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# "A COMPREHENSIVE REVIEW: EXPLORING THE POTENTIAL OF NANOSUSPENSION-LOADED ORAL DISSOLVING FILMS: A MODERN APPROACH TO SOLUBILITY ENHANCEMENT"

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## ABSTRACT

Conventional dosage forms are preferred for their ability to provide immediate drug release and rapid therapeutic response. However, poor solubility is a common problem in drug development, often leading to inadequate bioavailability. Enhancing drug solubility and oral bioavailability is a significant challenge in formulation processes. Various approaches, such as pH adjustment, particle size reduction, Sono-crystallization, inclusion complexation, liquid-solid methods, solid dispersion methods, self-emulsifying methods, supercritical fluid processes, freeze drying, spray drying, and hot melt extrusion, are available to improve solubility and dissolution rates. Choosing the right technique is crucial to enhance drug dissolution and bioavailability, preventing the rejection of new chemical entities due to low solubility. Recently, nanosuspensions have garnered interest as a promising method to enhance the bioavailability of poorly soluble drugs. These submicron colloidal particles, ranging from 1 to 100 nm, offer unique advantages over traditional solubility enhancement methods. Techniques like media milling and high-pressure homogenization have enabled the commercial production of stable nanosuspensions. Nanosuspensions improve drug solubility in aqueous media, speeding up drug release and achieving faster maximum plasma levels. They address issues of poor solubility and bioavailability, altering the pharmacokinetics of drugs to improve safety and efficacy. Nanotechnology surpasses the limitations of conventional solubility and bioavailability enhancement methods. Oral disintegrating films or strips use water-soluble polymers to quickly hydrate with saliva, adhere to mucosal surfaces, and disintegrate within seconds, releasing medication for Oro mucosal absorption when placed on the tongue or in the oral cavity. The mucosa, with its thin membrane and large veins, is highly permeable, providing rapid drug bioavailability due to swift blood flow. Oral films offer significant advantages over other dosage forms, including rapid dissolution and disintegration in the oral cavity, reduced dosing intervals, and improved onset of action, efficacy, and safety profiles.

**KEYWORDS**: Nanosuspension, Solvent Casting Method, Oral Fast Dissolving Films, Enhanced Bioavailability, Water Insoluble Drugs, Nanotechnology.

## INTRODUCTION

Nanoscience breakthroughs are revolutionizing nearly every scientific field, making life easier today. This expanding research area focuses on structures, devices, and systems with unique properties due to their atomic arrangements on the 1–100 nm scale. The novel characteristics of these nanomaterials drive innovation and offer new solutions across various industries. As nanotechnology advances, it continues to hold immense potential for further transformative impacts.[1] Nanotechnology is one of the most promising technologies of the 21st century. It is the ability to convert the nanoscience theory to useful applications by observing, measuring, manipulating, assembling, controlling and manufacturing matter at the nanometre scale.

The field is now nearing 50 years of research and application. It is a continually growing area of study that impacts almost every scientific discipline, including natural sciences, engineering, materials science, medicine, agriculture, and information and communication technologies. This list keeps expanding as the field evolves.[2]

### Classification of NP'S

Nanoparticles (NPs) are categorized based on their morphology, size, and chemical properties. Key classes include metal NPs, ceramic NPs, polymeric NPs, and

lipid-based NPs. Each class has distinct physical and chemical characteristics that determine their applications in various fields.

**1. Carbon based NP'S**

Fullerenes and carbon nanotubes (CNTs) are two major classes of carbon-based nanoparticles. Fullerenes, composed of globular hollow cages made of sp2 hybridized carbon atoms arranged in pentagonal and hexagonal units, are notable for their electrical conductivity, high strength, and versatility. CNTs, with diameters of 1–2 nm, have tubular structures resembling rolled graphite sheets, which can be single-walled (SWNTs), double-walled (DWNTs), or multi-walled (MWNTs). Synthesized through methods like laser vaporization and chemical vapor deposition (CVD), CNTs are utilized in nanocomposites for commercial applications such as fillers, efficient gas adsorbents, and support mediums for catalysts.[3]

**2. Metal NP'S**

Metal nanoparticles (NPs) are composed of metal precursors and exhibit unique optoelectrical properties due to localized surface plasmon resonance (LSPR). NPs of alkali and noble metals, such as Cu, Ag, and Au, have a broad absorption band in the visible range of the electromagnetic spectrum. The synthesis of metal NPs with controlled facets, size, and shape is crucial in modern advanced materials science.[4]

**3. Ceramics NPs**

Ceramic nanoparticles (NPs), inorganic non-metallic solids synthesized through heating and cooling, exist in various forms such as amorphous, polycrystalline, dense, porous, or hollow. They are of significant research interest due to their applications in catalysis, photocatalysis, dye photodegradation, and imaging.

**4. Polymeric NPs**

Polymer nanoparticles (PNPs), typically organic-based, are often referred to collectively in the literature. They mainly exist as nanospheres or nano capsules. Nanospheres are solid matrix particles with molecules adsorbed on their surface, while nano capsules encapsulate a solid mass within the particle. PNPs are easily functionalized, leading to a wide range of applications.[5]

**Nanosuspensions**

Nanosuspensions (NSs) are finely dispersed colloidal systems made up of submicron-sized drug particles. These particles are generally smaller than 1 micron. Although the definitions of nanosuspensions can vary, they are often used interchangeably with the term nanocrystals. Typically, nanosuspensions consist of pure active pharmaceutical ingredients (APIs) ranging from 10 to 1000 nanometres in size, which are stabilized using surfactants or polymers. Another common definition describes these particles as being between 200 and 600 nanometres and formed entirely of pure active substances. Essentially, an NS refers to nanosized drug crystals prepared with stabilizing agents.[6]

**Advantages of Nanosuspensions**

1. Nanosuspensions offer a rapid onset of action and enhanced bioavailability.
2. Long-term physical stability is maintained due to the presence of stabilizers.[5]
3. They are simple to produce and can be scaled up easily.
4. Medications with a high log P value are required for nanosuspension production.
5. The duration of drug content and its absorption are improved when nanoparticles adhere to the gastrointestinal (GIT) mucosa.[7]

**Preparation of nanosuspension**

Several methods for preparing drug nanocrystals have been investigated, primarily categorized into bottom-up and top-down approaches. Top-down processes involve breaking down larger particles through milling or homogenization to obtain nanoparticles. In contrast, bottom-up processes involve assembling and controlling precipitation at the nanometre scale to form nanoparticles.

**Bottom-up process**

In bottom-up techniques for producing drug nanoparticles, molecules in solution aggregate to form particles, which can be crystalline or amorphous. This process, also known as classical precipitation, involves dissolving the drug in a solvent and then adding it to a non-solvent to precipitate the drug. To prevent the particles from growing to micrometre size, factors influencing particle structure must be controlled, and stabilizers like surfactants should be added. Other bottom-up methods include Sono crystallization, high gravity-controlled precipitation, confined impinging liquid jet precipitation, and multi-inlet vortex mixing. These processes offer possibilities for incorporating multiple active ingredients into a single nanocarrier and customizing nanoparticle surface functionality. However, a significant drawback is the use of organic solvents, which need to be removed, raising production costs. Additionally, for drugs with low solubility in water and organic solvents, large solvent volumes are necessary, making bottom-up processes less favourable for pharmaceutical manufacturing of marketed drugs.[8]

**Top-down processes**

Starting from large crystals in the micrometre range, drug nanocrystals are produced by reducing crystal size through methods like milling and high-pressure homogenization.

**Milling**

- **Wet Milling:** Drug particles are dispersed in a surfactant/stabilizer solution and milled, often using bead mills (Nanocrystal technology). This method utilizes ceramic, stainless steel, glass, or resin-

coated beads as milling media, leading to size reduction through shear forces. However, it faces issues like erosion of milling material and product adherence to milling surfaces. Coated beads can reduce impurities from erosion. This method has produced FDA-approved drugs like Rapamune®, Emend®, Tricor®, and Megace.

**Homogenization**

- **Microfluidizer Technology:** Produces small particles by colliding two fluid streams under high pressure (up to 1700 bar). Requires numerous cycles for sufficient size reduction.
- **Dissocubes® Technology:** Uses piston-gap homogenizers to produce nanoparticle suspensions in water at room temperature. High pressures (up to 4000 bar) cause cavitation and shockwaves, reducing particle size. It may cause issues with water-sensitive drugs.
- **Nano pure® Technology:** Utilizes dispersion media with low vapor pressure (e.g., oils, PEG) and optionally low temperatures, minimizing cavitation. Suitable for temperature-sensitive drugs and can use nonaqueous media to prevent hydrolysis. The resulting suspensions can be used directly in capsules or tablet production.[9][10][11]

**Characterization of Nanosuspension**

1. **Particle Size Distribution** The particle size distribution is crucial for understanding a formulation's physiochemical properties, such as saturation solubility, dissolution rate, and physical stability. Techniques like Photon Correlation Spectroscopy (PCS) can measure particle sizes ranging from 3 nm to 3 µm. Laser Diffraction (LD) can provide a relative size distribution for particles between 0.05 µm and 80 µm.
2. **Dissolution Rate and Saturation Solubility** Nanosuspensions offer advantages over other formulations by enhancing the dissolution rate and saturation solubility of the drug. These parameters, determined using various physiological solutions, help in assessing the in-vitro behaviour of the formulation.
3. **pH Value** To ensure the stability of the aqueous preparation and minimize pH drift, the pH should be measured at room temperature.
4. **Stability of Nanosuspension** To prevent drug crystals from aggregating into larger particles, stabilizers are added to the formulation. Common stabilizers include poloxamers, polysorbates, povidone, and lecithin. These stabilizers help maintain the stability of the nanosuspension.[12][13][14]

**Oro dispersible films**

Oral disintegrating films (ODFs) or strips are dosage forms designed to dissolve rapidly in the mouth. Made from water-soluble polymers, these films quickly hydrate upon contact with saliva, adhere to the mucosal membrane, and disintegrate within seconds, allowing the medication to be absorbed through the oral mucosa. The mucosa, with its thin membrane and rich blood supply, is highly permeable, ensuring rapid bioavailability of the drug.[15]

ODFs offer distinct advantages over other oral dosage forms. Their large surface area allows them to dissolve and disintegrate quickly in the oral cavity, reducing the dosing interval and improving the onset of action. This enhances the efficacy and safety profile of the therapy, providing a convenient and efficient means of drug delivery.[5][16]

**Figure 1: Oral fast dissolving films.**

**Advantages of Oral Disintegrating Films (ODFs)**

1. **Ease of Swallowing**: ODFs dissolve quickly in the mouth, making them an excellent choice for people who struggle with swallowing pills. They do not require water for administration, unlike traditional tablets.
2. **Precise Dosage**: ODFs offer accurate dosing, ensuring that patients receive the exact amount of medication needed.

3. **Low Thickness and Flexibility**: These films are thin and flexible, providing a comfortable experience during administration.
4. **Acceptability**: Patients generally prefer ODFs due to their ease of use and the absence of a need for water.
5. **Adaptability and Portability**: ODFs are easy to transport, handle, and store, making them highly convenient.
6. **Suitable for Dysphagia Patients**: They are particularly beneficial for individuals with dysphagia, or difficulty swallowing.
7. **Taste Masking**: ODFs can effectively mask the taste of bitter or unpleasant-tasting medications.
8. **Enhanced Stability**: They can improve the stability of certain active ingredients.
9. **Improved Patient Compliance**: The user-friendly nature of ODFs can lead to better adherence to medication regimens.[17][18]

**Disadvantages of oral dissolving films**

- **Dose Limitations**: High doses are difficult to incorporate into ODFs, usually needing to stay below 40 mg per 4 $cm^2$.
- **Bitter Medications**: Not suitable for bitter-tasting medications due to the challenge of effective taste masking.
- **Dose Homogeneity**: Achieving uniform drug distribution within the film is technically complex.
- **Special Packaging**: Requires specialized packaging to maintain stability and protect from moisture.
- **Irritation**: Drugs that irritate the oral mucosa are unsuitable for administration via ODFs.[19][20]

**Method of preparation of oral dispersible film**

**Solvent Casting Method**

- This is a widely used technique for creating ODFs.
- **Steps**

1. Dissolve film-forming polymers (e.g., HPMC, CMC, PVP) in an appropriate solvent.
2. Add plasticizers, surfactants, flavours, and sweeteners to the polymer solution.
3. Cast the solution onto a flat surface (like a glass plate) and allow it to dry.
4. Cut the dried film into desired shapes, such as strips.

- **Advantages**: This method is simple, versatile, and easily scalable.

**Hot-Melt Extrusion (HME)**

- This method involves melting polymers and other excipients together.
- The mixture is extruded through a die to create a continuous film.
- After cooling, the solidified film is cut into individual doses.
- **Suitability**: Ideal for heat-stable drugs and thermoplastic polymers.

**Solid Dispersion Extrusion**

- Similar to HME, but specifically for drugs that form solid dispersions.
- Drug and polymer are mixed, melted, and extruded to create a film.
- **Benefits**: Enhances drug solubility and bioavailability.

**Rolling Method**

- A less commonly used technique.
- Involves rolling a mixture of drug, polymer, and other excipients between two rollers to form a thin film.
- The film is then cut into doses.[20][21][22]s

**Excipients used in Oral dissolving films**

 **Strip-Forming Polymers**

- Provide structural integrity to the film.
- Should make up at least 45% by weight of the dry film.

 **Plasticizers**

- Enhance flexibility.
- Improve the film's handling properties.

 **Active Pharmaceutical Ingredients (API)**

- The drug component of the film.
- Crucial for the film's intended medicinal effect.

 **Sweetening Agents**

- Improve taste.
- Enhance patient compliance.

 **Saliva Stimulating Agents**

- Increase saliva production.
- Aid in the rapid dissolution of the film.

 **Flavoring Agents**

- Enhance the film's palatability.

 **Coloring Agents**

- Provide visual identification.

 **Stabilizing and Thickening Agents**:

- Maintain the film's stability during handling and shipping.[20][23][24]

**Evaluation of oral dissolving films**

**Quality Control Tests**

1. **Scanning Electron Microscopy (SEM)**
   - **Purpose**: To investigate the morphology of films.
   - **Procedure**: Examine films at a specific magnification.

2. **Organoleptic Evaluation**
   - **Purpose**: To assess taste using in-vitro techniques.
   - **Tools**: Taste sensors and specially constructed equipment.

- **Application**: Suitable for high-throughput testing of oral pharmaceutical formulations.[22][25]

**3. Thickness Measurement**

- **Purpose**: To ensure uniformity of film thickness, which affects dose precision.
- **Procedure**: Measure at multiple sites using a micrometre screw gauge.

**4. Mechanical Properties Assessment**

- **Properties Evaluated**
  - **Tensile Strength**: Maximum tension at which the strip breaks.
  - **Formula**: Tensile Strength = FMaxA\frac{F_{\text{Max}}}{A}AFMax
  - **Tear Resistance**: Force needed to start tearing at a low loading rate (51 mm/min).
  - **Measurement Unit**: Newtons or pounds-force.
  - **Elastic Modulus**: Ratio of stress (force) to corresponding strain.
  - **Formula**: Elastic Modulus = FCs·A\frac{F}{C_s \cdot A}Cs·AF
  - **Percentage Elongation**: Increase in length as a percentage of the initial length.
  - **Formula**: % Elongation=Increase in length Initial Length of Strip×100\% \text{ Elongation} = \frac{\text{Increase in length}}{\text{Initial Length of Strip}} \times 100% Elongation=Initial Length of Strip Increase in length×100

**5. Folding Endurance**

- **Purpose**: To assess the durability of films.
- **Procedure**: Repeatedly fold films at the same location until they break.

**6. Swelling Property**

- **Procedure**

1. Weigh each film sample.
2. Place the sample on a pre-weighed stainless steel wire mesh.
3. Dip the mesh with the film into a 15 ml vial of simulated saliva solution.
4. Monitor the film's weight increase until it stabilizes.

- **Calculation**
  - **Degree of Swelling**: Degree of Swelling=Wt−W0W0\text{Degree of Swelling} = \frac{W_t - W_0}{W_0}Degree of Swelling=W0Wt−W0
  - Where WtW_tWt is the weight of the film at time ttt, and W0W_0W0 is the initial weight of the film.[26]

**7. Disintegration Time**

- **Procedure**

1. Place the film in a glass dish containing 25 ml of distilled water.
2. Observe visually while spinning for 10 seconds.
3. Note the time when the film begins to disintegrate.

- **Typical Timeframe**: Fast-dissolving oral films usually disintegrate in 5 to 30 seconds.

**8. Dissolution Test**

- **Procedure**

1. Use the basket or paddle apparatus as described in pharmacopoeias.
2. Conduct tests in simulated saliva solution or pH 6.4 phosphate buffer at 37±0.5°C.
3. Take samples at regular intervals.
4. Analyse the samples using a UV-Visible spectrophotometer.[27]

## CONCLUSION

**Use of Nanosuspensions in Oral Fast Dissolving Films (OFDFs) for Water-Insoluble Pharmaceuticals**

Addressing the challenge of water-insoluble pharmaceuticals, which often suffer from low solubility and bioavailability, nanosuspensions present a novel and practical solution. However, the aggregation of nanoparticles within these suspensions can pose significant issues, potentially compromising their effectiveness. To mitigate this problem, Oral Fast Dissolving Films (OFDFs) have emerged as an innovative approach to stabilize and optimize nanosuspensions.

**Stabilization and Optimization through OFDFs**

The process of converting nanosuspensions into OFDFs is particularly advantageous because it helps maintain the nanoscale particle size, which is crucial for the suspension's efficacy. OFDFs are recognized as an ideal dosage form, especially for children, geriatric, and pediatric patients, due to their ease of use and quick dissolution in the mouth. For these films to be effective, they must exhibit good stability and consistency in their dosage form.

**Large-Scale Manufacturing and Formulation**

The large-scale production of nanosuspensions necessitates the use of effective and reliable production techniques. Ensuring that the formulation of these films incorporates appropriate physical and mechanical properties is essential. The quality and performance of both the films and the nanosuspensions are heavily dependent on the ingredients used in their formulation.

**Evaluation and Patient Utilization**

A comprehensive evaluation of these formulations involves rigorous testing to ensure they meet the required standards. Such tests include assessing the stability, dissolution rate, mechanical properties, and overall effectiveness of the OFDFs.

In conclusion, Oral Fast Dissolving Films are proving to be highly beneficial for patients requiring quick relief from various illnesses and ailments. The use of OFDFs in stabilizing nanosuspensions not only enhances the solubility and bioavailability of water-insoluble pharmaceuticals but also ensures that patients,

particularly those who have difficulty swallowing traditional tablets, receive their medication in a more convenient and effective manner.

**REFERENCES**


1. Bayda S, Adeel M, Tuccinardi T, Cordani M, Rizzolio F. Molecules-25-00112-V2.Pdf. Molecules, 2020; 25(Figure 1): 1–15.
2. Pokrajac L, Abbas A, Chrzanowski W, Dias GM, Eggleton BJ, Maguire S, et al. Nanotechnology for a Sustainable Future: Addressing Global Challenges with the International Network4Sustainable Nanotechnology. ACS Nano., 2021; 15(12): 18608–23.
3. Ealias AM, Saravanakumar MP. A review on the classification, characterisation, synthesis of nanoparticles and their application. IOP Conf Ser Mater Sci Eng., 2017; 263(3).
4. Khan I, Saeed K, Khan I. Nanoparticles: Properties, applications and toxicities. Arab J Chem [Internet], 2019; 12(7): 908–31. Available from: https://doi.org/10.1016/j.arabjc.2017.05.011
5. Swetha M, Dutt N, Rao TR. Comprehensive Review on Nanosuspension Loaded in Oral Dissolving Film-The Trending Approach to Enhance the Solubility of BCS Class-II Drugs, 2024; 14: 68–75.
6. Pınar SG, Oktay AN, Karaküçük AE, Çelebi N. Formulation Strategies of Nanosuspensions for Various Administration Routes. Pharmaceutics, 2023; 15(5).
7. Junyaprasert VB, Morakul B. Nanocrystals for enhancement of oral bioavailability of poorly water-soluble drugs. Asian J Pharm Sci [Internet]. 2015; 10(1): 13–23. Available from: http://dx.doi.org/10.1016/j.ajps.2014.08.005
8. Piazzini V, Landucci E, Urru M, Chiarugi A, Pellegrini-Giampietro DE, Bilia AR, et al. Enhanced dissolution, permeation and oral bioavailability of aripiprazole mixed micelles: In vitro and in vivo evaluation. Int J Pharm [Internet]. 2020; 583(April): 119361. Available from: https://doi.org/10.1016/j.ijpharm.2020.119361
9. Shen B De, Shen CY, Yuan XD, Bai JX, Lv QY, Xu H, et al. Development and characterization of an orodispersible film containing drug nanoparticles. Eur J Pharm Biopharm, 2013; 85(3 PART B): 1348–56.
10. Chen H, Khemtong C, Yang X, Chang X, Gao J. Nanonization strategies for poorly water-soluble drugs. Drug Discov Today [Internet], 2011; 16(7–8): 354–60. Available from: http://dx.doi.org/10.1016/j.drudis.2010.02.009
11. Merisko-Liversidge E, Liversidge GG. Nanosizing for oral and parenteral drug delivery: A perspective on formulating poorly-water soluble compounds using wet media milling technology. Adv Drug Deliv Rev [Internet]. 2011; 63(6): 427–40. Available from: http://dx.doi.org/10.1016/j.addr.2010.12.007
12. Al-Nemrawi NK, Dave RH. Formulation and characterization of acetaminophen nanoparticles in orally disintegrating films. Drug Deliv., 2016; 23(2): 540–9.
13. Lai F, Sinico C, Ennas G, Marongiu F, Marongiu G, Fadda AM. Diclofenac nanosuspensions: Influence of preparation procedure and crystal form on drug dissolution behaviour. Int J Pharm., 2009; 373(1–2): 124–32.
14. Publishing B. systems in the Holy., 2011; 11(3): 356–9.
15. Irfan M, Rabel S, Bukhtar Q, Qadir MI, Jabeen F, Khan A. Orally disintegrating films: A modern expansion in drug delivery system. Saudi Pharm J [Internet], 2016; 24(5): 537–46. Available from: http://dx.doi.org/10.1016/j.jsps.2015.02.024
16. Elshafeey AH, El-Dahmy RM. Formulation and development of oral fast-dissolving films loaded with nanosuspension to augment paroxetine bioavailability: In vitro characterization, ex vivo permeation, and pharmacokinetic evaluation in healthy human volunteers. Pharmaceutics, 2021; 13(11).
17. Dhadwad NS, Shelke SJ. Fast Dissolving Oral Films: a Review, 2023; 11(5): 2320–882. Available from: www.ijcrt.org
18. Patil SL, Mahaparale PR, Shivnikar MA, Tiwari SS, Pawar K V., Sane PN. Fast Dissolving Films : Innovative Drug Delivery System. Int J Res Rev Pharm Appl Sci [Internet], 2013; 2(3): 482–96. Available from: http://ijrrpas.com/wp-content/uploads/2012/08/Fast-Dissolving-Oral-Films-An-Innovative-Drug-Delivery-System.pdf
19. Kurniawati putri. No Titleتزاز الاد كتروني الإل.. ال الـ تواصل» ط فرة عـلى تـ تغذى جرائـم. Univ Nusant PGRI Kediri, 2017; 01: 1–7.
20. Patil SD, Ambekar SS, Tadavi SA, Pawar SP. Review On Mouth Dissolving Film : The Advancement In Oral Drug Delivery, 2024; 2(3): 559–68.
21. Devaraj H, Venkatachalam S, Radhakrishnan A. A Review on Formulation of Oral Dissolving Film. Available online www.jocpr.com J Chem Pharm Res [Internet]. 2018; 10(4): 151–9. Available from: www.jocpr.com
22. Bala R, Khanna S, Pawar P, Arora S. Orally dissolving strips: A new approach to oral drug delivery system. Int J Pharm Investig., 2013; 3(2): 67.
23. Chandramouli M, Shivalingappa RP, Basavanna V, Doddamani S, Shanthakumar DC, Nagarajaiah SR, et al. Oral Thin-films from Design to Delivery: A Pharmaceutical Viewpoint. Biointerface Res Appl Chem., 2023; 13(2): 1–23.
24. MS A, C V. Formulation and Evaluation of Fast Dissolving Oral Films of Diazepam. J Pharmacovigil., 2016; 4(3): 602–9.
25. Kumar Gunda R, Suresh Kumar J, Priyanaka C, Sravani L, Naveena B, Yamini B, et al. Formulation development and evaluation of oral dissolving films-a review; J Anal Pharm Res [Internet]. 2022; 11(3): 131–4. Available from: http://medcraveonline.com

26. Naik TS, Khale A, Kanekar H. Evauation of Mouth Dissolving Films: Physical and Chemical Methods. nternational J Pharm Phytopharm Res., 2014; 4(1): 62–5.
27. Vallindhra PB, Krishna YP, Gangadhar P, Sunny P, Dhanendra R, Nagendra M. Formulation and Evaluation of Memantine Oral Dissolving Films. Int J Res Pharm Chem., 2022; 12(3): 30–30.