INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: https://www.ijpsjournal.com

Review Article

Recent Advances In Oral Solid Dosage Form Formulation And Development

Kale Megha K., Wagh Snehal A., Walunj Ankita A.*, Dhage Shubhangi S., Awari Monika S., Bhalekar S. M., Lamkhade. G. J.

Samarth Institute of Pharmacy, Belhe, Maharashtra, India

ARTICLE INFO

Published: 19 Oct 2024
Keywords:
Pharmaceutical Solid dosage form, Advanced excipients, AI technique, 3D printing, nano-technology, Digital pills.
DOI:
10.5281/zenodo.13955626

ABSTRACT

The most sensible, safest, and natural way to take medication is through the mouth. An overview of the most recent materials and technologies utilized to address issues with patient compliance, pharmaceutical release, absorption, and overall efficacy will be given in this article. Because of their superior patient compliance, portability, stability, and convenience of handling, tablets are the most often used solid oral dose form. Over time, tableting technology has made considerable advancements. This work seeks to shed light on advancements in tablet excipients, production procedures, analytical methods, and the use of Quality by Design. The term "dosage form" describes the physical shape of a medication, such as a solid, liquid, or gas, that enables proper administration to certain body sections. Manufacturing has also benefited from co-processed multifunctional ready-to-use excipients with shorter processing periods, especially for tablet dosage forms. To enhance the performance of products and processes, new advancements in granulation techniques have been created, such as reverse wet, thermal adhesion, steam, melt, freeze, foam, and moist and pneumatic dry granulation. Additionally, a variety of particle engineering methods, such as co-precipitation, hotmelt extrusion, extrusion-spherization, have been used to create robust tablet formulations.

INTRODUCTION

Conventional dosage forms remain the most widely used and have a firm hold in all types of pharmaceutical preparations meant for oral use, even in this age of innovation and improvement in drug delivery for improved therapeutic outcomes. [1]. Tablet doses form have integrated automation in manufacturing and several sophisticated tablet kinds to meet the demands of the expanding market. Because of its durability and patient acceptance, the tablet is the most often utilized dosage form among all those available. In 2014,. Film and sugar coatings were necessary for

***Corresponding Author:** Walunj Ankita A.
Address: *Samarth Institute of Pharmacy, Belhe, Maharashtra, India*
Email : ankitawalunj29@gmail.com

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

improved aesthetic qualities including color, texture, tongue feel, and flavor masking; so, the coating plays a crucial role in the tablet's composition. [2]. A drug's dosage form is its physical shape, such as a solid, liquid, or gas, that allows it to be administered to specific body areas in its appropriate form. This section presents a pharmaceutical study of completed solid oral dosage forms from the perspective of what makes the delivery form special and effective—that is, the physical characteristics and drug substance's condition in the matrix. Polymeric pharmaceutical excipients enable hiding undesirable physicochemical features of pharmaceuticals and, as a result, modifying their pharmacokinetic profiles to improve the therapeutic impact when packaging difficult compounds into solid oral dosage forms. [3]. Consequently, there are now a plethora of synthetic and natural polymers that may be purchased commercially as pharmaceutical excipients, providing possible answers to a range of issues. For example, the various polymers may provide enhanced solubility, shellability, viscosity, biodegradability, sophisticated coatings, cohesion, pH dependence, and crystallization inhibition. This article's goal is to present a comprehensive overview of the many applications of pharmaceutical polymers in solid oral dosage forms. [4].

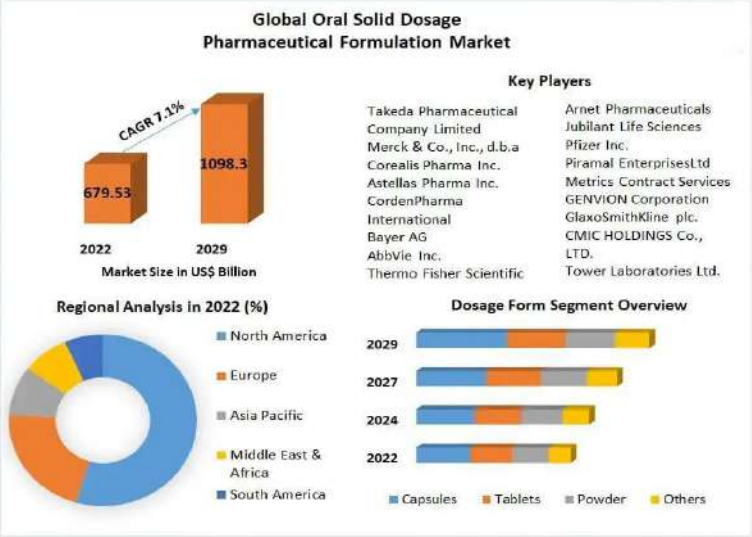

Fig. 1 [52].

Types-

1. Bilayer Tablet
2. Mini tablet
3. Mouth Dissolving Tablet
4. Inlay Tablet
5. Layer Tablet
6. CliniCaps
7. Pastilles
8. Child Ecstasy Tablet
9. Gummy Bears
10. Lollipop

1. Bilayer Tablet-

A particular kind of layer tablet made up of precisely two layers is called a bilayer tablet. varied active pharmaceutical ingredients (APIs) or the same API with varied release characteristics might be included in each layer. [5-9]. This design offers enhanced control over drug delivery compared to single-layer tablets.

Fig.2 [53].

Key Characteristics of Bilayer Tablets

- Two Distinct Layers: Each layer has specific properties.
- Each layer can contain different drugs or the same drug with varying release mechanisms.
- Improved Therapeutic Efficacy: Tailored drug release for optimal treatment outcomes.
- Enhanced Patient Compliance: Fewer pills to take, increasing adherence.

Benefits of Bilayer Tablets

- Precise Drug Delivery
- Combination Therapy
- Immediate and Sustained Release
- Overcoming Drug Incompatibilities
- Pain Management
- Diabetes Management
- Drug Compatibility [10].

2. Mini Tablet-

Mini tablets are scaled-down versions of regular tablets, with screens that normally measure between 7 and 8 inches. They put mobility and convenience first without compromising on necessary functionality. [11].

Fig.3 [54].

Key Characteristics

Compact size:

- Easy to carry and fit in bags or pockets.
- Lightweight: Ideal for on-the-go use.

Affordable:

- Generally, more budget-friendly compared to larger tablets.
- Focus on core functionalities: Often prioritize basic tasks like browsing, email, and media consumption.

Benefit

- Mini tablet reduces a high temperature (fever).
- It works by blocking the release of certain chemical messengers that cause fever.
- It may be prescribed alone or in combination with another medicine
- You should take it regularly as advised by your doctor.

3. Mouth Dissolving Tablet –

Orally disintegrating tablets (ODTs), sometimes referred to as mouth dissolving tablets or fast-

melting tablets, are a kind of dosage form that dissolves quickly in the mouth without the need for water. They provide a practical and effective means of giving medication, particularly to individuals who have trouble swallowing. [12].

Fig.4 [55].

Common excipients include

- **Disintegrants:**

These substances accelerate the breakdown of the tablet.

- **Sweeteners:**

Improve taste and palatability.

- **Flavoring agents:**

Enhance the overall sensory experience.

- Once placed in the mouth, the tablet dissolves quickly, releasing the active ingredient for absorption through the oral mucosa. [13].

4. Inlay Tablet:

A Cutting-Edge Medication Administration Method One portion of an inlay tablet is covered while the other is revealed, making it a special kind of layered tablet. With this design, many drug release characteristics may be combined into one dosage form. [14].

Fig.5 [56].

Benefits

- This design can improve drug efficacy, reduce dosing frequency, and enhance patient compliance. Applications of Inlay Tablets
- Inlay tablets have shown potential in various therapeutic areas, including:
- **Diabetes management:**

Combining immediate-release and sustained-release antidiabetic drugs.

- **Pain management:**

Combining fast-acting pain relievers with long-acting analgesics.

- **Cardiovascular diseases:**

Delivering different drugs for heart conditions.

5. Layer Tablet-

A tablet having many separate layers, each containing various active pharmaceutical ingredients (APIs) or the same API with varied release patterns, is called a layer tablet. With this design, a single tablet can have immediate-release, delayed-release, or sustained-release qualities for customized medication administration.[15].

Fig.6 [57].

Key Characteristics of Layer Tablets

- **Multiple Layers:**

Can consist of two or more layers.

- **Different APIs:**

Each layer may contain different active ingredients.

- **Varying Release Profiles:**

Layers can have immediate, delayed, or sustained release characteristics.

- **Improved Patient Compliance:**

Reduces the number of pills needed, enhancing adherence.

Benefits of Layer Tablets

- **Optimized Drug Delivery:**

Precise control over drug release timing and rate.

- **Reduced Dosing Frequency:**

Fewer pills to take throughout the day.

- **Improved Therapeutic Efficacy:**

By combining different drug actions, better treatment outcomes can be achieved.

- **Cost-Effective:**

Can reduce production costs compared to separate tablets. [16].

6. Clinicaps-

Clinicaps are a type of empty gelatin capsule specifically designed for use in clinical trials. They are characterized by:

- **Two-piece design:**

Similar to standard gelatin capsules but with a tighter fit.

- **Tamper-evident closure:**

The elongated cap locks tightly onto the body, making it difficult to open without leaving visible evidence.

- **Shorter length:**

Designed for easier swallowing.

Why use Clinicaps?

Double-blind studies:

They effectively conceal the contents, ensuring that neither the patient nor the researcher knows whether a capsule contains the active drug or a placebo.

Prevention of tampering: The tight closure helps maintain the integrity of the study medication. Essentially, Clinicaps are a crucial tool in conducting fair and accurate clinical trials.

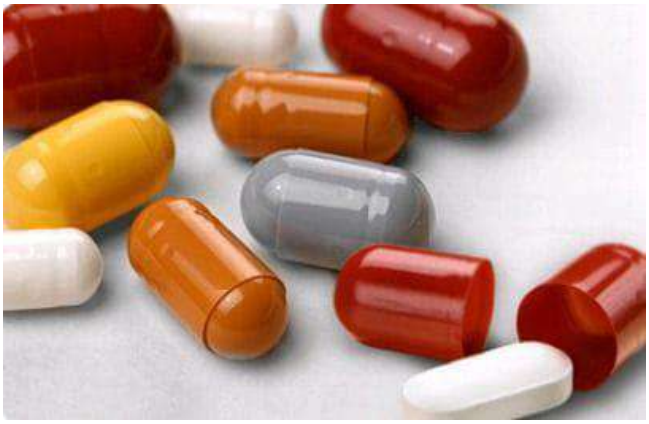

Fig.7 [58].

7. Pastilles-

Pastilles are small, solid pieces of confectionery or medication designed to be slowly dissolved in the mouth. They are often associated with soothing sore throats or freshening breath.

Types of Pastilles

Medicated pastilles:

Contain active ingredients to treat specific conditions, such as sore throats, coughs, or allergies.

Sweet pastilles:

Enjoyed for their flavor and texture, often containing sugar or artificial sweeteners.

Fig.8 [59].

Key Characteristics

- **Solid form:**

Typically, round or oval-shaped.

- **Slow dissolution:**

Designed to be slowly dissolved in the mouth, releasing flavor or medication gradually.

- **Various flavors:**

Available in a wide range of flavors to suit different preferences.

Common Uses

- **Sore throat relief:**

Medicated pastilles can soothe irritation.

- **Cough suppression:**

Some pastilles contain ingredients to suppress coughs.

- **Fresh breath**:

Sweet pastilles can help freshen breath.

- **Enjoyment:**

Sweet pastilles are often consumed as a treat.

8. Child Ecstasy Tablet

3,4-methylenedioxy-methamphetamine (MDMA) a psychoactive substance mostly used for its euphoric and empathogenetic effects, belonging to the groups of medications known as substituted methylenedioxy-phenethylamine and amphetamine. Pharmacologically, MDMA functions as a reuptake inhibitor and a serotonin-norepinephrine-dopamine releasing agent. [17]. Commonly used to refer to MDMA in tablet form, "Ecstasy" may also refer to the presence of potential adulterants. MDMA in the form of

crystalline powder free of adulterants, such as "molly" in the US and "Mandy" in the UK. MDMA possession is prohibited in the majority of nations. There are a few specific exclusions for scientific and medical research. In certain mental diseases, MDMA may be beneficial to health; nevertheless, it can also have negative consequences, such as neurotoxicity and cognitive impairment.

Fig.9 [60].

9. Gummy Bears-

Gummy bears are beloved for their chewy texture and fruity flavors. These small, bear-shaped candies are a popular treat enjoyed by people of all ages.

Key Characteristics

- **Chewy texture:**

Soft and pliable.

- **Fruity flavors:**

Often come in a variety of fruit-inspired tastes.

- **Colorful appearance:**

Vibrant colors make them visually appealing.

- **Gelatin-based:**

Traditionally made with gelatin, though vegetarian alternatives are available.

Fig.10 [61].

Ingredients

Typical ingredients in gummy bears include:

- **Gelatin:**

Provides the chewy texture (or a vegetarian alternative like pectin).

- **Sugar:**

Sweetens the candy.

- **Corn syrup:**

Adds moisture and texture.

- **Flavoring:**

Provides the fruity taste.

- **Food coloring**:

Creates the vibrant colors.

- **Citric acid:**

Gives the candy a tangy flavor.

10. Lollipop-

Lollipop Lozenges:

Sweet Relief Lollipop lozenges are essentially throat lozenges in the delightful form of a lollipop. They combine the soothing properties of traditional lozenges with the fun and enjoyment of a lollipop. [18].

Key Features

- **Delicious taste:**

Often come in a variety of fruity or menthol flavors.

- **Soothing relief:**

Help to alleviate sore throats, coughs, and other throat discomforts.

- **Long-lasting relief:**

The lollipop format allows for extended contact with the throat.

- **Fun and engaging:**

Especially appealing to children. [19-22].

Fig.11 [62].

Benefits

- **Effective relief:**

Provide targeted relief for throat irritation.

- **Child-friendly:**

The lollipop form makes medication more enjoyable for kids.

- **Hydration:**

Helps keep the throat moist.

- **Convenience:**

Easy to carry and consume.

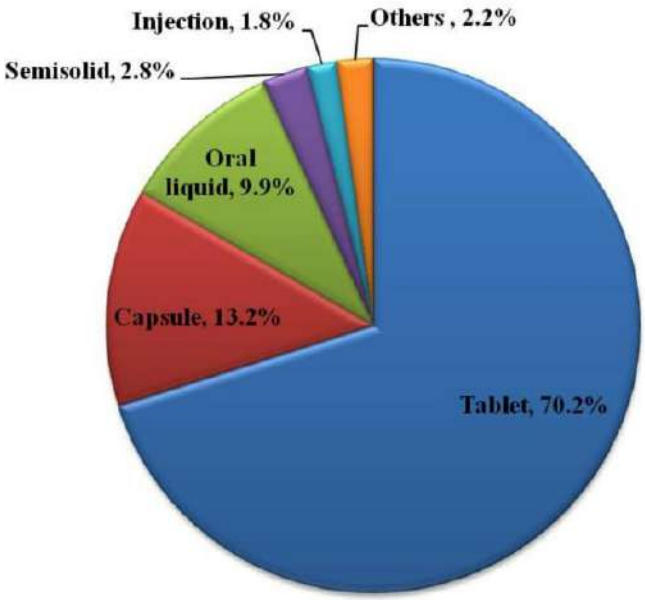

Fig.12 [63].

Recent Advances in oral solid dosage forms-

New Technological Advancements in Solid Oral Dosage Forms-

The field of pharmaceutical technology is constantly evolving, with a particular focus on improving the efficacy, safety, and convenience of solid oral dosage forms. Here are some of the most promising advancements [23-25].

1. 3D Printing Technology

Personalized medicine:

Allows for the creation of customized dosages and formulations based on individual patient needs. Complex medication delivery systems: Make it possible to create tablets with several layers or components and precise drug release characteristics.

Enhanced bioavailability:

By maximizing the features of medication release, this can improve drug absorption. Additive manufacturing, also referred to as 3D printing, is transforming the pharmaceutical sector by providing previously unheard-of flexibility in the creation of solid dosage forms. [26].

Fig.13 [64].

Challenges and Future Directions

- While 3D printing holds immense promise, several challenges need to be addressed for its widespread adoption in pharmaceutical manufacturing:
- **Material compatibility:**

Ensuring that printing materials are biocompatible and suitable for drug delivery.

- **Scale-up:**

Developing efficient and cost-effective processes for large-scale production.

- **Regulatory approval:**

Obtaining necessary approvals for 3D-printed drugs.

- **Intellectual property:**

Protecting innovative 3D-printed dosage form designs.

- Despite these challenges, ongoing research and development efforts are focused on overcoming these hurdles and realizing the full potential of 3D printing in the pharmaceutical industry. [27-30].

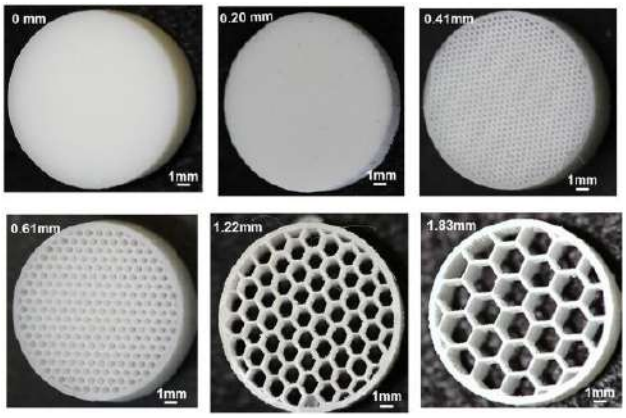

Fig.14 [65].

2. Nanotechnology

Improved medication delivery: Drug solubility, bioavailability, and targeting can all be enhanced by nanoparticles. Controlled release: Allows for longer or more gradual medication release for more effective treatment. Increased stability: Prevents medication deterioration during production and storage. [31]. Solid dosage forms with intricate drug delivery mechanisms are a major development in pharmaceutical science. These methods seek to address issues with conventional dosage forms, including inadequate therapeutic results, restricted drug targeting, and low bioavailability. [32-35].

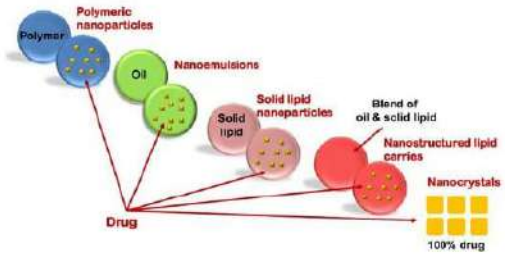

Fig.15 [66].

Types of Complex Drug Delivery Systems

Controlled Release Systems:

These systems deliver the drug at a predetermined rate over an extended period.

Matrix systems:

The drug is dispersed within a polymeric matrix.

Coated systems:

The drug is coated with a polymeric material that controls drug release.

Osmotic systems:

The drug is released through an osmotic pressure-driven mechanism Nanotechnology has revolutionized the pharmaceutical industry, particularly in the development of solid dosage forms. By manipulating matter at the nanoscale, scientists have been able to create innovative drug delivery systems with enhanced efficacy and safety.

Key Applications of Nanotechnology in Solid Dosage Forms

- **Enhanced Drug Solubility:**

Many drugs have poor water solubility, limiting their bioavailability. Nanotechnology can address this by reducing particle size to the nanoscale, increasing the surface area, and improving dissolution rate. [36].

- **Controlled Drug Release:**

Nanoparticles can be engineered to release drugs at a controlled rate, extending drug action and reducing dosing frequency.

- **Targeted Drug Delivery:**

By attaching specific ligands to nanoparticles, drugs can be targeted to specific cells or tissues,

- **Solid Lipid Nanoparticles (SLNs):**

Lipid-based nanoparticles that provide a stable matrix for drug encapsulation.

- **Nanocrystals:**

Drug particles reduced to the nanoscale to improve solubility and dissolution rate.

Challenges and Future Directions

While nanotechnology offers significant advantages, there are also challenges to overcome, such as:

- **Scalability:**

Producing nanoparticles in large quantities while maintaining consistent quality can be difficult. [37-38].

- **Biocompatibility and Toxicity:**

Ensuring the safety of nanoparticles for human use is crucial.

- **Regulatory Approval**:

Navigating the regulatory landscape for nanotechnology-based drugs can be complex. Despite these challenges, the potential benefits of nanotechnology in solid dosage forms are immense, and ongoing research is focused on addressing these issues and translating nanotechnology into clinical applications.

3. Digital Pill Technologies

- **Patient adherence:**

Incorporates sensors and tracking mechanisms to monitor drug intake and provide real-time data.

- **Drug counterfeiting prevention**:

Enables authentication and verification of drug authenticity.

- **Dosage optimization:**

Collects data on drug efficacy and safety to optimize treatment plans. Digital pills, also known as smart pills or ingestible sensors, represent a significant advancement in drug delivery and patient care. [39].

- B**enefits of Digital Pills**

Improved Medication Adherence:

By tracking medication intake, digital pills can help patients and healthcare providers identify patterns of non-adherence and develop strategies to improve compliance.

- **Enhanced Patient Care:**

Real-time data on medication use allows for more personalized treatment plans and timely interventions.

- **Research and Development:**

Digital pills can provide valuable data for drug development and efficacy studies.

Fig.16 [67].

Challenges and Future Directions

While digital pills hold great promise, there are challenges to overcome, such as:

- **Patient Privacy:**

Ensuring the secure handling and protection of patient data is crucial.

- **Cost:**

The technology may be expensive for some patients and healthcare systems.

- **Patient Acceptance:**

Overcoming concerns about privacy and the added complexity of using a wearable device. Despite these challenges, the potential benefits of digital pills are substantial, and ongoing research and development are focused on addressing these issues and expanding the applications of this technology. [40].

4. Advanced Excipients

Improved drug delivery:

New excipients with specific functionalities enhance drug release, solubility, and stability.

- **Enhanced patient experience:**

Excipients can improve taste, texture, and overall acceptability of dosage forms. The Unsung Heroes of Drug Delivery Excipients, often overlooked, play a critical role in the formulation and performance of solid dosage forms. Recent advancements in excipient technology have led to the development of innovative excipients that enhance drug delivery, improve product stability, and enhance patient experience.

Types of Advanced Excipients

- **Co-processed Excipients:**

These are pre-blended combinations of multiple excipients, offering improved functionality and processability. [41-43]. For example, a combination of a binder and a disintegrant can enhance tablet disintegration while ensuring good tablet strength.

- **Functional Polymers:**

These polymers possess specific properties that can be tailored to meet specific formulation needs. For instance, hydrophilic polymers can improve drug solubility, while hydrophobic polymers can be used for controlled release formulations.

- **Lipid-Based Excipients:**

These excipients can enhance drug solubility, bioavailability, and taste masking. They are widely used in self-emulsifying drug delivery systems (SEDDS) and solid lipid nanoparticles (SLNs).

- **Sweeteners and Flavorings:**

Advances in taste masking technology have led to the development of sweeteners and flavorings that can effectively mask the unpleasant taste of drugs, improving patient compliance. [44].

Benefits of Advanced Excipients

- **Improved Drug Delivery:**

Enhance drug solubility, bioavailability, and release profile.

- **Enhanced Product Stability**:

Protect drugs from degradation and extend shelf life.

- **Improved Patient Compliance:**

Enhance taste, texture, and overall acceptability of dosage forms.

- **Simplified Manufacturing:**

Reduce process steps and improve manufacturing efficiency.

Challenges and Future Directions

- While advanced excipients offer significant advantages, challenges such as cost, regulatory approval, and compatibility with other formulation components need to be addressed.
- Future research and development efforts will focus on:
- Developing excipients with multifunctional properties: Combining multiple functionalities into a single excipient to simplify formulations.
- Exploring natural-based excipients: Identifying and developing excipients from renewable sources to improve sustainability. [45].

5. Artificial Intelligence (AI)

- **Formulation optimization:**
- AI can accelerate the formulation development process by predicting optimal drug combinations and excipient ratios.
- **Manufacturing process improvement:**

AI-driven process control can enhance efficiency and product quality. [46-47].

Predictive modeling:

- AI can be used to predict drug performance and identify potential safety issues.
- These advancements are transforming the landscape of solid oral dosage forms, offering significant potential to improve patient outcomes and address unmet medical needs. Artificial intelligence (AI) is rapidly transforming the pharmaceutical industry, and its impact on solid dosage form development is particularly significant. By leveraging vast amounts of data and advanced algorithms, AI can optimize formulation, manufacturing, and quality control processes [48].

Applications of AI in Solid Dosage Form

Formulation Development:

- Predicting drug-excipient interactions and compatibility.
- Identifying optimal formulation parameters for desired drug release profiles.
- Accelerating the design of new dosage forms.
- Process Optimization [49].
- Improving manufacturing efficiency through predictive modeling and process control.
- Identifying potential drug candidates and optimizing their properties.
- Predicting drug efficacy and safety.

AI Techniques Used in Solid Dosage Form

- **Machine Learning:**

Used for pattern recognition, prediction, and classification tasks.

- **Deep Learning:**

For complex data analysis and image recognition.

- **Natural Language Processing (NLP):**

For extracting information from scientific literature and patents.

Challenges and Future Directions

While AI offers immense potential, challenges such as data quality, model interpretability, and regulatory considerations need to be addressed. Future research should focus on developing robust AI models that can handle complex pharmaceutical data and integrating AI seamlessly into the drug development process. [50].

CONCLUSION:

These advanced oral dosage form formulations provide the medical community and patients a number of significant benefits. Customers may be satisfied if newly developed tablets are able to suit patient requests and the growing pharmaceutical sector. Their significant contributions have resulted in production advancements for tablets as well as a number of distinctive tablet adaptations that have made a strong market presence. Formulation experts are always attempting to create improved dosage forms, which will eventually benefit the healthcare system, on a

global scale. Process analysis techniques and quality by design have been used..

ACKNOWLEDGEMENT

We would like to acknowledge and express our profound thanks to Dr. Bhalekar, S.M. for enabling our endeavor. Her guidance and instruction enabled me to finish every stage of writing my paper. We thank our institute for giving us the opportunity to carry out this review.

REFERENCES:

1. K. Sako, T. Sawada, H. Nakashima, S. Yokohama, T. Sonobe, Influence of water soluble fillers in hydroxypropylmethylcellulose matrices on in vitro and in vivo drug release, J. Control. Release 81 (2002) 165-172.
2. Moroni, A novel copovidone binder for dry granulation and direct-compression tableting, Pharm. Technol. 25 (2001) 8-13.
3. Amidon GL, Lennernas H, Shah VP, Crison JR. A theoretical basis for a biopharmaceutic drug classification: The correlation of in vitro drug product dissolution and in vivo bioavailability. Pharm Res. 1995;12(3):413-20.
4. Kim S, Wei C, Kiang S. Crystallization Process Development of an Active Pharmaceutical Ingredient and Particle Engineering via the Use of Ultrasonics and Temperature Cycling. Org Process Res Dev. 2003;7(6):997-1001.
5. Waknis V, Chu E, Schlam R, Sidorenko A, Badawy S, Yin S, Narang AS. Molecular basis of crystal morphology-dependent adhesion behavior of mefenamic acid during tableting. Pharm Res. 2014;31(1):160-72.
6. Dalziel G, Nauka E, Zhang F, Kothari S, Xie M. Assessment of granulation technologies for an API with poor physical properties. Drug Dev Ind Pharm. 2013;39(7):985-95
7. Cole ET, Cadé D, Benameur H. Challenges and opportunities in the encapsulation of liquid and semi-solid formulations into capsules for oral administration. Adv Drug Deliver Rev. 2008;60(6):747-56.
8. Merck Index (12th Edition). Budavari, editor. Whitehouse Station, NJ.: Merck Research Laboratories; 1996.
9. Wells JI. Pharmaceutical Preformulation: The Physicochemical Properties of Drug Substances. Rubinstein MH, editor. Chichester: Ellis Horwood Limited; 1988
10. United States Pharmacopeia and National Formulary. USP 36-NF 31. Rockville, MD.: United States Pharmacopeia Convention; 2013. p. 1174 Powder Flow.
11. Jenike A. Storage and Flow of Solids. Utah, University of. 1964.
12. Bhardwaj S, Jain V, Sharma S, Jat RC, Jain S. 2010. Orally disintegrating tablets: a review. Drug Invent Today. 2:81–88.
13. Bircan Y, Comoglu T. 2012. Formulation technologies of orally fast disintegrating tablets. Marmara Pharm J. 16:77–81.
14. Rajalakshmi R, Sireesha A, Lakshmi SM.Inlay Tablet a novel approach. International journal of advanced pharmaceutics .2011; 1(1): 1-10.
15. Plachetka JR, Kothapalli VM, Gilbert DL. Multilayer dosage forms containing NSAIDS and Triptans. USP7,332,183 B2.2008;1-20.
16. Daniel KD,Hutchins BM,Elkins CL, Lee H. Solid Drug Tablets For Implantable Drug Delivery Device US 2013/0129824 A1.2013;1-8.
17. Arshad, M.S.; Zafar, S.; Yousef, B.; Alyassin, Y.; Ali, R.; AlAsiri, A.; Pitt, K. A review of emerging technologies enabling improved solid oral dosage form manufacturing and processing. Adv. Drug Deliv. Rev. 2021, 178, 113840. [Google Scholar] [CrossRef] [PubMed].
18. Andrews, G.P. Advances in solid dosage form manufacturing technology. Philos. Trans. R.

Soc. A Math. Phys. Eng. Sci. 2007, 365, 2935–2949. {Google Schola}

19. Dey S, ChattopadhyayS,Mazumder B. Formulation and Evaluation of Fixed-Dose combination of Bilayer Gastroretentive Matrix Tablet Containing Atorvastatin as Fast-Release and Atenolol as SustainedRelease.BioMed Research International.2014; 12.
20. Audrkzet MP, Bonduelle M. 1993. Review article on orally disintegrating tablets. J Young Pharm. 20:372–378.
21. Awasthi R, Sharma G, Dua K, Kulkarni GT. 2013. Fast disintegrating drug delivery systems: a review with special emphasis on fast disintegrating tablets. J Chronother Drug Deliv. 4:15–30.
22. Batchelor HK, Marriott JF. 2015. Formulations for children: problems and solutions. Br J Clin Pharmacol.. 79:405–418.
23. Bhardwaj S, Jain V, Sharma S, Jat RC, Jain S. 2010. Orally disintegrating tablets: a review. Drug Invent Today. 2:81–88.
24. Bi Y, Sunada H, Yonezawa Y, Danjo K, Otsuka A, IIDA K. 1996. Preparation and evaluation of a compressed tablet rapidly disintegrating in the oral cavity. Chem Pharm Bull. 44:2121–2127.
25. Bi YX, Sunada H, Yonezawa Y, Danjo K. 1999. Evaluation of rapidly disintegrating tablets prepared by a direct compression method. Drug Dev Ind Pharm. 25:571–581.
26. Pahwa R, Piplani M, Sharma PC, Kaushik D, Nanda S. 2010. Orally disintegrating tablets-friendly to pediatrics and geriatrics. Arch Appl Sci Res. 2:35–48
27. Petrovick GF, Kleinebudde P, Breitkreutz J. 2018. Orodispersible tablets containing tastemasked solid lipid pellets with metformin hydrochloride: influence of process parameters on tablet properties. Eur J Pharm Biopharm. 12:137–145.
28. Preis M. 2015. Orally disintegrating films and mini-tablets-innovative dosage forms of choice for pediatric use. AAPS PharmSciTech. 16:234–241.
29. Rahman Z, Zidan AS, Khan MA. 2010. Risperidone solid dispersion for orally disintegrating tablet: its formulation design and nondestructive methods of evaluation. Int J Pharm. 400:49–58.
30. Rao Y, Bandari S, Mittapalli R, Gannu R. 2008. Orodispersible tablets: an overview. Asian J Pharm. 2:2–25.
31. Sastry S, Nyshadham J, Fix J. 2000. Recent technological advances in oral drug delivery – a review. Pharm Sci Technol Today. 3: 138–145
32. Rohit S Gupta, Ratnadeep R Deshmukh, Priyanka U Randive, Akshay V Kshirsagar, Jaypalsing N Kayte (2018) Study of Phar
33. Mudie DM, Amidon GL, Amidon GE. Physiological parameters for oral delivery and in vitro testing. Mol Pharm 2010;7(5):1388–1405.
34. K. Marshall, E.M. Rudnic, in: G.S. Banker, C.T. Rhodes (Eds.), Drugs and the Pharmaceutical Sciences: Modern Pharmaceutics, vol. 121, Marcel Dekker, New York, 1990, pp. 23–66.
35. Gomez-Orellana, Strategies to improve oral drug bioavailability, Expert Opin.Drug Deliv. 2 (2005) 419–433
36. R. McLaughlin, S. Banbury, K. Crowley, Orally disintegrating tablets. The effect of recent FDA guidance on ODT technologies applications, Pharm. Technol.(Suppl.) (20090
37. Velmurugan S, Vinushitha S. 2010. Oral disintegrating tablets: an overview. Int J Chem Pharm Sci. 1:1–12.
38. Walsh J, Cram A, Woertz K, Breitkreutz J, Winzenburg G, Turner R, Tuleu C. 2014. Playing hide and seek with poorly tasting

pediatric medicines: do not forget the excipients. Adv Drug Deliv Rev. 73:14–33.
39. Yadav D, Mishra A. 2017. Preparation and evaluation of orodispersible tablet of anti-inflammatory drug celecoxib. J Pharm Pharm Sci. 1:35–39.
40. Timmins P, Brown J. Formulation Technology Enables the Delivery of HIV Medicines. European Industrial Pharmacy Journal. 2013;19 12-7.
41. Tahami, K., & Singh, J., (2007). Smart polymer based delivery systems for peptides and proteins. Rec. Pat. Drug Deliv. Form., 1(1), 65–71
42. .Anderson, O., et al., (1995). Problems when swallowing tablets. Tidsskr NorLaegeforen., 115 , 947–949.Arora, S., Ali, J., Ahuja, A., Khar, R., & Baboota, S., (2005). Floating drug delivery systems: A review. AAPS Parm. Sci. Tech., 6(3), E372–E390.
43. Avery, S. W., & Dellarosa, D. M., (1994). Approaches to treating dysphagiain patients with brain injury. Am. J. Occup. Ther., 48, 235–239
44. .Cherukuri, S. R., & Fuisz, R., (1995). Process and apparatus for making tablets and tablets made there from. European Patent, 0677,147A2.
45. Cherukuri, S. R., & Fuisz, R., (1997). Process and apparatus for making tablets and tablets made there from. US Patent 5,654,003.
46. Shailesh S. New Generation of Tablet: Fast Dissolving Tablet. Pharmainfo. net. 2008; 6(1)8. Kumari S, Visht S, Sharma PK, Yadav RK. Fast dissolving drug delivery system: review article. Journal of Pharmacy Research. 2010; 3(6): 1444-9.
47. Ashish P, Mishra P, Main P, Harsoliya M, Agrawal S. A review on-recent advancement in the development of rapid disintegrating tablet. Int J Life Sci Pharm Res. 2011; 1: 7-16.
48. Yadav G, Kapoor A, Bhargava S. Fast dissolving tablets recent advantages: A review. International Journal of Pharmaceutical Sciences and Research. 2012; 3(3): 728
49. Rewar S, Singh CJ, Bansal BK, Pareek R, Sharma AK. Oral dispersible tablets: An overview; development, technologies and evaluation. International Journal of Research and Development in Pharmacy and Life Sciences. 2014; 3(6): 1245-57
50. Hannan PA, Khan JA, Khan A, Safiullah S. Oral dispersible system: A new approach in drug delivery system. Indian Journal of Pharmaceutical Sciences. 2016; 78(1): 2.
51. Slavkova M, Breitkreutz J. Orodispersible drug formulations for children and elderly. European Journal of Pharmaceutical Sciences. 2015; 75: 2-9.
52. https://www.maximizemarketresearch.com/market-report/oral-solid-dosage-pharmaceutical-formulation-market/121388/
53. https://images.app.goo.gl/teKMH41ZrqjikBWx7
54. https://www.google.com/imgres?h=295&w=524&tbnh=168&tbnw=299&osm=1&lns_uv=1&source=lens-native&usg=AI4_-kTak_H5a512fKzCblFGUBE5XVDTlA&imgurl=https://www.losan-pharma.de/wp-content/uploads/2021/02/losan_minitabletten_gelb.jpg&imgrefurl=https://www.losan-pharma.de/manufacturing-services/stick-packs/mini-tablets/&tbnid=b-0q4MguneoRyM&docid=SZMHW9CHugslRM
55. https://images.app.goo.gl/pnLNLXKzYtuQMjU57
56. https://www.pharmtech.com/view/optidose-technology
57. https://images.app.goo.gl/y6DsZkKocvwpFCu26

58. https://images.app.goo.gl/Wfzw93FDKRJ9ECJR9
59. https://www.google.com/imgres?h=487&w=800&tbnh=175&tbnw=288&osm=1&lns_uv=1&source=lens-native&usg=AI4_-kTWkqpU_37mgiiSHHDxFteAOu2ESQ&imgurl=https://thumbs.dreamstime.com/b/medical-lozenges-relief-cough-sore-throat-irritation-isolated-white-background-colds-drop-colorful-pastille-red-orange-143208636.jpg&imgrefurl=https://www.dreamstime.com/photos-images/cough-sweets.html&tbnid=hkoVNta3JXNhuM&docid=pV2BdfEiRJ6QlM
60. https://images.app.goo.gl/7fHzEfQNsMavqN687
61. https://images.app.goo.gl/Q8dJckP8BjgXmKr66
62. https://images.app.goo.gl/tKBFSkfmfEgQKMb19
63. https://images.app.goo.gl/tksLWS2h31vEys399
64. https://images.app.goo.gl/Wfzw93FDKRJ9ECJR9
65. https://images.app.goo.gl/nvwvXArtnmJDrvQv9
66. https://images.app.goo.gl/vtLifTY1KoEWQMEk8
67. https://images.app.goo.gl/QPpWozN2e6Q7mHkb8

HOW TO CITE: Kale Megha K., Wagh Snehal A., Walunj Ankita A., Dhage Shubhangi S., Awari Monika S., Bhalekar S. M. Lamkhade. G. J. , Recent Advances In Oral Solid Dosage Form Formulation And Development, Int. J. of Pharm. Sci., 2024, Vol 2, Issue 10, 1075-1091. https://doi.org/10.5281/zenodo.13955626