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A REVIEW ON SOLID DISPERSION

Onkar Satish Randive*[1], Prof. Priya Daindade[2], Dr. Tushar T. Shelke[3]

[1]Student, Department of Pharmacy, Genba Sopanrao Moze Collage of Pharmacy, Pune, Maharashtra, India.

[2]Guide, Department of Pharmacy, Genba Sopanrao Moze Collage of Pharmacy, Pune. Maharashtra, India.

[3]Principal, Genba Sopanrao Moze Collage of Pharmacy, Pune. Maharashtra, India.

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***Corresponding Author: Onkar Satish Randive**
Student, Department of Pharmacy, Genba Sopanrao Moze Collage of Pharmacy, Pune, Maharashtra, India.

ABSTRACT

Solid dispersion is a useful technique for increasing the rate at which poorly water-soluble medications dissolve and, consequently, their bioavailability. This study will concentrate on different techniques for preparing solid dispersions. Pharmaceutical excipients that are used to formulate solid dispersions come in a wide variety of hydrophilic and hydrophobic carriers. The different synthetic, natural, semisynthetic, and modified natural hydrophilic carriers that are used to formulate solid dispersions are summarised in this review.

KEYWORDS: Solubility; Solid dispersion; Bioavailability; Eutectic mixtures; Lyophilisation.

INTRODUCTION

The oral route of drug administration is the most widely used delivery method, because it is convenient and simple to consume for a patient, swallowing a dosage form is a familiar and comfortable way to take medicine. Because of this, oral medication is usually more effective than other routes of administration, such as parenteral, in terms of patient compliance and, consequently, drug treatment.

It has been shown that a variety of solid dispersion systems can enhance the dissolution characteristics of medications that are not very soluble in water. When creating oral delivery systems for medications that are not very water soluble, the use of solid dispersions in drug formulation provides a range of processing and excipient options that provide flexibility.

The drugs are divided into four subclasses by the Biopharmaceutical Classification System (BCS) based on permeability and solubility. Drugs belonging to BCS classes II and IV have poor solubility issues. Improving the solubility of these BCS II and IV belonging drugs is the most difficult task. Solid dispersion, particle size reduction (Micronization and Nanonization), salt formation, pH alteration, polymorph and pseudo-polymorph formation, complexation method, surfactant, and co-solvent are some of the methods used for this purpose. However, among these methods, solid dispersion is simple and produce highly accurate results for improving solubility.

The carrier dissolves and the drug disappear as small colloidal particles when the solid dispersion is exposed to aqueous media. This increases the dissolution rate's surface area and, consequently, the bioavailability of drugs that are not very water soluble. By increasing the porosity and decreasing the size of the particles, the drug in a soluble hydrophilic carrier increases the rate of dissolution. Therefore, it is possible to increase these drug's bioavailability and decrease side effects by improving their drug release profile.

Solid dispersion

The dispersion of one or more hydrophobic active ingredients in a hydrophilic inert carrier in a solid state created by melting (fusion), solvent, or melting solvent method is known as solid dispersion. A hydrophilic matrix and a hydrophobic drug combine to form the final product; the matrix can be crystalline or amorphous, with amorphous materials generally being more soluble than crystalline ones.

Classification of solid dispersion on the basis of recent advancement

Depending on the molecular arrangement, solid dispersions can be of the following types:

- Eutectic mixtures:

Solid eutectic mixtures are usually prepared by rapidly cooling the co-melt of the two components in order to obtain a physical mixture of very fine crystals of the two components.

- Solid solutions:

Depending on the miscibility, the two types of solid solutions are

Continuous solid solutions

In continuous solid solutions, the components are miscible in all proportions i.e. the bonding strength between the components is stronger than the bonding between the individual component.

Discontinuous solid solutions

In discontinuous solid solutions, the solubility of each of the component in the other component is limited in nature.

Depending on the distribution of the solvates in the solvendum, solid solutions can be of two types:

- Substitutional crystalline solution

These are those solid solutions which have a crystalline structure, the solute molecules substitute for the solvent molecules in the crystal lattice.

- Interstitial crystalline solid solution

These are those solid solutions in which the dissolved molecules occupy the interstitial spaces between the solvent molecules in the crystal lattice.

Amorphous solid solutions

In amorphous solid solutions, the solute molecules are dispersed molecularly but irregularly within the amorphous solvent.

Glass solutions and glass suspension

A glass solution is a homogenous system in which the solute dissolves in the glassy solvent. The glassy state is characterised by transparency and brittleness below the glass transition temperature. The term glass refers to a pure chemical or a mixture of pure chemicals in the glassy state.

Classification of solid dispersion on the basis of recent advancement:

1. First generation solid dispersion:

Sekiguchi and Obi used the idea of eutectic mixtures to describe solid dispersions for the first time in 1961. They said that the creation of eutectic mixtures increases the bioavailability of poorly soluble drugs by improving the rate of drug release. Crystalline carriers were used to create these solid dispersions. Sugars and urea are two examples of crystalline carriers that are used. The primary drawback of first generation although solid dispersions have good thermodynamic stability, their crystalline nature makes them less soluble than amorphous forms.

2. Second generation solid dispersion:

In the second generation, amorphous carriers were used instead of crystalline ones to disperse drugs, which are usually polymers. It was discovered that second-generation solid dispersions were more efficient than first-generation solid dispersions because of their thermodynamic

stability. The primary problems with second generation solid dispersions are drug precipitation and recrystallization, which affect drug release in vitro or in vivo.

The polymeric carriers are divided into two groups:

- Synthetic polymer – povidone, polyethylene glycols and polymethacrylates.
- Natural Polymer – hydroxypropylmethylcellulose, ethyl cellulose, starch derivatives like cyclodextrin.

3. Third generation solid dispersion :

Solid dispersion surfactants of the third generation employ a polymer mixture or a carrier. If the carrier has surface-active or self-emulsifying properties, it can improve the dissolution profile of poorly soluble drugs, increasing their bioavailability. The chemical and physical stability of the solid dispersion is enhanced by avoiding nucleation and agglomeration. Examples of these carriers are inulin, Gelucire, poloxamer, etc.

4. Fourth generation solid dispersion :

Controlled release solid dispersions are another name for these types of dispersions. It contains a medication in a short biological half-life and poor water solubility. Either water-soluble or water-insoluble carriers are used.

Solid dispersion techniques

1. Melting method.
2. Solvent methods.
3. Melting solvent method (melt evaporation).
4. Melt extrusion methods.
5. Kneading technique.
6. Melt agglomerations Process.
7. Electro spinning.
8. Super Critical Fluid (SCF) technologies.
9. Spray Drying.
10. High-pressure homogenization.
11. Polymeric alteration.
12. Lyophilisation techniques.

1. Melting method

This method involves directly heating the drug and hydrophilic carrier mixture until it melts. After that, the melted mixture is vigorously stirred on an ice bath to rapidly solidify it. Crushed, ground, and sieved is the final solid mass.

The advantages of this method are:

- Simplicity
- Economy

The disadvantages of this method are

- When the drug and carrier are compatible and mix well at the heating temperature is this method used.
- When the drug-carrier miscibility changes, this method may cause phase separation while cooling.
- At high temperatures, a variety of substances, including drugs and carriers, may break down during the fusion process.

2. Solvent methods

Preparing a solution with the drug and a hydrophilic carrier is the first stage in the solvent method. In order to create a solid dispersion, the solvent or solvents must be completely removed in the second step, because organic solvents evaporate at relatively low temperatures.

This method has the advantage of preventing the thermal breakdown of medications or carriers.

3. Melting solvent method

This technique involves dissolving the medication in a suitable solvent, then immediately adding the solution to the polyethylene glycol melt. The melt is then evaporated until a clear, solvent-free layer is left behind. The film is further dried to preserve its weight. This process offers unique advantages from both solvent fusion and evaporation.

Additionally, the liquid solvent used may affect the drug's polymorphic form, which precipitates as a solid dispersion. Practically speaking, it works best with drugs that have high

melting points or are thermo labile and it is only useful for drugs with low therapeutic doses, such as less than 50 mg.

4. Melt extrusion methods

The drug and carrier are first combined at melting temperature for a short period of time, and then they are extruded at a high rotational speed using a corotating twin-screw extruder. Before being extruded and formed into tablets, granules, pellets, sheets, sticks, or powder, the drug-carrier mixture is melted and homogenised all at once. The intermediates can then be processed further to create regular tablets.

Because the drug-carrier mix is only exposed to a high temperature for about a minute, the melt extrusion method has the significant benefit of processing medications that are somewhat thermo labile. The dispersions always contain 40% (w/w) of the drug. To get rid of particles bigger than 355 μ, samples are ground in a cutting mill for one minute and then sieved.

5. Kneading technique

In order to create a solid dispersion, the drug and polymer carrier are triturated with a small amount of a solvent to create a thick, dough-like paste. The drug is then made more soluble and frequently amorphous by kneading this paste for a predetermined amount of time, which improves the interaction between the ingredients. The final solid dispersion product is obtained by pulverising and sieving the mixture after it has been kneaded and dried, usually in an oven or by air drying.

6. Melt agglomerations Process

The process of melt agglomerations uses a binder as a carrier. Solid dispersing can be prepared in two ways: first, by spraying the drug onto melted binder plus excipients; second, by melting the binder drug and excipient above the binder's melting temperature. It may be better to use a rotary process to control temperature when using a high binder content.

This method works well for uniform drug mixing, but finer particles cause mass adhesion and larger particles cause densification.

7. Electro spinning Method

Using a millimetre-scale nozzle, a polymeric fluid stream solution or melt is delivered to create solid fibres. A conductive capillary attached to a reservoir holding a polymer melt or

solution and a conductive collection screen is subjected to a strong electrostatic field. Because it is the simplest and least expensive method, it can be used in the future to prepare solid dispersions and has great potential for creating Nano fibres and regulating the release of biomedicine.

8. Super Critical Fluid (SCF) technologies

This method uses carbon dioxide as a solvent for the organic solvent but as an anti-solvent for the solute. The drug particles may recrystallize at significantly smaller particle sizes after becoming soluble in SCF. Drug particles can be micronized within a limited range of particle sizes, frequently to sub-micron levels, thanks to the flexibility and accuracy provided by SCF processes. SCFs are appealing for pharmaceutical research because of their low operating conditions (temperature and pressure).

9. Spray Drying

The required amount of carrier is dissolved in water, and the drug is dissolved in a suitable solvent. After that, solutions are mixed using sonication or another appropriate technique to create a transparent solution, which is subsequently spray-dried with a spray dryer.

10. High- pressure homogenization

A drug powder is dissolved in an aqueous surfactant solution and then passing through a high-pressure homogeniser to create Nano suspensions. The drug can be broken down from micro particles to nanoparticles by the cavitation force that is experienced.

The hardness of the drug substance, the processing pressure, and the number of cycles all affect the particle size. However, this method may only break up brittle drug candidates into nanoparticles.

11. Polymeric alteration

Different crystalline forms of a drug that may have different properties are known as Polymorphs. Polymorphs may differ in physicochemical properties such as physical and chemical stability, shelf-life, melting point, vapour pressure, intrinsic solubility, dissolution rate, morphology, density and biological activities as well as bioavailability.

12. Lyophilisation techniques

During lyophilisation, mass and heat are moved to and from the product being made. This technique was proposed as an alternative to solvent evaporation. The drug and carrier are co-

dissolved in a common solvent, frozen, and sublimed to produce a lyophilised molecular dispersion. We call this process lyophilisation.

Evaluation of physicochemical properties of solid dispersion:

1. Phase Solubility Study

The shaking flask method is used to conduct this study in the presence of a polymer (carrier). Most of it is carried out in accordance with Higuchi and Connors. 25 millilitres of a polymer solution containing 1%, 2%, 3%, 4%, and 5% is used to dissolve the drug. For 48 hours, the sample is stored at 37 °C to 0.5 °C in an orbital flask agitator. A UV spectrophotometer is then used to filter and analyse the sample in order to determine the drug's concentration.

2. Saturation Solubility Study

Batches of drugs and solid dispersions are added in excess to 25 millilitres of distilled water until it reaches super saturation. After that, it is kept at 37 °C +/- 0.5 °C for 48 hours in an orbital flask shaker. After that, it is kept at 37 °C +/- 0.5 °C for 48 hours in an orbital flask shaker.

3. Drug content

A UV spectrophotometer is used to determine the drug content after a known amount of solid dispersion is dissolved in a solvent. The following formula is used to calculate the percentage of drug loading and entrapment efficiency:

% Drug loading = (Weight of drug in solid dispersion powder) / (Weight of solid dispersion powder) X 100.

Characterization of Solid dispersions:

There are numerous methods for contributing data on the physical characteristics of solid dispersion systems**.** The enhanced dissolution of inadequately water-soluble pharmaceuticals in solid dispersions can be demonstrated using standard dissolution techniques.

1. Fourier Transform Infrared Spectroscopy (FT-IR) :

Drug-polymer (carrier) compatibility studies are primarily characterised by FT-IR. Its primary use is in the investigation of drug-polymer interactions in solid states. Crystalline structure is indicated by sharp vibrational bands.

2. Differential Scanning Calorimetric (DSC) :

It is an effective method for researching amorphous material. It can also identify exothermic and endothermic peaks. On the basis of melting point, it also determines whether or not the drug has been absorbed into the polymer (carrier).

3. Powder X-ray Diffraction (PXRD) :

This technique is mostly useful for determining the crystalline or amorphous nature of solid dispersions. More crystalinity is indicated by a sharper peak. Compound identification and complex formation are aided by the diffraction technique.

4. Scanning electron microscopy :

This technique is used to describe the shape of particles.

Applications of Solid Dispersions

1. To make poorly soluble drugs more soluble in order to improve their absorption, bioavailability, and rate of dissolution.
2. To protect unstable drugs from decomposition processes such as hydrolysis, oxidation, recrimination, isomerisation, photo oxidation, and others.
3. To reduce some medications' adverse effects.
4. They cover up the disagreeable taste and odour of drugs.
5. Improved drug release from gels and ointment creams.
6. To prevent clear of unwanted incompatibilities.
7. To distribute a small number of solid-form medications uniformly.
8. To produce a sustained-release dosage form of a fast-release primary dose.
9. To decrease the pre-systemic inactivation of medications such as progesterone and morphine.
10. For administering gaseous or liquid substances in a solid dosage (up to 10%).

CONCLUSION

Solid dispersion is a useful method for improving or controlling the release profiles of pharmaceutically active substances; it is frequently quick, easy, and economical, and it may be able to solve the problem of poorly soluble substances. These carriers may come from natural sources or synthetic ones. Melt or solvent evaporation techniques were typically used to create solid drug dispersions. These carriers may come from natural sources or synthetic ones. A number of carriers remain unexplored to this day. In order to improve solubility, research on such carrier materials should be conducted.

REFERENCES

1. Amidon GL, Lennernas H, Shah VP and Crison JR (1995). Theoretical basis for a biopharmaceutical drug classification: the correlation of in vitro drug product dissolution and in vivo bioavailability. Pharm Res., 12(3): 413-420

2. Lobenberg R, Amidon GL. Modern bioavailability, bioequivalence and biopharmaceutical classification system. New scientific approaches to international regulatory standards. Eur J Pharm Sci. 2000, 50(1):3–20.
3. NChaudhary A, Nagaich U, Gulati N, et al. Enhancement of solubilization and bioavailability of poorly soluble drugs by physical and chemical modifications. J Adv Pharm Technol Res. 2012, 2(1):32–67.
4. Savjani K, Gajjar A, Savjani J. Drug solubility: Importance and enhancement Technique. ISRNP. 2012, 1-10.
5. Jansens S, Mooter GV. Review: physical chemistry of solid dispersions. J Pharm Pract. 2009, 61(12):1571–1586.
6. Singh et al, A review on solid dispersion, IJPLS, 2011, 2(9), 1078-1095
7. Yamashita K, Nakate T, Okimoto KA, et al. Establishment of new preparation method for solid dispersion formulation of tacrolimus. Int J Pharm. 2003, 267:79–91.
8. Dixit et al, A review- solid dispersion,2014, World Journal of Pharmacy and Pharmaceutical Sciences, 3(9), 238- 257
9. Arunprasad K, Narayanan N, Rajalakshmi G. Preparation and Evaluation of solid Dispersion of Terbinafine Hydrochloride. IJPSRR. Aug 2010, 3: 130- 134
10. Sun D, JuT, Lee P. Enhanced kinetic solubility profiles of indomethacin amorphous solid dispersions in poly(2- hydroxyethyl methacrylate) hydrogels. Eur J Pharm Biopharm. 2012: 81: 149-158.
11. Dhirendra K, Lewis S, Udupa N, et al. Solid Dispersions: A Review. Pak J Pharm Sci. 2009, 22(2):234–246
12. Lobenberg R, Amidon GL. Modern bioavailability, bioequivalence and biopharmaceutical classification system. New scientific approaches to international regulatory standards. Eur J Pharm Sci. 2000, 50(1):3–20.
13. Blagden N, Gavan P, York P. Crystal engineering of active pharmaceutical ingredients to improve solubility and dissolution rates. Adv Drug Del Rev. 2007, 59(30):617–630.
14. Leuner C, Dressman J. Improving drug solubility for oral delivery using solid dispersions. Eur J Pharm Biopharm. 2000, 50(1):47–60.
15. Pandey M, Jaipal A, Charde S, Goel P, Kumar L. Dissolution enhancement of felodipine by amorphous nanodispersions using an amphiphilic polymer: insight into the role of drug-polymer interactions on drug dissolution. Pharm Dev Technol. 2015, 1-12.
16. Rao M, Mandage Y, Thanki K, Bhise S. Dissolution Improvement of Simvastatin by Surface Solid Dispersion Technology. Dissolution Technologies. 2010, 27- 34.

17. Sareen S, Mathew G, Joseph L. Improvement in solubility of poor water-soluble drugs by solid dispersion. Int J Pharma Inv. 2012, 2: 12-17.