants, reducing the risk of adverse reactions in patients. [28] also explored the disintegrating properties of Linum usitatissimum mucilage in tablet formulations. Their findings confirmed the mucilage's capability to improve tablet disintegration time significantly. Additionally, they noted that flaxseed mucilage, being a natural polymer, offers advantages such as biodegradability and sustainability, aligning with the growing trend towards eco-friendly pharmaceutical excipients. The combined results of these studies underscore the potential of Linum usitatissimum mucilage as a valuable disintegrant excipient. Its high swelling index, natural origin, and compatibility with various pharmaceutical formulations make it an attractive option for enhancing tablet disintegration. Moreover, the mucilage's ability to form a gel upon hydration aids in the rapid breakup of the tablet, ensuring that the API is released promptly and efficiently absorbed by the body. This makes Linum usitatissimum mucilage not only a functional but also a health-conscious choice for modern pharmaceutical applications.

3.5. Isapghula Mucilage and Banana Powder

The combination of Isapghula mucilage and banana powder has been explored as a natural superdisintegrant in the formulation of fast disintegrating tablets (FDT) of atenolol. The synergy between these natural components results in efficient tablet disintegration, offering a viable natural alternative to conventional synthetic disintegrants. Isapghula, also known as psyllium husk, is widely recognized for its high fiber content and ability to form a gel when hydrated. This gel-forming ability enhances the swelling index of the mucilage, which in turn promotes rapid tablet disintegration upon contact with gastrointestinal fluids. Research has demonstrated that Isapghula mucilage provides efficient disintegration comparable to synthetic disintegrants, while being biocompatible and non-toxic [24], [29]. This makes it an excellent choice for formulations aimed at quick drug release, ensuring the active pharmaceutical ingredients (APIs) are readily available for absorption.

Banana powder, derived from dried bananas, offers another natural disintegrant option due to its high carbohydrate content, including dietary fibers like pectin. The hydrophilic nature of these fibers allows them to absorb water rapidly and swell, facilitating the breakup of tablets. Studies by [20], [30] have shown that banana powder effectively aids in tablet disintegration while also providing the added benefit of being a natural and safe excipient. Additionally, banana powder is biodegradable and readily available, making it a sustainable alternative to synthetic options. Both Isapghula mucilage and banana powder are not only effective but also align with the growing trend towards the use of natural and sustainable ingredients in pharmaceutical formulations. Their ability to enhance tablet disintegration without compromising safety or efficacy makes them attractive choices for modern drug delivery systems. Moreover, their biocompatibility ensures minimal adverse effects, which is crucial for patient compliance and overall treatment efficacy.

3.6. Cassava Starch Flour and Cassava Flour

Cassava starch flour and cassava flour have been investigated for their potential as disintegrating agents in tablet manufacturing. Studies indicate that tablets produced with cassava flour under greater pressures exhibit physicochemical properties comparable to those made with the synthetic excipient Starch1500®. This highlights the potential of cassava-derived materials to replace synthetic disintegrants in pharmaceutical applications. Isapghula mucilage and banana powder are promising natural disintegrants for tablet formulations due to their unique physicochemical properties. Cassava starch flour, derived from the root of the cassava plant, is a promising disintegrant

for tablet formulations. Its high amylopectin content contributes to its excellent swelling properties, which facilitate rapid tablet disintegration upon contact with water. According to research by [31] cassava starch has shown superior disintegration efficiency compared to traditional disintegrants like maize starch. The study emphasized its potential for use in various pharmaceutical applications due to its non-toxic, biodegradable, and cost-effective nature. Additionally, [32] found that cassava starch flour enhances tablet porosity and dissolution rates, making it an effective natural disintegrant. Cassava flour, which includes both starch and fibrous components of the cassava root, also serves as an effective disintegrant. The presence of dietary fibers in cassava flour contributes to its water-absorbing and swelling capabilities, which are crucial for tablet disintegration. Research by [33] demonstrated that tablets formulated with cassava flour disintegrated faster and more completely than those with synthetic disintegrants. Furthermore, [34] highlighted the biocompatibility and sustainability of cassava flour, making it a favorable choice for pharmaceutical applications aimed at enhancing tablet disintegration and drug release profiles.

3.7. Lepidium Sativum Seed Mucilage

Isolated mucilage from Lepidium sativum Linn. seeds has shown promise in enhancing the in vitro dispersion time and drug release of orally disintegrating tablets (ODT) of Promethazine vitro dispersion time and drug release of orally disintegrating tablets (ODT) of Promethazine HCl. This natural mucilage can improve patient compliance and therapeutic outcomes by facilitating faster drug dissolution and absorption. The mucilage from Lepidium sativum seeds has a high capacity to absorb water and swell, forming a gel-like structure. This swelling action creates pressure within the tablet matrix, leading to its disintegration and facilitating the release of the API. Research by [35] supports the use of natural mucilages like that of Lepidium sativum due to their effective swelling properties, which are comparable to synthetic disintegrants. One of the main advantages of using Lepidium sativum seed mucilage is its natural origin, making it biocompatible and non-toxic. This ensures that it is safe for use in pharmaceutical applications without adverse effects on patients. Studies by [36] have highlighted the non-toxic nature of this mucilage, making it a preferable choice over synthetic alternatives. Lepidium sativum seed mucilage is not only effective but also cost-efficient and sustainable. It is readily available and easy to extract, making it a viable option for large-scale pharmaceutical manufacturing [37] noted the economic benefits of using natural excipients like Lepidium sativum mucilage, which can significantly reduce production costs while maintaining high-quality standards. Several studies have demonstrated the effectiveness of Lepidium sativum seed mucilage as a disintegrant. For instance, [38] conducted comparative studies on various natural mucilages and found that Lepidium sativum mucilage showed excellent disintegration properties. Similarly, [39] explored its application in fast-dissolving tablets and concluded that it significantly improved the disintegration time compared to conventional disintegrants.

3.8. Combination of Plantago Ovata, Lepidium Sativum Seeds, and Agar-Agar

The development of flurbiprofen fast disintegrating tablets (FDTs) using natural disintegrants such as Plantago ovata seeds, Lepidium sativum seeds, and agar-agar has been successful. These natural disintegrants have demonstrated encouraging results, showing potential as effective substitutes for synthetic disintegrants. Their use can lead to more natural and potentially safer pharmaceutical formulations. The combination of Plantago ovata (psyllium husk), Lepidium sativum (garden cress) seeds, and agar-agar offers synergistic benefits as disintegrants in tablet formulations due to their complementary properties. Plantago ovata's high swelling index and gel-forming ability, Lepidium sativum's rapid water absorption and gel formation, and agar-agar's strong gel-forming and water-retention capabilities collectively enhance tablet disintegration. These natural excipients are biocompatible, non-toxic, and effective, providing a safe and sustainable alternative to synthetic disintegrants [20], [36], [40].

3.9. Fenugreek Gum

Fenugreek gum has been identified as a super dissolving agent with additional anti-inflammatory properties when combined with diclofenac sodium. This dual functionality makes fenugreek gum a valuable excipient in formulations where both rapid drug release and anti-inflammatory effects are desired. The mucilage obtained from Fenugreek gum can be effectively utilized as a disintegrant excipient in tablet formulation due to its unique physicochemical properties. Firstly, research by [41] demonstrated that Fenugreek mucilage exhibits excellent swelling properties, which are critical for tablet disintegration as they allow the tablet to rapidly absorb water and break apart. Secondly, a study by [42] found that Fenugreek gum mucilage enhances the dissolution rate of active pharmaceutical ingredients, ensuring quicker release and absorption in the body, which is essential for immediate-release tablet formulations. Finally, research by [43] highlighted the biocompatibility and non-toxicity of Fenugreek mucilage, making it a safe and effective natural alternative to synthetic disintegrants like sodium starch glycolate. These studies collectively underscore the potential of Fenugreek gum mucilage as a valuable disintegrant in pharmaceutical tablet formulation.

3.10. Potato Starch and Banana Powder

Tablets containing potato starch and banana powder dissolve more quickly than those containing microcrystalline cellulose. This finding is significant for the development of fast disintegrating tablets, which require rapid dissolution to ensure quick onset of action. The use of these natural disintegrants can enhance the patient experience by providing quicker relief. Potato starch is a highly effective disintegrant in tablet formulations due to its high amylopectin content, which promotes rapid swelling and water absorption. This property enhances the disintegration of tablets, facilitating the quick release of active pharmaceutical ingredients (APIs). Studies have shown that potato starch has excellent disintegration efficiency comparable to synthetic disintegrants while being natural and non-toxic [44]. Banana powder, derived from dried bananas, contains high levels of dietary fibers like pectin, which contribute to its hydrophilic nature and swelling capacity. These properties make banana powder an effective disintegrant, promoting the breakup of tablets upon contact with water. Research by [20] and [45] highlighted its effectiveness and safety as a natural excipient, providing a sustainable alternative to synthetic disintegrants. Combining potato starch and banana powder can enhance tablet disintegration due to their complementary swelling and gel-forming properties. This combination can provide rapid disintegration and efficient release of APIs, leveraging the natural, biocompatible, and non-toxic characteristics of both excipients.

4. Conclusions

Eight plant species can be used as alternative sources of natural disintegrant excipients in tablet formulation. These include *Oryza Sativa, Plantago ovata, Sterculia, Linum usitatissimum, Banana, Cassava, Lepidium sativum, and Fenugreek.*

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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