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Solid Dispersion: Pharmaceutical Technology for the Improvement of Various Physical Characteristics of Active Pharmaceutical Ingredient

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Abstract: More than 60% of new chemical entities discovered by the pharmaceutical industry suffer from poor water solubility. The poor solubility or lipophilic nature of most of the compounds discovered by the pharmaceutical industry today is the main problem. Due to this reason various pharmaceutically potent products not reaching the market. Solid dispersions are used for the improvement of solubility and oral bioavailability of poorly water-soluble drugs. This approach is a very beneficial for poorly water soluble drugs to improving the release rate and hence the oral bioavailability. Nowadays, the poor water solubility or swelling nature of a wide variety of polymers has the benefit of controlled release dosage forms through solid dispersion system. The main benefit of solid dispersion is simplicity of manufacturing and scale up processes. In this review article, it is intended to discuss the various advantages and disadvantages of solid dispersion and it compile some preparation techniques. Classification of solid dispersions on the basis of release mechanisms has been highlighted.

Key words: Solid dispersions · Solid solution · Solubility enhancement · Bioavailability

INTRODUCTION

Oral route is the most common route of drug administration due to ease of ingestion and convenience in self administration as compared with other routes [1, 2]. Although the oral route is preferred over other routes (such as parenteral route), but for many drugs it is inefficient mode of delivery. The reason for this may be the poor-water solubility of drug. As a result of which poor bioavailability is the major problem when an active agent (poor water-soluble) deliver via oral route [3-5]. When an active agent is administered by oral route, initially it dissolve in gastric and/or intestinal fluids then there is partitioning of agent between the fluid and membranes of the GI tract which results in the entry into the systemic circulation. Therefore, for poorly aqueous soluble drugs; dissolution is the rate-determining step and further drug with poor permeability; will show permeation rate limited absorption. To overcome such types of problem various solid dispersion systems have been demonstrated in literature to enhance the dissolution properties of poorly water-soluble drugs. Other methods, such as use of surfactant, salt formation, metastable polymorph, solid deposition, complexation with cyclodextrins and micronization are also utilized to enhance the rate of dissolution of such type of drugs. But these approaches may suffer from some disadvantages whereas as solid dispersions offers more of excipient and processing options that allow for various flexibility during formulation of oral dosage form for poorly water-soluble drugs. Reduction in the particle size of a drug may increase the rate of absorption of drug having dissolution rate limited GI absorption or for drugs with poor water solubility. The reduction in particle-size can be achieved by [6]:

- Grinding and trituration;
- Ball milling;
- Fluid energy milling;
- Precipitation in controlled fashion by changing temperature or solvents;
- Ultrasonic waves;
- Spray drying

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For the first time, Sekiguchi and Obi, in 1961 demonstrated the use of solid dispersion in reduction of the particle size and hence enhances the rate of dissolution and absorption.

Solid Dispersion: When one or more active ingredients are dispersed in a carrier matrix (which are inert) at solid-state, prepared by melting-solvent method or fusion method, is known as solid dispersion [1]. The term solid dispersion refers to products composed of a hydrophobic drug and a hydrophilic matrix. They are generally represented as amorphous products but the form of drug can be either amorphous or crystalline. To stabilise the solid dispersion formulation surfactants can be used so as to remove the problem of drug recrystallization and thus enhancing their solubility [7]. In general, the solute is poorly water-soluble drug which act as guest whereas the solvent used in solid dispersion is water-soluble compound that act as carrier. There is an influence of the nature of carrier on the release/dissolution characteristics of the dispersed drug. It has been found that release of drug from the matrix is faster when a water-soluble carrier is used whereas water-insoluble carriers show a slower release of the drug from the matrix. The reason for fast rate of dissolution is the solute being present as a molecular dispersion and due to its high surface area [8].

Advantages:

- Solid dispersions are used for the improvement of the bioavailability of poorly water-soluble drugs [1, 8, 9].
- Enhance the dissolution of drug [9].
- Reduce presystemic metabolism this may be due to carrier inhibit the enzyme responsible for biotransformation of the drug.
- Through use of the solid dispersions, the liquid form of the drug can be transformed to the solid form.
- Easier to produce [7].
- Solid dispersions are in solid state hence preferred by patients as compared to the solubilisation products, as solubilisation products are in liquid state [10,11].
- Solid dispersions are better than other particle size reducing techniques to enhance the solubility, because the other size reduction technique reduces the size to a limit approximately 2–5 ìm which does not cause enough enhancement in drug solubility or drug release in the small intestine [12] and to improve the bioavailability [10,11,13].
- The problems of solid powder such as less size of particle shows poor mechanical properties (include high adhesion and poor flow properties) can be overcome by use of solid dispersions [11,12].
- The equipments involved in the preparation are available at small and large scale.
- There are various carriers which can act as “solid” solvent.
- The extended-release solid dispersion can also be prepared [14].

Disadvantages: There are few disadvantages of solid dispersions such as-

- Poor stability is a major disadvantage of solid dispersion. The amorphous state of a drug may undergo crystallization [15-18].
- Aging may decrease the dissolution rate and there may be changes in crystallinity.
- Due to tackiness in some solid dispersions leads to handling problem.
- Solid dispersions may be deteriorated in presence of moisture and excessive temperature. The presence of moisture influences the crystallinity of the drugs [18, 19]. Some polymers used in the solid dispersion are hygroscopic in nature and may absorb moisture, that may result in the crystal growth or the amorphous form may be convert to crystalline state. Some time the metastable form of drug may be change to stable form. Hence, there may be decrease in solubility and dissolution rate [16, 20].
- There is difficulty in understanding the physical structure of solid dispersions.
- It is also difficult to understand relation between structure of drug and its release from solid dispersion.
- There may be a problem of solvent residue.

Reasons for improvement in the solubility of drug using solid dispersion technique: There are various reasons include-

Reduction of Particle Size of Drug: Solid dispersions are used to reduce the particle size of drug. Solid dispersions create a dispersion of poorly water-soluble drug in hydrophilic carriers. As there is high surface area, due to which there may be increased rate of dissolution and further bioavailability get enhanced [21, 22].

Enhance Porosity of Drug Particle: In solid dispersions, a high degree of porosity may present in drug particles. The properties of carrier may influence the porosity of drug particles; for example when polymers having linear structure are utilized leads to produce larger and more porous particles as compared with solid dispersions that contain reticular polymers. More porous the particle, result in a higher dissolution rate [23, 24].

Improved Wetting of Drug Particles: If the drugs have good wetting properties then its solubility may be better [11]. In some studies it was found that carrier like urea [25], which are not having any surface activity may improve drug wettability. Cholic acid and bile salts are the example of carriers with surface activity [26, 27].

Amorphous State of Drugs: To break the crystal lattice of an amorphous drug during the dissolution process there may be less requirement of energy [28].

Techniques of Preparation: The various preparation methods are as follows-

Melting Method: In this method specific amount of a drug and a water-soluble carrier are used to prepare a physical mixture. Subsequently physical mixture is heated directly until it melts further mixture is cooled using ice bath under continuous stirring. Finally the prepared solid mass is crushed, pulverized, and sieved [1]. The polymers used to prepare the solid dispersion by melting method are Poly (ethylene glycol) and poly (vinyl pyrollidone). Note that to get rapid solidification, the molten mass is poured on a stainless steel plate and flowing air. Simplicity and economy are advantages of this direct melting method. The disadvantage of this method can include formation of an inhomogeneous solid dispersion [29]. Use of surfactant can prevent such type of condition [30, 31]. Another problem is that when cooling is performed at faster rate than there may be chances of yielding solid dispersions which are amorphous [32, 33].

Hot Melt Extrusion Method: In this method extruder is utilized for intense mixing of the components. The components of extruder are hooper, barrel, a kneading screw, heating jacket and a die. Generally physical mixture of both carrier and drug is introduced into the hopper then passed through screw and finally it is extruded from the die [34]. The advantage of this method is to get various shapes and designs of the heated drug-matrix mixture into ophthalmic inserts, implants, or oral dosage forms [35]. Other advantages like continuous production of solid dispersions are possible so that large-scale production can easily acheived. The product produced by this technique can be easily handled because any shape can be adopted. Like other methods, miscibility of drug and matrix also create a problem. Thermolabile compounds may be degraded due to production of heat generation in the extruder [36].

Solvent Method: In this method solid dispersions are prepared by dissolving two solid components (a guest and a carrier) in a common solvent further solvent is removed by evaporation at lower temperature under vacuum [1]. The advantage of this method is that use of low temperature prevents thermal decomposition of drugs or carriers; however this method suffers from some disadvantages such as higher cost of preparation.

Melting-Solvent Method: In this method generally drug is dissolved into suitable liquid solvent and further added to melted media such as PEG [1].

Spray Drying: In this method drug and carrier are dissolved in an organic solvent and spray drying is carried out to obtain dried mass. The dried product is crushed, pulverized & sieved through a suitable sieve. The product is stored in desiccated environment until packaging [34, 17]. Generally sticky mass is produced in this process [38].

Particle Size Reduction Method: The various methods of particle size reduction include spray drying and comminution. The limitations of method include physical stress during comminution may degrade the drug product especially for thermo-sensitive or unstable active compounds [34].

Kneading Method: Mixture of drug and carrier is prepared in a mortar and moisten with methanol. Moisten mass is kneaded for 30 minutes and dried under vacuum for 24 hours. The powder so produced is passed through sieve no. 60 and stored in desiccators.

Biopharmaceutical Classification System (BCS): In this classification, drugs are categorized (on the basis of aqueous solubility and membrane permeability) into four classes i.e. Class I, Class II, Class III and Class IV. The drugs with low aqueous solubility and high membrane

permeability are termed as Class II drugs. Thus, for improving the absorption and bioavailability of drugs (especially BCS class II drugs) solid dispersion technologies are considered most promising technique.

	Permeability	
Solubility	High	Low
High	Class I Propanolol Metoprolol Diltiazem	Class III Cimetidine Acyclovir Captopril Ranitidine
Low	Class II Mefanimic acid Ketoconazole Nifedipine Naproxen Carbamazepine	Class IV Taxol Cefuroxime Tobramycin Furosemide Clorthiazide

Classification and Fast-release Mechanisms: On the basis of release mechanisms the various systems of solid dispersions can be classified and discussed in the following six groups [1]:

- Solid solutions;
- Simple eutectic mixtures;
- Glass solutions and glass suspensions;
- Compound or complex formations between the drug and the carrier;
- Amorphous precipitations of drug in a crystalline carrier and
- Any combinations among Groups 1-5.

Solid Solutions: A solid solution can be prepared by dissolving a solid solute in a solid solvent. Solid solutions are also known as a mixed crystal. In a comparison of dissolution rate between the solid solution and eutectic mixture of a poorly soluble drug; it was founded that the drug in solid solution as compared to the eutectic mixture achieves a faster dissolution rate. The reason for this, the size of the drug particle reduced to its molecular size in the solid solution [38].

Continuous Solid Solution: In this, method both the components are mixed to each other to obtain miscible solid state. The reason may be that the strength of bonding between the molecules of each of the individual components is weaker than the strength of bonding between the two components. The soluble carrier presents in the crystal lattice of drug that may result, in faster dissolution rate as compared to the pure compound [1].

Discontinuous Solid Solution: In this the solute have limited solubility in solid solvent [1].

Substitutional Solid Solution: In this type of solid solution the solute molecule act as an substitutes (in the crystal lattice of solid solvent) for the solvent molecule. Continuous or discontinuous solid solution can be prepared by this method. As possible the size of solute and solvent are of similar dimension [1].

Simple Eutectic Mixtures: Eutectic mixtures are prepared by fusion method. In this method fused liquid of two components are rapidly solidify. The reason contributing to the faster rate of dissolution of a drug dispersed in the eutectic includes [1]:

- An increase in drug solubility may occur due to increase in specific surface area (as there is reduction of particle size).
- As the carrier surrounds the drug particle, and when it come in contact with fluid the carrier dissolve in a short time and drug get permeate through the GI membrane.
- Absence of agglomeration and aggregation between the particles of hydrophobic drug. An aggregate of particle is said to be formed when strong inter- and intramolecular or atomic cohesive forces are involved in the particle assembly, whereas when relatively weak cohesive forces are involved for gathering of two or more particles, it is known as agglomerate. During processing operations or handling an electrostatic surface charge may be generated on particles; this may be involved in bringing particles together.
- Excellent wettability because the soluble carrier encircled each single crystallite of the drug, so that the carrier gets rapidly dissolves and result in the intimate contact of drug with the water.

Glass Solutions and Glass Suspensions: In a glass solution, the solute dissolves in a glassy solvent. Either a pure chemical or mixtures of chemicals are described by the term “glass” [1]. Below glass transition temperature the transparency and brittleness are determined to characterize the glassy state. Citric acid, dextrose, galactose, sucrose, PVP, PEG, urea and sucrose are used as carrier to form glass solutions [39].

Compound or Complex Formations: For the solid dispersion of poorly soluble drugs the ideal hydrophilic carriers may be used; but the implication of the possibly occurring complexation or chealation reactions should not be overlooked [1]. The pharmacological action of various drugs such as prostigmine, novocaine, penicillin, hexobarbital, hexylresorcinol and quinine may be retarded by polyvinylpyrrolidone.

Amorphous Precipitations in a Crystalline Carrier- In this method drug may be precipitate out in an amorphous form in the crystalline carrier. It have been postulated that in presence of a carrier, the drug with high supercooling property has more tendency to solidify as an amorphous form [1].

Some recent patents on solubility enhancement using solid dispersion techniques are shown in given table:

Patent No.	Author Name	Work	Reference
5456923	Nakamichi, Izumi, Kouichi, Hiroyuki, Shogo	They prepared solid dispersion by employing twin-screw extruder technique. According to them a solid dispersion can be produced without heating a drug and a polymer to their melting points or beyond thier melting point. Also they can be produced without using an organic solvent for dissolving both components. They suggested that the resulting solid dispersion show good characteristics.	40
6956043	Guitard, Patrice, Haeberlin, Barbara, Link, Rainer, Richter, Friedrich	They invent oral pharmaceutical compositions comprising a macrolide (rapamycin or ascomycin) in solid dispersion.	41
6677362	Ghebre-sellassie, Isaac, Reisch, Robert, Parikh, Fawzi, Mahdi B, Nesbitt, Russell U.	They produced solid dispersion by using polyvinylpyrrolidone as carrier. In their work without using organic solvents or melting temperatures (fusion), they combine polymer with drug. But polyethylene glycol is employed as a transition compound, which act by plasticizing the polymer or partially solubilizes the drug.	42
6753330	Takano; Niichiro ; Kawashima; Hiroyuki ; Shinoda; Yasuo ; Inagi; Toshio	Their invention provides a solid dispersion composition containing hydroxypropylmethyl cellulose (carrier), 2-benzyl-5-(4-chlorophenyl)-6-[4-(methylthio) phenyl]-2H-pyridazin-3-one and polyoxyethylene polyoxypropylene glycol.	43
20090143423	Rudolf Schroeder, Tanja Heitermann	According to them in solid dispersion product at least one N-aryl urea-based pharmaceutically active agent is to be present.	44
0580860	Nakamichi, Izumi	They invent a process for producing a solid dispersion of a drug dissolved or dispersed in a polymer, characterized by employing a twin-screw extruder being equipped with paddle means.	45

Some of the marketed formulations prepared using solid dispersion techniques are given in below table:

Product Name	Drug	Dosage	Dose (mg)	Company
Grispeg	Grisefulvin	Tablet	250	Pedinal Pharm Inc.
Cesamet	Nabilone	Tablet	300	Eli Lilly
Sporanox	Itraconazole	Tablet	250	Janssen
Rezulin	Troglitazone	Tablet	200	Pfizer
Kaletra	Lopinavir	Capsules, Tablet	250	Abbott

Studies on Solid Dispersion: Maulvi *et al* prepared solid dispersion of aceclofenac using Avicel 200 and Sylysia 350 as polymers, in different ratios. They prepared solid dispersion by employing kneading method. In their studies they found that there was low *in vitro* dissolution rate of pure aceclofenac as compared to dissolution rate of aceclofenac from solid dispersion which was significantly higher. The nature and amount of polymer used in solid dispersion affect the dissolution rate of the drug. They found there was high dissolution rate of Avicel 200-aceclofenac solid dispersion as compared to that of Sylysia 350-aceclofenac solid dispersion. Finally they recommend that to improve the dissolution profile of aceclofenac, solid dispersion technique can be used [46].

Alfred *et al.* studied the influence of hygroscopicity of polymer on phase behaviour of amorphous solid dispersions in the presence of moisture. In their studies, before and after exposure to high relative humidity drug-polymer miscibility were measured using infrared spectroscopy and differential scanning calorimetry. They select poly(vinylpyrrolidone-*co*-vinyl acetate), polyvinyl pyrrolidne and hypromellose acetate succinate as polymers in their studies. The drugs such as indomethacin, felodipine, pimozide, indomethacin, and quinidine were selected. In some preparation such as felodipine-poly(vinylpyrrolidone-*co*-vinyl acetate), quinidine-polyvinylpyrrolidne, pimozide-poly(vinylpyrrolidone-*co*-vinyl acetate), pimozide-hypromellose acetate succinate, and quinidine-

poly(vinylpyrrolidone-*co*-vinyl acetate) systems they found moisture-induced drug-polymer demixing. But moisture-induced drug-polymer demixing was absent in the other hypromellose acetate succinate dispersions. After investigation they proposed that a less hygroscopic polymer with strong polymer-drug interactions will be less prone to moisture-induced phase separation [47].

Lim *et al.* prepared solid dispersion of l-sibutramine by employing a spray drying technique using hydrophilic polymers such as hydroxypropyl methylcellulose, citric acid and gelatin. They investigate the thermal characteristics, solubility and crystallinity of solid dispersions. They compared dissolution of Reductil (a sibutramine hydrochloride monohydrate-loaded commercial product) with sibutramine base-loaded solid dispersion. In their studies they founded that there was higher solubility of solid dispersions prepared with gelatin, irrespective to the amount of polymer. The highest solubility of 5.03+/-0.24 mg/ml was observed in the solid dispersion consist of sibutramine base/ gelatin/ hydroxylpropyl methylcellulose/ citric acid at the weight ratio of 1/0.8/0.2/0.5. In above study they found following carrier citric acid, hydroxylpropyl methylcellulose and gelatin enhance solubility of sibutramine base when delivered as solid dispersion form [48].

Rahman *et al.* prepared risperidone-loaded solid dispersion using methyl-â-cyclodextrin as carrier by employing solvent evaporation method. For a faster release of drug they incorporate solid dispersion of drug into orally disintegrating tablets. They used D-mannitol or galenIQ™-721 as diluent and superdisintegrant (Kollidon ® or sodium starch glycolate) in prepration of tablets. They observed that formulation containing galenIQ™-721 and sodium starch glycolate show increased disintegration time whereas this time decreased for formulation containing mannitol and Kollidon ® [49].

R Marinella *et al.* prepared a fast dissolving inulin-based solid dispersion tablet of TMC240 (a poorly soluble agent and HIV protease inhibitor). In a single-dose study conducted in dogs on oral administration of solid dispersion they found improvement in the release pattern of TMC240 from solid dispersion [50].

Varshosaz *et al.* prepared solid dispersions of mesalazine and budesonide with different drug to polymer ratios. They were employed dextran of different molecular weights as carrier. In their study tablets of mesalazine and budesonide were prepared by compressing solid dispersions of drugs. In rats the *in vivo* effectiveness of prepared formulations against acetic acid induced ulcerative colitis were compared to the references (mesalazine and budesonide suspensions) and control (untreated) groups. The results of studies had shown the release of 25% of the drug in the first 6 hours and100% in caecal contents when solid dispersion of budesonide with dextran (molecular weight 10,000) in the ratio of 1:7 were administered. They founded there was an improvement in inflammatory signs of induced ulcerative colitis in rat [51].

Badry *et al.* prepared and characterized solid dispersions of indomethacin. Indomethacin is a non-steroidal anti-inflammatory drug, which is water insoluble. They prepared solid dispersion of drug with carrier Gelucire 50/13 and polyethylene glycol 4000 by employing hot melting method by using drug to polymer ratios of 1:1, 1:2 and 1:4. They were examined the physical state of the drug through scanning electron microscopy, differential scanning calorimetry and X-ray powder diffractometry. They found that there were 4-folds or 3.5- folds enhancement in the drug solubility when the highest ratios of the polymer (1:4) in case of solid dispersion of indomethacin-polyethylene glycol or indomethacin-Gelucire, respectively were used. They also suggested that with an increase in amount of polymer, the dissolution rate of indomethacin from its physical mixture or solid dispersion increased with an increasing amount of polymer [52].

Konno *et al.* studied the effect of different types of polymer on the dissolution rate of amorphous felodipine solid dispersions. They formed solid dispersions of felodipine by using poly(vinylpyrrolidone) and hydroxypropyl methylcellulose acetate succinate. On comparison between solid dispersions containing poly (vinylpyrrolidone) and hydroxypropyl methylcellulose acetate succinate, it was founded that hydroxypropyl methylcellulose acetate succinate maintain the high level of supersaturation for longer time, hence resulted in increased dissolution rate of the amorphous solid dispersions [53].

Sun *et al.* prepared the solid dispersion consisting of nimodipine using Plasdone-S630 and Eudragit-E100 as carriers. They were employed hot-melt extrusion method. In their studies they compared dissolution of pure drug and solid dispersion of nimodipine, in which there was enhanced dissolution (about 80% within 30min). In their studies the added nimodipine solid dispersion powder to a mixture of Plasdone-S630 and poly ethylene glycol 400. Nimodipine semi-solid capsules were resulted when nimodipine solid dispersion were transferred to hard hydroxypropyl methylcellulose capsules. They observed

there was increased dissolution from nimodipine semi-solid capsules (about 95% in 20min). They were also conducted a study in dogs for determination of the relative bioavailability of the nimodipine semi-solid capsules (test) and Nimotop (reference). There results showed that between nimodipine semi-solid capsules and Nimotop, there was no significant difference in the areas under the plasma concentration-time curve. But it was indicated that there was faster release of nimodipine from nimodipine semi-solid capsules and the apparent rate of absorption of nimodipine from Nimotop (tmax=3.1h) ($P<0.05$) was markedly slower than that from nimodipine semi-solid capsules (tmax=1.3h), hence nimodipine semi-solid capsules was well absorbed [54].

Janssensa *et al.* prepared solid dispersion of itraconazole with Kollicoat IR® by employing hot stage extrusion method. Kollicoat IR® was a coating polymer for instant releasing of tablets. They found that due to exposure to heat and shear forces during the extrusion process there was increase in the crystallinity of polymer. They found there was increase in the dissolution rate of glassy itraconazole and Kollicoat IR® (20/80, w/w) as compared to that of pure glassy itraconazole [55].

Kim *et al.* prepared felodipine solid dispersion by employing solvent wetting method and poly (vinylpyrrolidone), hydroxyl propyl methyl cellulose, mannitol and sorbitol as carriers. They found negligible changes in rate of dissolution when mannitol and sorbitol were used as carriers. They also founded that there was no influence of amount of ethanol used on dissolution rate of drug [56].

Finia *et al.* prepared solid dispersion of diclofenac by using polyethylene glycol 6000 and Gelucire 50/13 as carriers. They suggested that formation of larger crystals take place when Gelucire 50/13 was used as compared to polyethylene glycol 6000 containing solid dispersion [57].

Urbanetz *et al.* prepared nimodipine solid dispersion using polyethylene glycol 2000 as a carrier. In their studies they give emphasis on the physico-chemical characterisation (differential scanning calorimetry and macroscopic observation) of solid dispersion. They found absence of crystalline drug material in solid dispersions, which was the prerequisite for a high dissolution rate and a remarkable super saturation in the dissolution medium. They recommend some preventive parameters against recrystallisation such as by keeping low relative humidity and shock freezing during preparation of solid dispersion may prevent recrystallisation [58].

Ozawa *et al.* prepared solid dispersions of ethenzamide (water-insoluble drug) and theophylline (water-soluble drug) by using Carbopol as the carrier. They employed two methods, twin screw extruder and organic solvent method for preparation of solid dispersions. In their studies they compared dissolution of solid dispersions obtained by both methods. They found that the solubility of theophylline was reduced where as ethenzamide showed significantly increased in solubility. This was indicating that Carbopol slows the release of theophylline [59].

Chiou *et al.* prepared griseofulvin-loaded solid dispersion and also evaluated dissolution profile of griseofulvin from griseofulvin-succinic acid eutectic mixture. They studied the factors which enhances the dissolution rate of griseofulvin dissolution from its dispersion in succinic acid. In their studies they found that dissolution rates of griseofulvin from solid dispersions was influenced by particle size of drug in solid dispersions of griseofulvin [60].

CONCLUSION

In near future solid dispersions make the commercialization of water-insoluble and poorly water-soluble drugs. In the improvement of dissolution of poorly water-soluble drugs, solid dispersion systems act as an effective tool. In recent years, a great deal of knowledge has been collected about solid dispersion technology, but commercial application of solid dispersion is limited. But various approaches have been used to overcome the stability problem and to prepare the formulation practically feasible. The problems involved in the formulation of dosage forms have been regularly resolved by using a variety of alternative strategies like direct capsule filling and spraying on sugar beads. While there are some hurdles for solid dispersions like preparation cost and poor stability, although there lies a great advantage that is it will improve the mechanical properties of solid powders and hasten the release profile of poorly water-soluble drugs.

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