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Review Paper

A Review on Solubility Enhancement by Solid Dispersion Method

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ABSTRACT

The issue of poor solubility remains a significant barrier in the targeted drug delivery of many newly developed pharmaceutical compounds. It is estimated that at least 40% of novel drug candidates emerging from pharmaceutical research exhibit poor water solubility which directly impacts their therapeutic effectiveness due to inadequate absorption and low oral bioavailability. Enhancing the solubility and dissolution rate of such drugs is, therefore, one of the major challenges faced by formulation scientists today. Among the various formulation approaches available the development of solid dispersions using hydrophilic carriers has proven to be an effective strategy to address these issues. By dispersing the poorly soluble drug in a water-soluble matrix solid dispersions improve the wettability, dissolution rate, and ultimately the bioavailability of the drug. This technique has gained considerable attention as a promising method for enhancing the performance of hydrophobic drugs. This review focuses on the fundamental concepts of solid dispersions, including their types, rationale behind their use, advantages, limitations, and the manufacturing techniques involved. Furthermore, it discusses the challenges associated with the large-scale commercialization of solid dispersion-based formulations and the need for continued research to overcome these limitations.

INTRODUCTION

The oral route is the most commonly used and preferred method for drug administration due to its ease of use and patient convenience. However, it poses challenges when a drug has poor solubility or limited membrane permeability. Although over 90% of medications are taken orally, but their solubility in aqueous environments has a significant impact on their absorption, bioavailability, and overall pharmacokinetic profile. A drug's bioavailability, which is directly impacted by its solubility, determines its therapeutic efficacy. To produce the desired

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pharmacological reaction, the drug concentration in the systemic circulation must be reached.[1,3,7]
However, more than 40% of new drug candidates fail during development due to suboptimal biopharmaceutical properties, particularly poor solubility and low bioavailability. Over time, advancements in drug discovery have significantly impacted these properties, yet poorly water-soluble drugs continue to present challenges in oral dosage form development.[2,3]
In the gastrointestinal (GI) tract, low water solubility and poor membrane permeability are two typical traits that restrict drug absorption. Before a drug may cross the gastrointestinal tract's membranes, it must dissolve in the stomach or intestinal fluids. to enter the systemic circulation effectively. To increase the bioavailability of oral medications, Pharmaceutical research has focused on two primary areas: increasing the solubility and rate of dissolution of poorly soluble medications and improving their membrane permeability.
One intriguing approach to these problems is solid dispersion, a formulation method that increases the drug's solubility and bioavailability by dispersing it in a matrix that is physiologically inert. Corrigan claims that solid dispersions are byproducts of the conversion of a liquid medication. They are a useful tactic for enhancing oral drug administration since they can solidify a carrier combination and, in practice, exhibit better drug release patterns than traditional dosage forms. Solid dispersions, according to Chiou and Riegelman, are systems in which one or more active components are dispersed in a solid state inside an inert carrier matrix by means of solvent evaporation, melting (fusion), or a combination of the two processes.[10,7]

SOLUBILITY:

The maximum amount of a solute that can dissolve in a given volume of solvent under particular circumstances is referred to as solubility. Both quantitative and qualitative descriptions are possible.

- The quantitative representation of solubility is the concentration of a solute in a saturated solution at a particular temperature.
- In qualitative terms, it is defined as the innate capacity of two or more substances to mix and form a homogeneous molecular dispersion.

Regardless of the kind of solvent used, solubility is categorized by the British Pharmacopoeia (BP) and the United States Pharmacopoeia (USP) only on the basis of quantification. They offer precise standards for classifying substances according to their solubility, which is determined by the amount of solvent present. Need to dissolve a specific solute weight. [16,17]

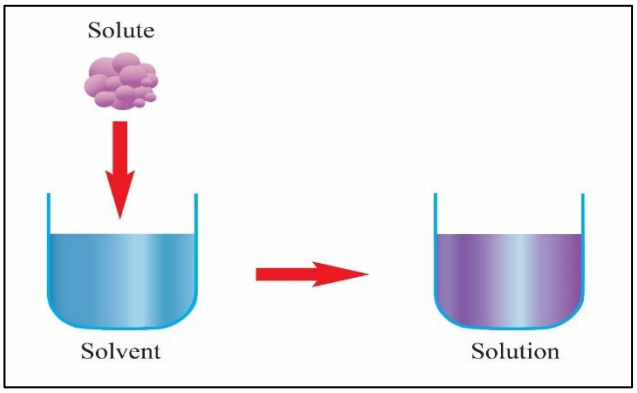

Figure 1: Solubility

Approximate Solubility Classification Based On Usp And Bp Standard

Table No.1 Solubility terms

Descriptive term	Part of solvent required per part of solute
Very soluble	**Less than 1**
Freely soluble	**From 1 to 10**

Soluble	**From 10 to 30**
Sparingly soluble	**From 30 to 100**
Slightly soluble	**From 100 to 1000**
Very slightly soluble	**From 1000 to 10,000**
Practically insoluble	**10,000 and over**

FACTORS AFFECTING SOLUBILITY: [19,20]

1. Particle Size:

Reducing particle size enhances solubility by increasing the surface area accessible for interaction with the solvent. This concept is used in procedures such as micronization, which shrinks particles to accelerate their rate of disintegration.

2. Temperature:

When it comes to solids dissolving in liquids, solubility generally increases as temperature rises—think of how sugar dissolves faster in hot water. However, the opposite is true for gases; they become less soluble in liquids at higher temperatures, which is why a warm soda loses its fizz faster

3. Pressure (For Gases in Liquids - Henry's Law):

Because more gas may dissolve in a liquid at higher pressures, carbonated drinks are bottled at high pressure to maintain their fizz. However, the solubility of solids and liquids is mostly unaffected by pressure.

4. Characteristics of Solute and Solvent ("Like Dissolves Like"):

The compatibility of a solute with a solvent has a significant impact on solubility. Polar solutes usually dissolve well in polar solvents, as shown by the dissolution of salt in water; however, non-polar solutes are more soluble in non-polar solvents, as occurs when oil is combined with Benzene. The better the solubility, the stronger the molecular attraction between the solvent and the solute.

5. Molecular Size and Structure:

Larger molecules or those with higher molecular weight tend to be less soluble because they are harder for solvent molecules to surround and dissolve. However, in organic compounds, increased branching in the carbon chain can improve solubility by making the molecule more compact and easier for the solvent to interact with.

Biopharmaceutical Classification System (BCS):

The Biopharmaceutical Classification System (BCS) is a scientific approach that groups drugs according to two important properties that affect absorption and bioavailability: permeability and solubility. Pharmaceutical researchers can use this system to predict how a medication will act in the body and create formulations that are optimized to increase its efficacy. [18,4]

One of the biggest challenges in drug research is making poorly water-soluble drugs more soluble because this might result in limited bioavailability and decreased pharmacological efficacy. Since most orally administered drugs must dissolve in gastrointestinal (GI) fluids before being absorbed into the bloodstream, their absorption is highly dependent on how well they dissolve and pass through biological membranes. To address solubility issues, various techniques such as nanotechnology, to improve drug solubility and absorption, cyclodextrin complexation, lipid-

based formulations, solid dispersion, and micronization have all been investigated.[19]

BCS CLASSIFICATION OF DRUGS:

The BCS classifies drugs into four groups according to their permeability and solubility:-

1. Class I (High Solubility, High Permeability): This class of drugs dissolves readily.in gastrointestinal fluids and readily pass through cell membranes. They are well-absorbed and exhibit predictable bioavailability. Examples Paracetamol, Metoprolol.

2. Class II (Low Solubility, High Permeability): These medications have trouble being absorbed because their poor solubility, despite having good permeability. Their bioavailability can be improved by increasing solubility and dissolution rate, often achieved through techniques like solid dispersions, particle size reduction, and the use of surfactants. Examples Ibuprofen, Ketoconazole.

3. Class III (High Solubility, Low Permeability): Despite having good solubility, these medications' weak permeability through the gut lining limits their absorption. Enhancing permeability using permeation enhancers or formulation modifications can help improve their bioavailability. Examples: Cimetidine, Ranitidine.

4. Class IV (Low Solubility, Low Permeability): This class of drugs faces the most challenges as they have both poor solubility and poor permeability, making absorption difficult. Advanced formulation strategies, such as Nano formulations, prodrugs, or lipid-based carriers, are required to improve their bioavailability. Examples Hydrochlorothiazide, Paclitaxel.[18,4]

SOLID DISPERSION:

Solid dispersion is a widely used technique to improve the solubility of drugs that do not dissolve well in water. It functions by distributing the poorly soluble drugs into a hydrophilic carrier, which may be crystalline or amorphous. Among these, **amorphous matrices** are generally preferred because they have higher solubility. Unlike crystalline structures, amorphous forms do not have a rigid, organized lattice, so they dissolve more easily without requiring extra energy to break down the crystal structure. The presence of hydrophilic carriers around the drug molecules enhances their solubility and wettability, ultimately leading to **faster dissolution rates** and improved drug absorption.[6,8]

ADVANTAGES OF SOLID DISPERSION TECHNIQUE:

1) Converts poorly soluble drugs into a more soluble form, increasing the dissolution rate.
2) drug dissolution leads to better absorption and higher bioavailability in the body.
3) Drugs are dispersed at the molecular level, reducing particle size and increasing surface area for better dissolution.
4) Hydrophilic carriers prevent drug molecules from clumping together, ensuring uniform dispersion
5) Converts crystalline drugs into an amorphous state, which has higher solubility.
6) Some solid dispersions can protect drugs from degradation due to environmental factors like heat, light, and moisture.
7) Increased solubility and absorption mean lower doses are needed to achieve the desired therapeutic effect.

DISADVANTAGES OF SOLID DISPERSION TECHNIQUE:

1) Some polymer carriers absorb moisture, which can lead to drug degradation or reduced stability.
2) Some drugs may not be compatible with the selected polymer or surfactant, leading to reduced drug release efficiency.
3) Solid dispersions may be sticky or have poor flow properties, making tablet or capsule formulation difficult.
4) In third-generation solid dispersions, certain sophisticated polymers and surfactants can be costly.

TYPES OF SOLID DISPERSIONS[6,8,14]:

The classification of solid dispersions is based on their molecular arrangement and composition.

1. Based on Composition:

Binary Solid Dispersion: includes a drug and a polymer-based carrier to boost solubility.

Ternary Solid Dispersion: includes a polymeric carrier, a drugs, and a surfactant to improve drug release.

Surface Solid Dispersion: Incorporates polymers such as polyvinyl pyrrolidone (PVP), polyethylene glycol (PEG), and polyvinyl pyrrolidone-vinyl acetate copolymer, formulated via the fusion method to improve solubility.

2. Based on Molecular Arrangement (Drug-Carrier Interaction):

Type 1 – Simple Eutectic Mixture The drug and carrier form a mixture that melts and solidifies at a specific ratio, improving dissolution.

Type 2 – Amorphous Precipitation in a Crystalline Matrix The drug is retained in an amorphous state, dispersed within a crystalline carrier.

Type 3 – The drugs is completely molecularly dissolved in the carrier, guaranteeing uniform dispersion.

Type 4 – Glass Suspension The drug exists in a dispersed form within an amorphous, glassy carrier.

Type 5 – Glass Solution Because the drugs is molecularly distributed throughout the amorphous carrier, its solubility and stability are improved.

1. Simple Eutectic Mixtures:

A molten mixture of two substances that are completely miscible in the liquid state but show limited solubility upon solidification can be rapidly cooled to form eutectic mixtures From a **thermodynamic standpoint,** a eutectic mixture is a finely blended physical combination of **two crystalline substances.** This characteristic is evident in its **X-ray diffraction pattern,** which reflects a composite of the individual diffraction patterns of both components.[6,4]

Examples of Eutectic Mixtures:

Aspirin – Urea, Ibuprofen – Menthol, Indomethacin – PEG, Naproxen – PEG

Eutectic mixes increase the surface area after dispersion, which speeds up the rate at which poorly water-soluble drugs dissolve, improving absorption and bioavailability.

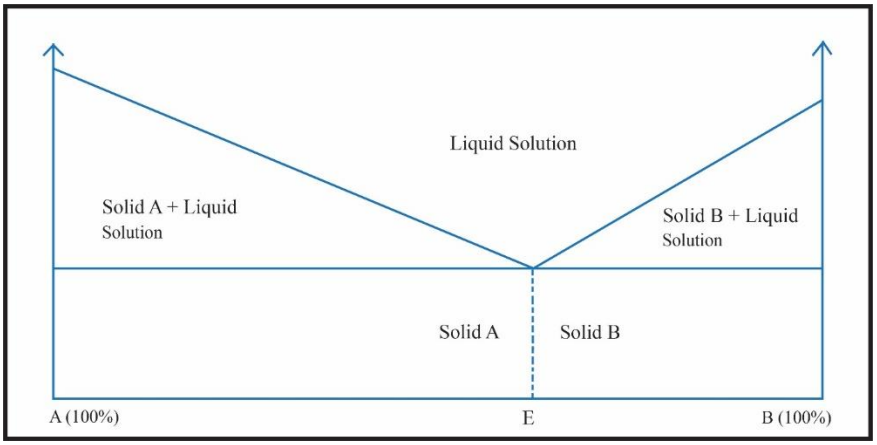

Figure 2: Simple Eutectic Mixtures

2. Amorphous Precipitation In A Crystalline Carrier:

This method improves solubility and dissolution rates by precipitating the drug in an amorphous state within a crystalline carrier, as opposed to eutectic mixes, where the drug stays in a crystalline form. Example *Sulfathiazole* precipitated in crystalline urea, leading to faster dissolution in water.[4,8]

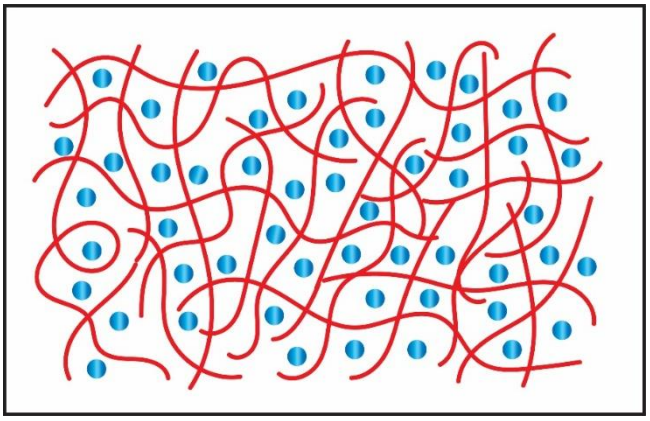

Figure 3: Amorphous Precipitation in a Crystalline Carrier

3. Solid Solutions:

A solid solution is a system in which two components co-crystallize creating a homogeneous single-phase structure. In this dispersion the drug is molecularly dispersed resulting in a dissolving rate that is significantly faster than that of eutectic mixtures.[4]

SOLID SOLUTIONS CAN BE CLASSIFIED BASED ON MISCIBILITY AND MOLECULAR DISTRIBUTION:

1. Classification Based on Miscibility:

- **Continuous Solid Solutions:** The components fully integrate in the solid state creating a uniform phase with enhanced intermolecular interactions compared to the individual components.
- **Discontinuous Solid Solutions:** One component has limited solubility in the other meaning they do not form a homogeneous mixture in all proportions.

2. Classification Based on Molecular Distribution:

- **Substitutional Solid Dispersions:** Drug molecules replace some carrier molecules within the crystal lattice.
- **Interstitial Solid Dispersions:** The crystalline structure of the carrier has interstitial gaps that are occupied by drug molecules.
- **Amorphous Solid Dispersions:** Drug molecules are randomly distributed within

an amorphous (non-crystalline) carrier improving solubility and bioavailability.

This technique is very helpful for improving the solubility and absorption of drugs that are not very soluble in water.

4. Glass Solutions And Suspensions:

A glass solution is a clear glass-like mixture in which the drug (solute) has completely dissolved in a matrix of carriers. When drug particles are suspended in a glassy carrier without completely dissolving, this is known as a glass suspension. The glassy state is recognized for its brittleness and transparency at temperatures below the glass transition temperature**.** Unlike crystalline solids Glassy materials lack a distinct melting point and instead undergo a gradual softening process. One of the key benefits of glass solutions is their lower lattice energy making it easier for the drug to dissolve compared to traditional solid solutions. This technique significantly enhances drug solubility and bioavailability.[4,8]

5. Compound Or Complex Formation:

In this approach, the **drug and carrier form a strong complex** in an aqueous medium improving solubility and dissolution. **Example** *Cyclodextrins* are commonly used to create drug complexes enhancing their **bioavailability.** Using a **low to moderate concentration** of the carrier improves dissolution efficiency. If a **higher carrier concentration** is used in a **solid solution** may further enhancing drug dissolution. This technique is especially beneficial for drugs with **poor water solubility** helping them achieve better **therapeutic effectiveness.[4,8]**

VARIOUS METHODS USED FOR PREPARATION OF SOLID DISPERSION:

Sr. No	Methods
1	Melting Method
2	Solvent Methods
3	Melting Solvent Method
4	Melt Extrusion Methods
5	Lyophilization Techniques
6	Melt Agglomerations Process
7	The Use Of Surfactant
8	Electro Spinning
9	Super Critical Fluid Technologies

1. Melting Method (Fusion Method):

The melting procedure, sometimes referred to as the fusion technique involves mixing a medication with a water-soluble carrier and heating the mixture until it completely liquefies. It is rapidly cooling in an ice bath after melting, stirring constantly. After that the solidified substance is broken. To create a fine powder ground and sieved. The molten mixture is usually spread as a thin layer on a metal plate like stainless steel to increase the uniformity of dispersion. On the other side cooling is aided by circulating water or air. This rapid cooling process known as the quenching technique helps immobilize the drug molecules within the carrier promoting finer dispersion and minimizing crystallization. However a major drawback of this method is that some drugs or carriers may **degrade at high temperatures** or **lose volatile components** due to evaporation. The fusion process can be carried out in a vacuum sealed container or in an environment with inert gases (like nitrogen) to minimize oxidation and deterioration in order to avoid these problems. Solid dispersions are frequently made using this technique to increase medication solubility and bioavailability.**[4]**

Example: Fenofibrate + Polyethylene Glycol (PEG) Fenofibrate is melted with PEG 6000 and solidified to form a solid dispersion. The resulting dispersion enhances solubility and dissolution rate.

2. Solvent Evaporation Method:

The solvent evaporation method is a usually used approach in pharmaceutical formulations notably for creating microparticles, nanoparticles, and solid dispersions. This process includes dissolving both the drug and polymer in a suitably volatile organic solvent or a combination of solvents. Once a clear and homogeneous solution is formed it is emulsified into an aqueous phase containing a stabilizer or surfactant under continuous stirring. The organic solvent gradually evaporates due to continuous agitation and sometimes mild heating leading to the precipitation of the polymer which encapsulates the drug. As the solvent is removed solid particles are formed which can be collected by filtration or centrifugation followed by drying. The main advantage of this technique is that it operates under mild conditions which is ideal for thermolabile drugs. Additionally the method allows for good control over particle size and drug loading efficiency. However, selecting appropriate solvents and stabilizers is critical to ensure biocompatibility and complete removal of residual solvents, which can otherwise pose toxicity concerns.[3,11]

3. Melting-Solvent Method:

This process blends melting and solvent methods. After dissolving the drug in a solvent it is combined with melted polyethylene glycol (PEG). The solvent is then evaporated leaving behind a solid dispersion. PEG 6000 can accommodate up to 5-10% (w/w) of liquid compounds without compromising its solid-state characteristics. However, drug and solvent compatibility with PEG is important. The solvent used may alter the drug's polymorphic form which can **affect its properties.** Although this process combines the advantages of solvent evaporation and fusion (melting) it works best with drugs that have a modest therapeutic dosage (less than 50 mg).[3,11]

4. Melt Extrusion Method:

Using this method the drug and carrier are combined and then run through a twin-screw extruder. The substance is melted mixed, and then formed into various shapes including tablets, pellets, pellets, sheets, and powders. This method's main advantage is that the drug is exposed It is appropriate for medications that are heat-sensitive because it is exposed to high temperatures for a brief period of time (around one minute).

Process Details: The drug concentration in the solid dispersion is usually 40% (w/w) the screw extruder has different zones for mixing and transporting the material. The temperature zones range from 100°C to 185°C to ensure proper melting and processing. After extrusion, the material is cooled, cut, and sieved to obtain the desired particle size. This method provides consistent drug distribution and enhances bioavailability making it widely used in pharmaceutical applications.[4,5]

Example: Fenofibrate + Kollidon VA64 Fenofibrate is mixed with Kollidon VA64 and processed using hot-melt extrusion. The dispersion improves drug release and bioavailability.[23]

5. Lyophilization Technique (Freeze-Drying):

A sophisticated method called lyophilization often known as freeze-dryin, is used to increase the stability and solubility of drugs that are not very soluble in water. It entails quickly freezing the solution after dissolving the drug and a hydrophilic carrier in the proper solvent. The frozen mixture is then subjected to vacuum drying allowing solvent removal without heat exposure. This process maintains the drug's structural integrity while forming a highly porous dispersion leading to enhanced dissolution rates. Example: Fenofibrate + Polyvinylpyrrolidone (PVP) Fenofibrate which does not dissolve easily in water is mixed with PVP and dissolved in a water-based solution. The

solution is rapidly frozen and subjected to vacuum drying which removes the solvent resulting in a porous high-surface-area dispersion. This process improves wettability, enhances solubility, and facilitates better drug absorption in the body. Advantages of Lyophilization[3,5]

6.Vial Freeze-Drying Process:

Lyophilization another name for vial freeze-drying is a carefully regulated process used to increase the solubility and stability of medicinal components. The active drug is first dissolved at a predetermined concentration in a suitable solvent. At the same time the carrier material is dissolved in water to prepare a separate solution. These two solutions are then combined in a 40:60 volume ratio to form a uniform mixture before undergoing the freeze-drying process. Once the mixture is prepared, it is rapidly frozen by immersing it in liquid nitrogen until it solidifies completely. By altering the carrier concentration while maintaining a constant drug concentration the drug concentration in the finished solid dispersion can be changed.**[11]**

7. Melt Agglomeration Process:

The melt agglomeration technique is commonly used to prepare solid dispersions, where the binder functions as both an adhesive and a carrier. This method involves two primary approaches**[4,5]**

Melt-In Procedure: The binder, drug, and excipients are heated together until the binder reaches its melting point allowing the ingredients to mix thoroughly.

Spray-On Procedure: The drug is dispersed in a melted binder and then spray-coated onto warmed excipients using a high-speed mixer among these techniques a rotary processor is often preferred over high-shear melt agglomeration because it provides improved temperature regulation and makes it possible to add more binder to the agglomerates.

8. Electrospinning Technique:

An inventive method for turning a polymeric melt or solution into solid fibers is electrospinning. This technique uses a tiny nozzle to extract ultra-fine fibers from a liquid solution or molten polymer using a high-voltage electrostatic field. The polymer the fibers are gathered on a conductive screen, and the solution is contained in a reservoir that is linked to a conductive capillary. Electrospinning is a process that uses high-voltage electricity to create ultra-fine polymer fibers. When an electric charge is applied to a liquid polymer solution, it forms a charged jet that stretches and thins as it travels through the air. The solvent evaporates mid-flight, leaving behind solid nanofibers that collect on a grounded surface, forming a delicate and web-like material. This technique is widely used in medicine, filtration, and textiles to produce materials with high surface area and unique properties.[4,5,6]

9. Supercritical Fluid (SCF) Technology

Supercritical fluid (SCF) technology is an advanced method used for particle size reduction and enhancing drug solubility. This technique utilizes carbon dioxide (CO_2) as both a solvent and an antisolvent, depending on its interaction with the drug and organic solvent. Various micronization processes have been developed using SCF technology including:

- Aerosol Solvent Extraction System (ASES)
- Precipitation with a Compressed Fluid Antisolvent (PCA)
- Gas Antisolvent (GAS) Process
- Solution-Enhanced Dispersion by Supercritical Fluids (SEDS)

- Supercritical Antisolvent (SAS) Process

SAS Process Mechanism

A drug-and-organic solvent solution is sprayed into a continuous supercritical CO_2 phase in the Supercritical Antisolvent (SAS) method. The medication precipitates as ultra-fine particles as the solvent is quickly removed by the CO_2.[5]

10. Spray Drying Technique

Spray drying is a popular method for quickly evaporating fluids to create solid dispersions.

Process Steps: Solution Preparation – Dissolve the drug in an organic solvent and the carrier in water. Dispersion & Spraying – A peristaltic pump is used to feed the prepared dispersion via a nozzle at a predetermined flow rate. Drying and Particle Formation: The solution is spray-dried at 65–70°C for the outlet and at 120°C for the input. Collection – The dried powder is collected using cyclone separation and transferred into vials for storage.[4]

11. High-Pressure Homogenization

Using this method, drug particles are dispersed in a solution of surfactants and then run through a high-pressure homogenizer. Drug microparticles are broken up into nanoparticles by the strong cavitation force increasing their solubility and bioavailability.[5]

12. Polymorphic Alteration

Different crystalline forms of a drug with distinct physical characteristics including as stability, solubility, and bioavailability, are called polymorphs. To guarantee consistent drug performance the most thermodynamically stable polymorph must be chosen.[3]

13. Inclusion Complexes

Inclusion complexes are formed by trapping drug molecules within a host molecule such as Cyclodextrins**,** to improve solubility and bioavailability**.** [3]

Preparation Methods:-

- **Kneading Technique:** After combining the medication and polymer with a tiny bit of water to create a thick paste it is dried and sieved.
- **Co-Precipitation**: The drug is dissolved in β-cyclodextrin solution under agitation and the precipitate is separated and dried.
- **Neutralization:** The drug is first dissolved in an alkaline solution (e.g., NaOH) followed by the addition of β-cyclodextrin. After neutralization with HCl an inclusion complex precipitate forms.
- **Co-Grinding:** The drugs and carrier are combined with a tiny bit of water, sieved, and vacuum-dried.
- **Spray-Drying Method:** After dissolving the drug and β-cyclodextrin in an appropriate solvent they are combined and dried with a spray dryer.
- **Microwave Irradiation:** A novel technique where the drug and cyclodextrin mixture is exposed to microwave energy enabling rapid complex formation.

APPLICATIONS OF SOLID DISPERSION TECHNIQUE:

1) Poorly soluble drugs struggle with low bioavailability. Solid dispersions increase drug surface area and improve wettability leading to better dissolution rates.
2) Solid dispertion technique enhancing dissolution drugs achieve higher systemic absorption resulting in better bioavailability compared to conventional formulations.

3) Solid dispersions when combined with suitable carriers aid in controlled or prolonged medication release, lowering dosage frequency and improving patient compliance.
4) Some drugs exist in a metastable amorphous state, which can revert to a crystalline form, affecting solubility. Solid dispersions help stabilize amorphous drugs ensuring long-term stability.
5) Bitter drugs can be unpleasant for patients. Solid dispersions encapsulate the drug, reducing bitterness and improving patient acceptability.
6) Class II drugs in the Biopharmaceutical Classification System (BCS) have good permeability but poor solubility. Solid dispersions improve total absorption by increasing solubility.
7) Hydrophobic drugs struggle with poor dissolution. Solid dispersions with hydrophilic carriers significantly increase their solubility.
8) Patients with gastrointestinal (GI) disorders, such as Crohn's disease often have poor drug absorption. Solid dispersions improve drug uptake, making them more effective [4,5]

CHARACTERIZATION OF SOLID DISPERSION:

1. **Drug Content Uniformity** — to ensure uniform distribution of drug in the carrier.
2. **Solubility Studies** — to assess enhancement in drug solubility.
3. **Dissolution Studies** — to evaluate improvement in dissolution rate.
4. **Fourier Transform Infrared Spectroscopy (FTIR)** — to detect possible drug–carrier interactions.
5. **Differential Scanning Calorimetry (DSC)** — to study thermal behavior and crystallinity changes.
6. **X-ray Diffraction (XRD)** — to determine changes in crystalline or amorphous nature.
7. **Scanning Electron Microscopy (SEM)** — to examine surface morphology.
8. **Particle Size Analysis** — to measure particle size and distribution.
9. **Stability Studies** — to evaluate physical and chemical stability over time. [3,4,5]

CONCLUSION

A significant number of newly developed pharmaceutical compounds exhibit poor water solubility which directly impacts their oral absorption and therapeutic effectiveness. Since the dissolution rate plays a crucial role in drug absorption enhancing solubility and bioavailability remains a key challenge for pharmaceutical scientists. Among the various approaches explored solid dispersion has emerged as one of the most effective and widely studied techniques for overcoming these limitations. Despite its proven benefits, the large-scale commercial application of solid dispersion technology still faces challenges, including scalability, cost-effectiveness, and stability concerns for certain drugs. Ongoing research and advancements in formulation strategies and manufacturing techniques are essential to overcome these barriers. If these issues are successfully addressed solid dispersion technology holds immense potential in revolutionizing drug formulation, ensuring better therapeutic outcomes, and enhancing the efficacy of poorly soluble drugs.

REFERENCES

1. WadkeDA, Serajuddin A, Jacobson H,"Preformulation testing". In: Lieberman HA, Lachman L, Schwartz JB, eds. Pharmaceutical Dosage Forms: Tablets. New York NY : Marcel Dekker; 1989.

2. Brahmankar DM, Jaiswal SB. Biopharmaceutics and Pharmacokinetics, Vallabh Prakashan, 1st Edn. 1995:347-352.
3. Shaikh SN, Hifzurrahman S, Athar MD, Dr. Khan GJ, Raza S, Mohd AA, "Review on solid dispersion of poor water soluble drug by using natural polymers" The Pharma innovation Journal 2019; 8(1):631-636.
4. Singh J, Walia M, Harikumar SL, Solubility enhancement by solid dispersion method: A Review, Journal of drug delivery & therapeutics, 2013; 3(5):148-155.
5. Singh S, Baghel RS and Yadav L, "A review on solid dispersion" International journal of pharmacy & life science 2011; 2(9):1078-1095.
6. Dixit ND, Niranjan SK. "A review: Solid dispersion" World journal of pharmacy and pharmaceutical science.2014; 3(9):238-257.
7. Ratnaparkhi MP, Chaudhari PD. Solubility Enhancement of Poorly Water Soluble Drug Using Natural Carrier. International Journal of Life Science and Pharma Research, 2017; 7(3):9-18.
8. Kumar B. Solid dispersion- A review, Pharma tutor.2017; 5(2):24-29.
9. Singh N and Sarangi MK. Solid dispersion-a novel approach for enhancement of bioavailability of poorly soluble drugs in oral drug delivery system, Global journal of pharmacy & pharmaceutical science, 2017; 3(2):001-008.
10. Vemula V, Legishetty V, Shrikanth L. Solubility enhancement techniques. Int Journal of P"ceutical Sciences Review & Research 2010, 5(1),41-51
11. Yadav B, Tanwar YS. Applications of solid dispersions. Journal of Chemical and Pharmaceutical Research. 2015; 7(2):965-978.
12. Bhaskar R, Monika OLA and Ravindra M. Ghongade. Review: Solid dispersion technique for enhancement of solubility of poorly soluble drug, Indian journal of pharmaceutical and biological research.2018; 6(2):43-52.
13. Kumari B, Bishnoi HK. Solid dispersion: its type and mechanism of enhancement of solubility by solid dispersion, Journal of pharma Research, 2019; 8(3):65-71.
14. Sneha D. Bhore. A Review on Solid Dispersion as a Technique for Enhancement of Bioavailability of Poorly Water Soluble Drugs. Research J. Pharm. and Tech. 2014; 7(12):1485-1491.
15. Vakhariya RR, Kumbhar SM, Lade RB, Salunkhe PS, Ubale RH. Dissolution Rate Enhancement of Ramipril by Solid Dispersion Technique. Asian J. Pharm. Res. 2020; 10(1):08-12.
16. The United States Pharmacopoeia, USP 30-NF 25, 2007
17. British Pharmacopoeia 2009
18. Chaudhary A, Nagaich U, Gulati N, Sharma V, Khosa R. Enhancement of solubilization and bioavailability of poorly soluble drugs by physical and chemical modifications. Journal of Advanced Pharmacy Education & Research 2012, 2(10), 32-67
19. Savjani K T, Gajjar A K, Savjani J K. Drug solubility: Importance and Enhancement techniques. ISRN Pharmaceutics 2012, 1 10
20. Jaiswal S B, Brahmankar D M. Biopharmaceutics and Pharmacokinetics. A Treatise 1999, 25, 165
21. Choudhary H, Yadav B, Patel P, Das P, Pillai S. Formulation and Evaluation of Ramipril Fast Dissolving Tablet using Solid Dispersion. Research J. Pharm. and Tech 2019; 12(8):3764 3772.
22. Dispersions composed of PVP VA64, Myrj 52 and itraconazole," Int. J. Pharm,2005;303(1):54-61.
23. Seth NS, "Formulation and evaluation of solid dispersion of olanzepine,"Int. J. Pharm. Sci. Res., 2011;2(2):691-697.

24. Chavan S, Patel K, Shelar D, Vavia P. Preparation of Oxcarbazine Solid Dispersion by Hot Melt Extrusion for Enhanced Dissolution: Doenstream Processing to tablets. Am. J. PharmTech Res, 2013;3 (1).
25. Rohini P, KiranKadali SDVS, BhagvanRaju M, Pavankumar K. Studies on dissolution enhancement of Itraconazole using water-soluble carriers. Inventi Rapid: Pharm Tech,1(1).
26. Dixit M, Kini AG, Kulkarni PK. A novel technique to enhancing the solubility and dissolution of flutamide.

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