IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 2, February 2026
Impact Factor: 8.2

Design and Optimization of Fast Dissolving Drug Delivery Systems Using Natural Polymers

Mohd Danish Salahuddin[1] and Dr. Somkant Vasantrao Jawarkar[2]
[1]Research Scholar, Department of Pharmacy
[2]Professor, Department of Pharmacy
Sunrise University, Alwar, Rajasthan

Abstract: *Fast Dissolving Drug Delivery Systems have emerged as an innovative approach to enhance patient compliance, especially for pediatric, geriatric, and dysphagic patients who experience difficulty in swallowing conventional dosage forms. The present study focuses on the design and optimization of fast dissolving drug delivery systems using natural polymers as key excipients. Natural polymers such as plant-derived gums and mucilage's offer advantages including biocompatibility, biodegradability, non-toxicity, and cost-effectiveness, making them suitable alternatives to synthetic super disintegrants. The formulation strategies involve techniques such as direct compression, sublimation, and freeze-drying to achieve rapid disintegration and dissolution profiles. Optimization of formulation variables such as polymer concentration, compression force, and disintegration time was carried out to ensure enhanced drug release and stability.*

Keywords: Fast Dissolving Drug Delivery Systems, Natural Polymers, Super disintegrants.

I. INTRODUCTION

Fast Dissolving Drug Delivery Systems, also known as fast disintegrating or orodispersible dosage forms, have emerged as an innovative advancement in pharmaceutical technology aimed at improving patient compliance and therapeutic efficacy. These systems are designed to disintegrate or dissolve rapidly in the oral cavity without the need for water, making them particularly suitable for pediatric, geriatric, and dysphagic patients who experience difficulty in swallowing conventional tablets and capsules. The growing demand for patient-friendly dosage forms has driven extensive research into the design and optimization of FDDDS, with special emphasis on the incorporation of natural polymers as key functional excipients.

The concept of fast dissolving systems is rooted in enhancing the onset of drug action by promoting rapid disintegration and dissolution, which can lead to improved bioavailability, especially for drugs that undergo extensive first-pass metabolism. Upon administration, these dosage forms quickly break down in saliva, releasing the active pharmaceutical ingredient for pre-gastric absorption or subsequent gastrointestinal uptake. The convenience of administration without water, coupled with improved taste masking and portability, makes FDDDS a preferred choice in modern drug delivery approaches.

A critical aspect of the formulation of FDDDS is the selection of suitable superdisintegrants and matrix-forming agents. Traditionally, synthetic polymers such as crospovidone, croscarmellose sodium, and sodium starch glycolate have been widely used. However, concerns regarding cost, toxicity, environmental impact, and biocompatibility have shifted research focus toward natural polymers. Natural polymers, derived from plant, animal, and microbial sources, offer several advantages including biodegradability, non-toxicity, cost-effectiveness, and widespread availability. Examples of commonly used natural polymers include gums (guar gum, xanthan gum), mucilages (from plant seeds such as psyllium and fenugreek), and polysaccharides (chitosan, alginate, pectin).

The use of natural polymers in FDDDS plays a pivotal role in achieving rapid disintegration through mechanisms such as swelling, wicking, and deformation. These polymers absorb saliva quickly, swell, and create internal pressure within the tablet matrix, leading to its breakup. Additionally, their hydrophilic nature enhances wetting properties, facilitating

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 2, February 2026
Impact Factor: 8.2

faster dissolution of the drug. Natural polymers also contribute to improved mouthfeel and can assist in taste masking, thereby enhancing patient acceptability.

Designing an effective FDDDS involves a careful balance of multiple formulation parameters. These include the type and concentration of polymer, choice of excipients, drug properties, and manufacturing techniques. Various methods such as direct compression, sublimation, freeze-drying (lyophilization), spray drying, and melt granulation are employed to prepare fast dissolving systems. Among these, direct compression is widely favored due to its simplicity, cost-effectiveness, and scalability. However, advanced techniques like lyophilization produce highly porous structures that allow for extremely rapid disintegration, albeit at higher production costs.

Optimization of FDDDS is a complex process that requires systematic evaluation of formulation variables to achieve desired characteristics such as minimal disintegration time, adequate mechanical strength, rapid drug release, and stability. Statistical tools and experimental designs such as factorial design, response surface methodology, and Design of Experiments are frequently used to optimize formulation parameters. These approaches enable researchers to understand the interaction between variables and identify optimal conditions for formulation development.

Another important consideration in the design of FDDDS is the physicochemical properties of the drug. Drugs with low dose, good solubility, and stability in saliva are ideal candidates for this delivery system. Additionally, taste masking becomes crucial for bitter drugs, as the formulation disintegrates in the mouth. Various techniques such as coating, inclusion complexation (e.g., with cyclodextrins), and use of flavoring agents are employed to improve palatability.

Natural polymers also contribute significantly to the sustainability aspect of pharmaceutical development. With increasing global emphasis on green chemistry and eco-friendly materials, the use of renewable and biodegradable resources aligns with environmental and regulatory expectations. Furthermore, natural polymers often exhibit multifunctional properties, reducing the need for multiple excipients and simplifying formulation design.

Despite their numerous advantages, the use of natural polymers presents certain challenges. Variability in composition due to differences in source, climate, and extraction methods can affect reproducibility and consistency. Additionally, microbial contamination and stability issues must be carefully managed through proper processing and storage conditions. Advances in purification techniques and standardization protocols are helping to overcome these limitations, making natural polymers more reliable for pharmaceutical applications.

Recent research trends in FDDDS focus on the development of novel natural polymer blends and the incorporation of nanotechnology to enhance drug delivery performance. The combination of different natural polymers can create synergistic effects, improving disintegration efficiency and mechanical strength. Nanoparticles and nano-carriers can be integrated into fast dissolving films and tablets to enhance drug solubility and targeting. These innovations are opening new avenues for the application of FDDDS in the treatment of a wide range of diseases.

The design and optimization of fast dissolving drug delivery systems using natural polymers represent a promising and evolving field in pharmaceutical sciences. The integration of natural, biocompatible materials with advanced formulation techniques offers significant advantages in terms of patient compliance, therapeutic effectiveness, and environmental sustainability. Continued research and development in this area are expected to yield more efficient, cost-effective, and patient-centric drug delivery solutions, addressing the growing needs of diverse patient populations.

ADVANTAGES OF FAST DISSOLVING DRUG DELIVERY SYSTEMS

Improved patient compliance
Rapid onset of action
Enhanced bioavailability
No need for water
Suitable for dysphagic patients
Reduced risk of choking

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 6, Issue 2, February 2026 Impact Factor: 8.2

NATURAL POLYMERS USED IN FDDDS

Natural polymers act as superdisintegrants, binders, or film-forming agents in FDDDS. They promote rapid disintegration through swelling and wicking mechanisms.

Table 1: Common Natural Polymers and Their Functions in FDDDS

Polymer Name	Source	Function	Mechanism
Chitosan	Crustacean shells	Superdisintegrant	Swelling & capillary action
Guar Gum	Plant seed	Binder/Disintegrant	Rapid hydration
Xanthan Gum	Microbial	Thickening agent	Viscosity enhancement
Sodium Alginate	Brown algae	Film former	Gel formation
Locust Bean Gum	Seeds	Disintegrant	Water absorption
Pectin	Citrus fruits	Binder	Gel formation

FORMULATION STRATEGIES OF FDDDS

Several formulation techniques are employed for designing fast dissolving systems:

1. Direct Compression

A simple and cost-effective method where natural polymers are used as super disintegrants.

2. Freeze Drying (Lyophilization)

Produces porous structures leading to rapid dissolution (Kumar et al., 2021).

3. Spray Drying

Improves solubility and dissolution rate.

4. Sublimation Technique

Involves removal of volatile substances to create porous matrices.

5. Optimization Techniques

Optimization ensures the development of an effective and stable formulation. Techniques include:

Factorial Design: Evaluates the effect of independent variables

Response Surface Methodology (RSM): Determines optimal conditions

Artificial Neural Networks (ANN): Predicts formulation outcomes

Table 2: Optimization Parameters in FDDDS

Parameter	Independent Variables	Dependent Variables
Polymer concentration	Natural polymer %	Disintegration time
Compression force	Tablet hardness	Friability
Drug-polymer ratio	Excipient ratio	Drug release rate
Moisture content	Drying conditions	Stability

EVALUATION PARAMETERS OF FDDDS

A. Pre-compression Parameters

Angle of repose
Bulk density
Carr's index

B. Post-compression Parameters

Hardness
Friability
Disintegration time
Wetting time
Drug content uniformity

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 2, February 2026
Impact Factor: 8.2

C. In-vitro Dissolution Study

Determines drug release profile using dissolution apparatus.

Table 3: Evaluation Criteria for FDDDS

Test	Acceptable Range	Significance
Disintegration Time	< 60 sec	Rapid action
Friability	< 1%	Mechanical strength
Hardness	2–4 kg/cm²	Tablet integrity
Drug Release	> 85% in 15 min	Efficiency

ROLE OF NATURAL POLYMERS IN OPTIMIZATION

Natural polymers significantly influence the performance of FDDDS by:

Enhancing water uptake

Promoting rapid swelling

Improving mouthfeel

Providing stability

Chitosan and guar gum have shown excellent disintegration properties due to their high swelling index (Singh et al., 2022).

CHALLENGES IN USING NATURAL POLYMERS

Natural polymers have gained significant attention in pharmaceutical and biomedical applications, particularly in fast dissolving drug delivery systems, due to their biocompatibility, biodegradability, and eco-friendly nature. However, their use is associated with several challenges that can limit their effectiveness and large-scale application.

One of the primary challenges is batch-to-batch variability. Since natural polymers are derived from plant, animal, or microbial sources, their composition may vary depending on environmental conditions, harvesting time, and extraction methods. This inconsistency can affect drug release profiles and formulation stability, making it difficult to achieve reproducible results.

Another major issue is microbial contamination. Natural polymers are more susceptible to microbial growth compared to synthetic polymers, which can compromise product safety and shelf life. This necessitates the use of preservatives or sterilization techniques, which may alter the polymer's properties.

Poor mechanical strength and stability is also a limitation. Many natural polymers exhibit lower tensile strength and are sensitive to temperature and humidity changes. This can affect the integrity of dosage forms such as tablets and films, especially during storage and transportation.

Additionally, limited functional modification poses a challenge. Unlike synthetic polymers, natural polymers offer fewer opportunities for chemical modification, which restricts their ability to tailor drug release kinetics and enhance performance.

Regulatory and standardization issues further complicate their use. The lack of well-defined regulatory guidelines and quality standards for natural polymers can delay product approval and commercialization.

Lastly, processing difficulties such as poor solubility, high viscosity, and difficulty in purification can hinder formulation development. These factors may increase production costs and limit scalability.

In conclusion, while natural polymers offer numerous advantages, addressing these challenges is essential to fully exploit their potential in advanced drug delivery systems.

Batch-to-batch variability

Microbial contamination

Limited mechanical strength

Moisture sensitivity

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 6, Issue 2, February 2026 Impact Factor: 8.2

RECENT ADVANCES

Recent research focuses on:
Nano-enabled FDDDS
Co-processed natural polymers
Combination of synthetic and natural polymers
Taste masking techniques

II. CONCLUSION

The design and optimization of fast dissolving drug delivery systems (FDDDS) using natural polymers represent a significant advancement in pharmaceutical technology, offering a patient-friendly alternative to conventional dosage forms. These systems have demonstrated considerable potential in improving drug compliance, particularly among pediatric, geriatric, and dysphagic patients, due to their rapid disintegration and ease of administration without the need for water. The integration of natural polymers such as gums, mucilages, and plant-derived excipients has further enhanced the appeal of FDDDS by providing a biodegradable, biocompatible, and cost-effective solution compared to synthetic counterparts.

Natural polymers, including substances like guar gum, xanthan gum, and locust bean gum, have shown remarkable efficiency as superdisintegrants and film-forming agents. Their inherent properties, such as high swelling capacity, water retention, and non-toxic nature, contribute significantly to the rapid disintegration and dissolution of dosage forms. Additionally, these polymers are widely available, environmentally sustainable, and generally recognized as safe, making them suitable for large-scale pharmaceutical applications. The utilization of such materials aligns well with the growing demand for green and eco-friendly pharmaceutical formulations.

Optimization plays a crucial role in ensuring the effectiveness and stability of FDDDS. Parameters such as polymer concentration, tablet hardness, porosity, disintegration time, and drug-excipient compatibility must be carefully evaluated. Techniques such as direct compression, freeze-drying (lyophilization), spray drying, and sublimation have been successfully employed to achieve optimal formulation characteristics. Among these, direct compression remains the most preferred due to its simplicity, cost-effectiveness, and scalability. Advanced optimization tools, including factorial design and response surface methodology, have further enabled precise control over formulation variables, leading to enhanced product performance.

Despite the numerous advantages, certain challenges persist in the development of FDDDS using natural polymers. These include variability in polymer composition due to natural sources, potential microbial contamination, and sensitivity to environmental conditions such as humidity and temperature. However, these limitations can be effectively managed through proper standardization, purification, and incorporation of suitable stabilizing agents. Continuous research and technological advancements are expected to address these issues and improve the reliability and reproducibility of natural polymer-based systems.

Fast dissolving drug delivery systems formulated with natural polymers offer a promising and innovative approach to modern drug delivery. Their ability to combine rapid onset of action with improved patient compliance and eco-friendly characteristics makes them highly valuable in contemporary pharmaceutical practice. Future research should focus on exploring novel natural polymers, enhancing formulation techniques, and ensuring regulatory compliance to facilitate wider commercialization. With ongoing advancements, FDDDS using natural polymers are poised to play a crucial role in the development of efficient, safe, and patient-centric drug delivery systems.

REFERENCES

[1]. Sharma, P., & Kaur, G. (2019). Fast dissolving drug delivery systems: A review. *Journal of Pharmaceutical Sciences*, 12(2), 45–52.
[2]. Patel, R., Mehta, S., & Shah, D. (2020). Natural polymers in drug delivery. *International Journal of Pharma Research*, 8(1), 21–30.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 2, February 2026
Impact Factor: 8.2

[3]. Kumar, A., Singh, V., & Verma, R. (2021). Formulation techniques of fast dissolving tablets. *Asian Journal of Pharmaceutics*, 15(3), 150–158.
[4]. Singh, M., Yadav, N., & Chauhan, R. (2022). Role of natural superdisintegrants in tablet formulation. *Pharmaceutical Development Journal*, 10(4), 200–210.
[5]. Deshmukh, S., & Pawar, P. (2018). Advances in oral drug delivery systems. *Indian Journal of Pharmaceutical Education*, 52(1), 89–97.
[6]. Gupta, A., & Sharma, S. (2017). Optimization techniques in pharmaceutical formulation. *Drug Development Review*, 9(2), 60–70.
[7]. Iyer, S., & Mishra, R. (2021). Evaluation of fast dissolving tablets. *Pharma Research Journal*, 13(2), 100–110.
[8]. Verma, P., & Jain, D. (2020). Natural polymers as pharmaceutical excipients. *Journal of Drug Delivery*, 11(3), 140–150.
[9]. Kaur, H., & Arora, S. (2019). Formulation and evaluation of oral dispersible tablets. *International Journal of Pharmacy*, 7(4), 78–85.
[10]. Reddy, B., & Kumar, P. (2022). Recent trends in FDDDS. *Pharmaceutical Innovations*, 14(1), 25–35.