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A COMPREHENSIVE REVIEW OF IMMEDIATE DISSOLVING FORMULATIONS: CURRENT STATE AND FUTURE PROSPECTS

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ABSTRACT

Immediate Dissolving Formulations (IDFs) have emerged as a promising drug delivery system that addresses patient convenience and compliance issues associated with conventional dosage forms. This review aims to provide an in-depth analysis of IDFs, highlighting their formulation strategies, challenges, and recent developments. IDFs represent a novel approach to drug delivery, offering rapid and convenient administration of pharmaceutical compounds. This abstract provides an overview of the key characteristics and applications of IDFs. IDFs are innovative dosage forms designed to dissolve or disintegrate quickly upon contact with saliva or other aqueous media, releasing the active drug for absorption in the oral cavity. This rapid dissolution eliminates the need for swallowing, making IDFs particularly advantageous for patients with swallowing difficulties, pediatric populations, and individuals requiring fast onset of action. Various techniques such as freeze-drying, direct compression, and spray-drying have been employed to create IDFs in various forms. IDFs offer several benefits, including enhanced bioavailability due to reduced first-pass metabolism, improved patient compliance, and a more predictable pharmacokinetic profile. Furthermore, they can be tailored to release the drug immediately.

Keywords: Immediate Dissolving Formulations (IDFs), drug delivery, pharmacokinetic profile

1. INTRODUCTION:

Immediate Dissolving Formulations (IDFs) encompass a range of pharmaceutical dosage forms designed to dissolve rapidly in the oral cavity, obviating the need for water. This innovation has gained considerable attention due to its potential to enhance patient adherence and provide rapid drug delivery **[1][2]**.

This review provides an overview of IDF, discusses its applications, and explores various estimation methods to assess its effectiveness.

IDF has gained prominence due to its numerous advantages, including:

i. Enhanced bioavailability: IDF facilitates quicker absorption of drugs, leading to higher bioavailability and faster onset of action.

Here are some approaches to enhance the bioavailability of IDFs:

Formulation optimization: Formulation optimization can be used to improve the bioavailability of IDFs.

Physicochemical modification: Physicochemical modification approaches can be used to enhance the efficacy of IDFs.

Nanoparticles: Organic based nanoparticles have been used to enhance the bioavailability of drugs **[3]**.

ii. Patient convenience: IDF eliminates the need for water or swallowing difficulties, making it particularly beneficial for pediatric, geriatric, and dysphagic patients.

These dosage forms are more convenient for patients as they do not require a delay in the onset of action. Immediate release dosage forms are particularly beneficial for indications requiring a rapid onset of action.

Innovative dosage forms or delivery systems may direct a drug to its specific site of action, improve patient compliance, and reduce the frequency of administration.

iii. improved compliance: The ease of administration and rapid drug release can enhance patient adherence to treatment regimens **[3] [4]**

A. PHARMACOKINETICS:

Both the pace and extent of absorption are crucial since it determines when a drug reaches a therapeutic level and, consequently, when it produces a pharmacological effect. Dissolution is slow in conventional dose forms because there is a delay in disintegration. Numerous variables, such as tissue permeability, perfusion rate, drug binding to tissue, illness status, drug interaction, etc., affect medication distribution. The pace of drug clearance from the body or the site of action, or biotransformation, determines the duration and intensity of effect. Drugs excreted by the kidneys have a longer half-life because renal clearance is slower.

B. PHARMACODYNAMICS:

Immediate release dosage forms are formulations that release the active drug immediately after oral administration. The pharmacodynamics of immediate release dosage forms depend on several factors, including the drug's physicochemical properties, the formulation of the dosage form, and the route of administration. Immediate release dosage forms are generally administered multiple times a day to maintain therapeutic drug levels in the body.

In vitro dissolution testing is an important tool for evaluating the performance of immediate release dosage forms. The dissolution profile of an immediate release dosage form can be affected by factors such as the drug's solubility, particle size, and formulation **[5][6]**.

C. USE OF IMMEDIATE DISSOLVING FORMULATIONS:

i. Pediatrics: Immediate Dissolving Formulations (IDFs), also known as orally disintegrating tablets (ODTs), are particularly useful in pediatric medicine due to their ease of administration, rapid dissolution, and palatability for children. Here are some common uses of IDFs in pediatrics.

Example:

A.Fever and Pain Relief:**[7][8][9][10]**

Example: Acetaminophen ODT (e.g., Tylenol® Meltaways)

B.Motion Sickness and Nausea:

Example: Dimenhydrinate ODT (e.g., Dramamine® Chewable)

ii. geriatrics: Elderly patients with swallowing difficulties can benefit from IDF formulations.

Examples:

A. Cardiovascular Medications:

Example: Sublingual nitroglycerin ODTs for angina.

B. Hypertension Management:

Example: Amlodipine besylate ODT for blood pressure control.

2. FORMULATION STRATEGIES:

I. Orally Dissolving Tablets (ODTs):

Tablets are solid pharmaceuticals that have been compressed into precise, moulded shapes. The mouth is typically used for oral delivery of table t**[11]**.

DEFINITION

Immediate release tablets are designed to dissolve and release their dosage form without the use of any additional rate-controlling elements, such as unique coatings or other methods **[12]**.

Figure 1: Orally disintegrated tablets (OTDs)

D. PHARMACEUTICAL COMPOSITION OF IMMEDIATE RELEASE TABLETS

i. Binder

A binder is something that combines other materials. Microcrystalline cellulose (MCC) is commonly used as a filler and binder in direct compression due to its outstanding bonding properties.

ii. Surfactants

One very useful class of excipients is surfactants, preferably present from 0 to 10 % w/w. commercial surfactants such as benzalkonium chloride, dioctyl sodium sulfosuccinate.

iii. pH Modifiers

Amounts between 0 and 10% w/w of pH modifiers, such as acids, bases, or buffers. When the dispersion polymer is anionic, acidic pH modifiers (such as acids like citric acid or succinic acid) prevent the medicinal component from dissolving. In contrast, basic pH modifiers like sodium acetate or amines speed up the pace at which the same kinds of medicinal substance dissolve.

iv. Diluents

Diluents, also known as fillers or bulking agents, are inactive ingredients used in pharmaceutical formulations to add bulk to a dosage form. In immediate release dosage forms, diluents play several important roles:

1. Blend Uniformity
2. Tablet Compression
3. Dosage Form Size
4. Disintegration

Commonly used diluents for immediate release dosage forms are Lactose, Starch, Microcrystalline Cellulose (MCC), Dibasic Calcium Phosphate, Calcium Carbonate, Mannitol, Sorbitol, and Sucrose.

v. Lubricants

Lubricants help in the manufacturing process by preventing sticking and adhesion of the formulation to equipment. some common lubricants used in the preparation of immediate release dosage forms are Magnesium Stearate, Stearic Acid, Talc, Sodium Lauryl Sulfate (SLS), Polyethylene Glycol (PEG), and Sodium Stearyl Fumarate.

vi. Glidants

Glidants include substances like silicon dioxide, talc, and corn flour. In order to increase the flowability of a powder, a glidant is usually added. Glidants are typically added right before compression while making tablets.

vii. Disintegrants

They help the dosage form break apart or disintegrate rapidly when it comes into contact with bodily fluids, thereby releasing the active drug for absorption. Here are some commonly used disintegrants in immediate-release dosage forms: Sodium starch glycolate, methyl cellulose, microcrystalline cellulose. The disintegrant typically makes up between 1% and 25% by weight of the dose form.**[12][13][14]**

E. VARIOUS MANUFACTURING TECHNIQUES FOR MDDDS INCLUDE:

i. direct compression

Due to their ability to be produced using standard tablet manufacturing and packaging equipment as well as the availability of tableting excipients with improved flow, compressibility, and disintegration properties, particularly tablet disintegrants, effervescent agents, and sugar-based excipients.

Flash tab uses DC-based technology and contains disintegrants, coated medication crystals, and microgranules. In this technology, two different kinds of disintegrants are employed: a disintegrating agent with a high swelling force, like modified cellulose, and a swelling agent, like starch, with a low swelling force. Microcrystalline cellulose (MCC) and low substituted hydroxypropyl cellulose (HPC), with a ratio of MCC to HPC ranging from 8:2 to 9:1. Due to its ability to absorb water and grow significantly without gelling at physiological temperatures **[15][16][17]**.

ii. spray drying

The formulations included sodium starch glycolate/croscarmellose as a disintegrant, mannitol as a bulking agent, and hydrolyzed and unhydrolyzed gelatin as a supportive ingredient for the matrix. With the addition of an acid (like citric acid) or an alkali (like sodium bicarbonate), disintegration and dissolution were further accelerated. This approach produced tablets that decomposed in an aqueous solution in under 20 seconds **[18][19]**.

iii. lyophilization or freeze-drying process

After the product has been frozen during the freeze-drying process, the water is sublimed from it. Drugs like famotidine, loperamide, piroxicam, oxazepam, lorazepam, domperidone, brompheniramine, olanzapine, ondansetron, and rizatriptan have all been manufactured using the patented Zydus technology (ZT) method. Claritin Reditab, Dimetapp Quick Dissolve, Feldene Melt, Maxalt- MLT, Pepcid RPD, Zofran ODT, and Zyprexa Zydis are among the MDT products that are offered in the United States. In order to provide completed dose units that are notably different from traditional oral systems, ZT uses a special freeze-drying technique. The process involves the following steps:

Stage 1 - An aqueous medication solution or suspension is prepared in bulk, and it is then precisely dosed into blisters that are already formed. Since the blister is the one that really shapes the tablet, it plays a crucial role in the whole product package.

Stage 2 - By putting the filled blisters through a specifically created cryogenic freezing process, which ensures that the tablets have a porous matrix to support the rapid disintegration property, it is possible to adjust the final size of the ice crystals. The majority of the remaining moisture is removed from the tablets during the sublimation process, which is where these frozen units are transferred after being frozen.

Stage 3 - Using a heat-seal procedure to close the open blisters will maintain product stability and defense against changing environmental factors **[16][17]**.

F. EVALUATION PARAMETERS:

i. weight variation test:

Twenty tablets are chosen at random

The weights of each and all tablets are calculated.

Calculated deviations from average weights for each individual tablet are then compared to the Pharmacopoeia's standard values.

% Weight variation,

$$= \frac{\text{Individual weight of each tablet} - \text{Average weight of 20 tablets}}{\text{Average weight of 20 tablets}}$$

ii. hardness test:

Hardness of the tablets is measured by using hardness testers like Monsanto hardness tester, Pfizer hardness tester etc. The pressure required to break the tablets is measured as a function of hardness (kg/ cm^2).[20]

iii. friability:

The Roche friabilator was used to test the friability of a sample of six randomly chosen tablets for 4 minutes at a speed of 25 rpm. By comparing the total weight of six tablets before and after surgery, the percentage weight loss is computed.

% Weight loss

$$= \frac{\text{Total weight of tablet before} - \text{Total weight of tablets after}}{\text{Total weight of tablets}} \times 100$$

iv. wetting time:

The key factors for mouth-dissolving tablets are wetting time and water absorption ratio. In a tiny petri dish fill with a water-soluble dye solution, a piece of filter paper that is cut in a circle is put. The time need to completely moist the tablet is calculated when it is placed on the paper **(Figure 2) [21]**.

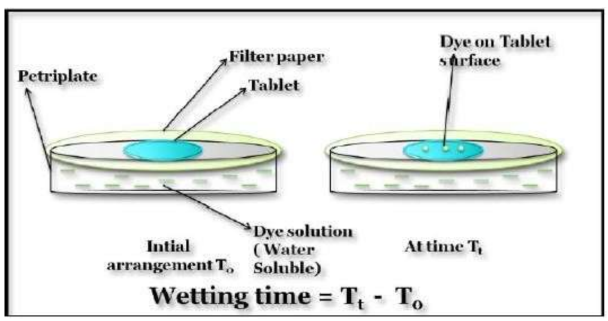


Figure: 2 wetting time

v. water absorption ratio: Similar to the procedure followed in determination of wetting time **(Figure 3)**. However, here the initial weight and the final weight (after complete wetting) of tablet are calculated and the water absorption ratio is calculated by given formula:

$$R = \frac{Wa - Wb}{Wb} \times 100$$

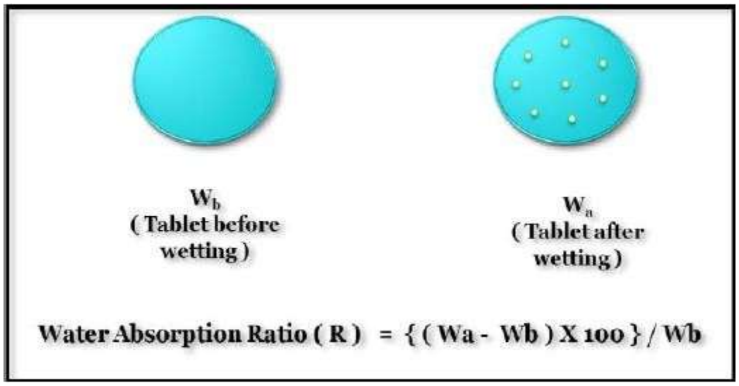


Figure: 3 Water absorption ratio

vi. disintegration time: Using a disintegration test instrument, the disintegration time for six randomly chosen tablets is measure. The typical disintegration time is calculate and compared to norms **[22]**.

vii. invitro dissolution studies: Six tablets are choose at random and submitted to drug release tests using the USP dissolving apparatus. A volume of 900 ml of dissolution liquid is utilize, and a temperature of 37 ± 0.5^0C is maintain. Up to 30 minutes, 5 ml of the sample is taken at 5-minute intervals and replace with 5 ml of new buffer solution. The samples ware filter and appropriately dilute, then an HPLC system or UV spectrophotometer is use to conduct the drug assay. The outcomes are again compare to benchmark values **[23]**.

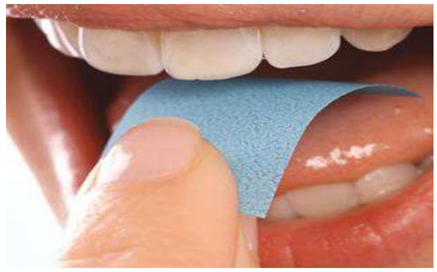
viii. uniformity of dispersion:

Two tablets are placed in 100 ml of water and swirl for two minutes. The dispersion goes through 22 meshes. If no residue remains on the screen, the tablets are regard to have pass the test **[24]**.

II. Fast Dissolving Films (Fdfs):

Orally fast dissolving films have recently offer to the market as a handy and user-friendly alternative to traditional dosage forms such as orally disintegrating tablets. Fast-dissolving medication delivery systems are an alternative to tablets, capsules, and syrups for pediatric and geriatric patients since they swiftly disintegrate and dissolve in saliva and can be easily ingested without the use of water.

They are thin, attractive films made of edible, water-soluble polymers that come in a variety of sizes and forms like rectangles, squares, and discs. A fast-disintegrating film is a thin film with a thickness of 1-10 mm and an area of 1-20 cm^2 of any geometry. Drugs should be incorporated up to a single dosage of around 30 mg **[25][26][27]**.



A. **FORMULATION CONSIDERATION**

Orally Fast dissolving films have areas ranging from 5 to 20 cm^2 and incorporate the drug in the form of a matrix using a hydrophilic polymer. The following is the general composition of an oral fast dissolving film:**[28]**

i. **active pharmaceutical ingredient**

The active pharmaceutical ingredient is usually present in the film composition at a concentration of 1-30% w/w. Because high drug doses are difficult to incorporate into a fast- dissolving oral film. Anti-histamine, anti-diarrheal, anti-depressant, and other drugs should be used as fast dissolving oral films.**[29][30]**

ii. **film forming polymer**

Polymer selection is one of the most important and vital elements for effective oral film manufacturing due to their tensile strength. Depending on the entire weight of the dry film, 45 %w/w polymer is typically utilized. The oral film is frequently composed of hydrophilic polymers that dissolve fast in the oral cavity when they come into contact with saliva.**[31][32]**

iii. **plasticizer**

The choice of plasticizer is depends upon its compatibility with the polymer as well as the form of solvent used in film casting. It increases the film's flexibility while decreasing its brittleness. They are used in concentrations ranging from 1 to 20% w/w of the dry polymer weight. Examples include Glycerol, propylene glycol, citrate derivatives such as triacetin, acetyl citrate etc. **[33][34]**

iv. **sweetening agents**

Sweetening agents have become an essential component in pharmaceutical agents intended to be disintegrated or dissolved in the oral cavity, and sweeteners are particularly important in pediatric formulations. Sweeteners are typically used in concentrations ranging from 3 to 6 % w/w, either individually or in combination. Sweeteners that are acceptable include:

A. Water soluble natural sweetener: Ribose, Xylose, glucose, sucrose, maltose, etc.

B. Water soluble artificial sweetener: Cyclamate salts, Calcium saccharin or Sodium salts, acesulfame-k, etc.

C. Fructose is sweeter than sorbitol and mannitol, and its sweetness is perceived faster in the mouth than sucrose and dextrose, so it is commonly used as a sweetener in oral films **[35]**.

v. surfactants

Surfactants act as a solubilizing, dispersing, and wetting agent, allowing films to disintegrate quickly and release the incorporated drug. Surfactants that are commonly used include poloxamer 407, sodium lauryl sulfate, tweens, etc. Out of these most predominantly used surfactant is poloxamer 407 due to its numerous advantages.

vi. saliva stimulating agent

Saliva stimulating agents are generally acidic in nature, promoting the disintegration of fast dissolving oral films by stimulating saliva production in the oral cavity. Some of the most commonly used saliva stimulating agents are citric acid, ascorbic acid, lactic acid, and tartaric acid **[36][37]**.

vii. stabilizing and thickening agents

In fast dissolving oral films, thickening and stabilizing agents are commonly used to enhance the consistency and viscosity of the dispersion or solution prior to casting. Natural gums such as xanthan gum, cellulosic derivatives can be used as stabilizing and thickening agents in concentrations up to 5% w/w **[38]**.

viii. flavoring agents

Flavoring agents would be added to pharmaceutical oral preparations because flavors are the ultimate goal for the patients when selecting preparations. Flavors can be incorporated to formulation at a volume of up to 10% w/w. Flavoring agent can be used individually or in combination. Cinnamon oil, Peppermint oil, oil of nutmeg are examples of flavor oils while cocoa, vanilla, coffee, chocolate, and citrus are fruity flavors and pineapple, apple, cherry, raspberry, are few examples of fruit essence type.

ix. Coloring agents

A coloring agent is a type of additive that adds color to a solution. In fast-dissolving oral films and other pharmaceutical formulations, titanium dioxide is the most widely employed coloring agent. Colorant concentrations greater than 1% w/w should be avoided **[39]**.

METHOD OF PREPARATION OF MOUTH DISSOLVING FILMS

The Mouth Dissolving film can be manufactured using one or a combination of the following processes:

i. solvent casting method [40][41]

Ingredients that are water soluble are dissolve In water.

- Drug and other ingredients are dissolve in a suitable solvent to form a clear viscous solution.
- Both solutions are mixed
- Degas under vacuum
- The resulting solution caste as a film.

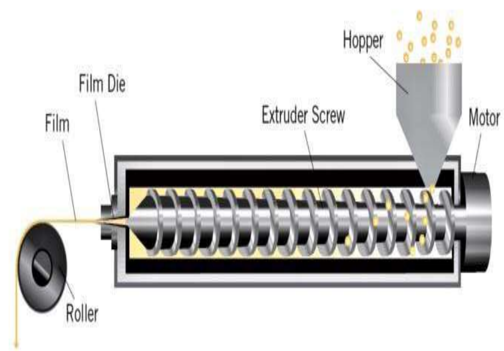


Figure 4: Solvent casting film system

ii. hot melt extrusion [42][43]

In solid form, the drug is mixed with carriers.

↓

The mixture is melted by an extruder equipped with heaters.

↓

Finally, the dies shape the melting mixture into films.

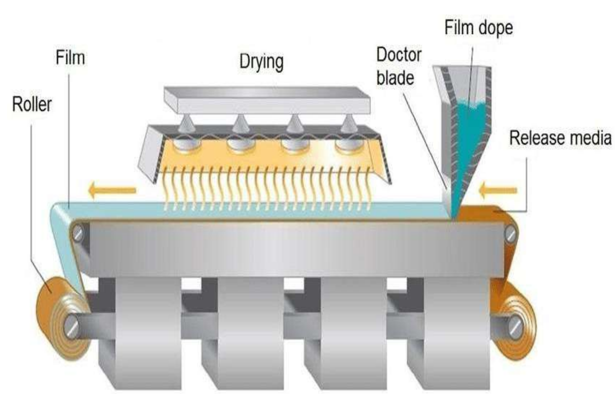


Figure 5: Hot melt extrusion

iii. rolling method [44]

Prepare a pre-mix of a film-forming polymer, a polar solvent, and other ingredients except a drug.

↓

Premix can be added to the master batch feed tank.

↓

It is fed to either or both of the first and second mixers through a first metering pump and control valve. Add the appropriate amount of drug to the desired mixer.

↓

Blend the drug with the master batch premix to give a uniform matrix. A specific amount of uniform matrix is then fed to the pan through the second metering pump.

↓

Finally, the film is forced on the substrate and carried away via the support roller.

↓

Then the wet film is dried using controlled bottom drying.

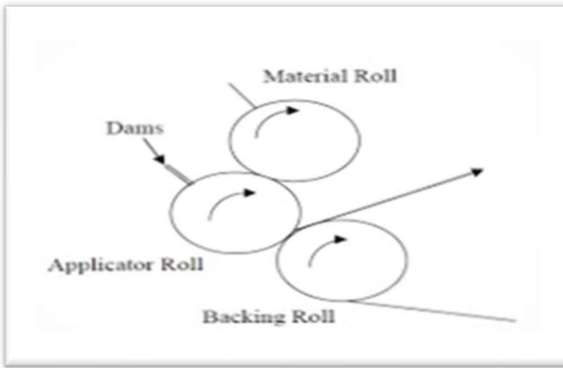


Figure 6: Three roller coating film forming unit

EVALUATION

The fast-disintegrating oral films are evaluated for the following parameters

i. thickness test

The thickness of the film is measure at five different places using a micrometer screw gauge, and an average of three values is calculate. This is essential to ensure uniformity in the thickness of the film, which is directly related to the accuracy of the dose in the film.

ii. folding endurance

By manually folding the same area of film until it breaks, folding endurance is evaluated. The number of folds a film can withstand before breaking is measured by its folding endurance value **[45]**.

iii. wetting time

A circular paper is placed in the petridish to evaluate wetting time, and 6 ml of 0.1 % w/v amaranth dye solution is prepare and add to the petridish. The film strip (2x2 cm^2) is place on the surface of tissue paper. The wetting time is the time require for the dye to appear on the surface of the film **[46]**.

iv. disintegration time

The disintegration apparatus mention in official pharmacopeias is used to determine a film's disintegration time. The disintegration time of a film is normally a function of its composition, as it varies with formulation and generally ranges from 5 to 30 sec. The USP disintegration apparatus is commonly used for this test. There are no official guidelines for determining the disintegration time of orally fast disintegrating films. There are two methods of determining film disintegration time:

• The slide frame method - Pouring a drop of distilled water onto the film clamped into slide frames placed on a petri dish. It is stated how long it takes for the film to dissolve.

• Petri dish method - A film is placed in a petri dish with 2 mL of distilled water. The time it takes for the film to dissolve completely is referred to as the disintegrating time **[47]**.

v. dissolution test

Dissolution testing can be carried out using either a standard basket or paddle apparatus described in any of the pharmacopeias. The dissolution medium will be chosen based on the sink conditions and the highest dose of the API. Many times the dissolution test can be difficult due to the tendency of the strip to float onto the dissolution medium when the paddle apparatus is employed **[48]**.

vi. contact angle

Contact angle measurements are performed at room temperature with a goniometer (AB Lorentz and Wetter, Germany). A drop of distilled water is placed on the surface of the dry film. Images of water droplets are captured by a digital camera within 10 seconds of their deposition. Image software is used to analyze the visual images in order to evaluate the contact angle **[49]**.

3. CHALLENGES IN IDF DEVELOPMENT:

i. taste masking [50][51][52][53]: The taste of active pharmaceutical ingredients can be unpleasant, necessitating effective taste-masking strategies.

Here are some common strategies for taste masking in immediate-release dosage forms:

1. Flavoring Agents: Adding sweetening and flavoring agents such as sucrose, sorbitol, or artificial flavors can help mask the bitter taste of medications.
2. Encapsulation: Encapsulation involves enclosing the drug particles in a taste-masking coating or shell, such as gelatin capsules. This prevents the taste of the drug from being released until the capsule dissolves in the gastrointestinal tract.

ii. stability issues: IDFs are susceptible to environmental factors, such as moisture and temperature, which can impact their shelf life.

Here are some common stability issues associated with immediate-release dosage forms, along with references for further reading:

1. Chemical Degradation: Active pharmaceutical ingredients (APIs) can degrade over time due to various factors such as exposure to moisture, heat, light, and chemical reactions with excipients. This can lead to a decrease in drug potency or the formation of potentially harmful degradation products **[54]**.

2. Physical Instability: Immediate-release liquid dosage forms can experience physical instability, including phase separation, settling of particles, or changes in color or appearance. These issues can affect dosing accuracy and patient acceptance **[55]**.

3. Microbial Contamination: Liquid formulations are susceptible to microbial growth if not properly preserved. Contamination can lead to reduced product shelf life and causes risks to patient safety **[56]**.

iii. regulatory considerations [57] [58] [59]:

Regulatory authorities, such as the U.S. Food and Drug Administration (FDA) in the United States and the European Medicines Agency (EMA) in Europe, provide guidelines and requirements that manufacturers must adhere to when developing and marketing immediate-release dosage forms. Below are some key regulatory considerations:

1. Drug Approval and Registration:

Before marketing an immediate-release dosage form, pharmaceutical companies must obtain regulatory approval. This typically involves submitting a New Drug Application (NDA) or a Marketing Authorization Application (MAA) to regulatory agencies.

2. Pharmacopeial Standards:

Immediate-release dosage forms must meet the quality standards specified in pharmacopoeias such as the United States Pharmacopeia (USP) or the European Pharmacopoeia (Ph. Eur.).

3. Bioequivalence Studies:

Generic versions of immediate-release dosage forms must demonstrate bioequivalence to the reference (innovator) product.

4. Labeling and Packaging:

This includes information on the drug's composition, dosage instructions, warnings, contraindications, and adverse effects. Packaging should also meet specific requirements to protect the product from environmental factors.

5. Post-Marketing Surveillance:

Once a product is on the market, manufacturers must continue monitoring its safety and efficacy through pharmacovigilance.

4. RECENT DEVELOPMENTS:

i. nanotechnology-based idfs: Utilizing nanoparticles to enhance drug solubility and bioavailability.

1.Nanoparticle-Based Drug Delivery Systems: Nanoparticles including liposomes, solid lipid nanoparticles (SLNs), and polymeric nanoparticles, have been used to encapsulate and deliver drugs with improved bioavailability and rapid release. These nanoparticles can protect sensitive drugs, control release rates, and enhance drug solubility.[60]

2. Nanoparticle-Based Inhalation Systems: Immediate-release inhalation formulations using nanoparticles have been explored for the treatment of respiratory diseases. Nanoparticles can improve drug dispersion, increase lung retention time, and facilitate rapid onset of action.[61]

ii. 3d printing: Customizable IDF production using 3D printing technology.

3D printing in pharmaceuticals, including immediate-release dosage forms, is an emerging technology with a growing body of research and development.

1. Personalized Medications: Pharmaceutical companies and research institutions are exploring the ability to tailor medication formulations to individual patient needs based on factors such as age, weight, and medical conditions.

2. Taste-Masked Dosage Forms: For pediatric and geriatric patients, the taste of medication can be a significant barrier to compliance. 3D printing can be used to create taste-masked dosage forms, improving palatability and adherence **[62][63][64][65]**.

iii. natural polymers: The use of natural polymers in IDF formulations to improve biocompatibility. Natural polymers in immediate release dosage forms.

1. Chitosan-Based Immediate Release Formulations **[66]**.

2. Pectin-Based Oral Films **[67]**.

5. FUTURE PROSPECTS:

i. tailored drug delivery: Personalized medicine using IDFs based on patient-specific requirements.

These systems aim to provide personalized and optimized drug delivery to meet individual patient needs. Here are some future prospects and trends in this field, along with references:

1. Biomaterials and Tissue Engineering: Tailored drug delivery systems may play a crucial role in regenerative medicine and tissue engineering. These systems can deliver growth factors, stem cells, or

therapeutic agents to promote tissue regeneration and repair **[68]**.

2. Patient-Centric Design: Future drug delivery systems will prioritize patient convenience and adherence. Technologies such as wearable drug delivery devices and mobile health apps will play a significant role in ensuring patients receive their medications as prescribed **[69]**.

6. CONCLUSION:

Immediate Dissolving Formulations offer a promising approach to drug delivery, improving patient compliance and providing rapid therapeutic effects. Despite challenges, recent advancements and ongoing research underscore their potential to revolutionize the pharmaceutical industry.

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