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Review on Techniques for Solubility Enhancement

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ABSTRACT

Solubility is the process of soluble solids in a liquid phase to provide a uniform system. Solubility is one of the most important parameters for achieving the desired fullness of a drug in the distribution system to reflect the chemical response. Water-soluble drugs usually require high doses to achieve plasma concentration after treatment orally. Groundwater melting is a major problem encountered in the development of new chemical enterprise construction. Any medicine to be absorbed should be present in the form of an aqueous solution in the place of absorption. Water is the preferred component of liquid medicine. Most drugs have a weak acid and a weak base and weak water solubility. A variety of techniques are therefore used to improve the solubility of soluble solvents including micronization, chemical modification, pH adjustment, solid dispersion, mixing, settling, micellar solubilization, hydrotropy etc. solubilizaton techniques for effective absorption and improved bioavailability.

Keywords: Solubility, solubility enhancement, co-solvent, pH, emulsions.

INTRODUCTION

Many methods can be changed to improve the melting of a poor melting tree and improve its natural availability. Common methods used to disperse the drug include micronization, chemical modification, pH adjustment, solid dispersion, mixing, micellar solvent, hydrotropy etc. and construction and development. [1, 2] Any drug to be absorbed should be present in the form of an aqueous solution in place of absorption. [3-6] The term 'dissolve' is defined as the maximum solute value that can be dissolved in a given solvent value. It can also be described in terms of price and quality. On average it is defined as a solute mixture in a solution filled with a certain temperature. In terms of quality, melting can be defined as the automatic interaction of two or more substances to create the same cell dispersion. The perfect solution is when the solute is equal to the solvent. Solubility is expressed in various concentrations such as fractions, percentage, molarity, molality, volume, molecular component. and reducing particle size. Although microemulsions and fusion systems are new methods. Different ways to improve melting are discussed below. [7 - 10]

Techniques for Solubility Enhancement

If the melting of substances in liquid sources is limited, construction methods are needed ahead of time for drug acquisition and remain essential for advanced drug selection and product development.
Various methods have been used in an effort to improve the solubility and solubility of water-soluble drugs, including the following:
a) Particle Size Reduction
b) Nanonization
c) Cosolvency
d) Hydrotropy
e) pH Adjustment
f) Sonocrystallization
g) Supercritical Fluid (SCF) Process
h) Solid Dispersion
i) Inclusion Complexation
j) Self-Emulsifying Or Self-Micro Emulsifying Systems
k) Liquisolid Methods
In these management strategies the company plays a key role in improving melting and dispersing. Polymers, superdisintegrants, surfactants have been widely studied in recent years to improve drug elimination. This part of this review discusses all the technical processes and effects of polymers, superdisintegrants and surfactants in the development of drug elimination while explaining the role and use of cyclodextrins, carbohydrates, hydrotropes, dendrimers, acids and carriers. mixed in promoting drug elimination [11].

(a) Particle Size Reduction [12]

The melting of a tree is usually related to the internal particle size of the tree; as the particles become smaller, the surface area up to the scale becomes larger. The larger surface area allows for greater interaction with the solvent leading to increased melting. Common methods of reducing particle size, such as starting and drying the spray, rely on machine pressure to separate the active component. Reducing particle size allows for an efficient, repetitive, and economical way to improve melting. However, mechanical strengths associated with initiation, such as digestion and digestion, often provide a significant amount of physical stress to a drug product that can cause damage. The heat stress that can occur during spray mixing and drying is also worrying when considering sensitive or unstable active compounds. Using traditional methods of almost soluble drugs may not be able to improve the solubility to the required level. Micronization is another common way to reduce particle size. Micronization increases the level of the excess drug by increasing the surface area, without increasing the melting point. Reducing the particle size of these drugs, which leads to an increase in area, improves the rate of dissolution. Micronization of the drug is performed by grinding techniques using jet mill, rotor stator colloid mills and other micronization methods are not suitable for high-dose drugs because they do not alter drug solubility [13]. These procedures were used in griseofulvin, progesterone, spironolactone diosmin, and fenofibrate. With each drug, the effectiveness of micronization improves its digestive absorption, and consequently its bioavailability and clinical effectiveness. Micronized fenofibrate showed a more than 10-fold increase (1.3% to 20%) in the 30-minute elimination of biorelevant media [14,15].

(b) Nanonization [16]

Recently, various nanonization techniques have been developed that increase the rate of dispersion and the presence of highly soluble drugs in water. Nanonization usually refers to the research and application of materials and structures at a nanoscale level of approximately 100 nm or less. Nanonization can lead to enhanced drug dissociation and pharmacokinetics, and may reduce systemic side effects [17]. In many new chemical companies with very low melting points, the improvement of oral bioavailability by micronization is not enough because the micronized product has a tendency to fuse, leading to a decrease in the active melting point, the next step is nanonization. There are various techniques used in the manufacture of drugs including Wet Milling, Homogenization, Emulsification-solvent evaporation technique, Pear Milling, spray drying etc. There are many examples of drug nanonization.

(c) Cosolvency [18]

The solubility of solvents in water can be increased by mixing it with a soluble solution in water where the tree dissolves easily. This process is known as cosolvency and the solvent used in combination is known as cosolvent. The Cosolvent system works by reducing the surface tension between the aqueous solution and the hydrophobic solute. Also known as solvent mixing. There is a dramatic change in drug dispersion by adding organic co-solvent to water. Cosolvents that receive hydrogen or groups of donors have a small amount of hydrocarbon. The hydrophobic hydrocarbon circuit often disrupts the hydrogen bonding water network leading to reduced intermolecular fluid attraction while hydrophilic hydrogen bonds ensure water solubility.

(d) Hydrotropy

Hydrotropy is a solvent where the addition of a large amount of secondary solute causes an increase in the liquid dispersion of the existing solute. Concentrated aqueous hydrotropic solutions of sodium benzoate, sodium salicylate, urea, nicotinamide, sodium citrate, and sodium acetate have been identified to improve the solubility of many water-soluble drugs.

(e) PH adjustment [19]

Improper solubility in water can be dissolved in water by the conversion of pH. In order to achieve the melting of this process, buffer volume and tolerance of the selected pH are important to consider. Soluble additives that increase the natural pH within the dose form up to a large pKaof the acidic weekly drugs increase the solubility of the drug, those auxiliary substances acting as alkalizing agents may increase the solubility of basic weekly drugs.

(f) Sonocrystallization [20]

The recycling of crystalline crystals using solvents and antisolvents has also been used successfully to reduce particle size. A novel method of reducing particle size on the basis of crystallization using ultrasound Sonocrystallization. Sonocrystallization uses ultrasound power displayed at a frequency of 20-100 kHz crystallization. Not only does it improve the level of nucleation but it is also an effective way to reduce the size and control the size distribution of active pharmaceutical ingredients. Most systems use ultrasound at a frequency of 20 kHz-5 MHz.

(g) Supercritical Fluid (Scf) Process.

The number of applications and technologies that include the most important fluids has also grown significantly. It has been known for more than a century that most liquids (SCFs) can dissolve soluble solvents, with the important point of carbon dioxide, the most widely used liquid. It is safe, environmentally friendly, and economical. Low operating conditions (temperature and pressure) make SCFs attractive in clinical research [21]. SCF

exists as a single phase above critical temperature (Tc) and pressure (Pc). SCFs have properties that are useful in product processing because they are intermediate between those of pure liquid and gas [22,23]

Therefore, it is possible to fine-tune the unique combination of structures required for the desired system. These unique SCF processing skills, long known and used in the food industry, have recently been adapted for medical use. The most commonly used solvents include carbon dioxide, nitrous oxide, ethylene, propylene, propane, n-pentane, ethanol, ammonia, and water. Once the drug particles have dispersed within the SCF, they can be recycled into much smaller particle sizes. The flexibility and precision given by SCF processes allow for the gradual formation of drug particles within a small range of particle size, usually to below micron levels. Current SCF processes have shown the potential to create nano suspensions of particles 5-2,000nm in diameter. Several pharmaceutical companies, such as Nektar Therapeutics and Lavipharm, specialize in particle engineering using SCF technology to reduce particle size and melt improvement [24,25]. A number of SCF processing methods are designed to address specific aspects of these deficiencies, such as rainwater antisolvents (PCA), Rapid Increase in Energy Solutions, Gas Antisolvent Recrystallization, Rain with Compressed Fluid Antisolvent, Impregnation or Bioactive Infusion. building materials, advanced Supercritical Fluid Dispersion Solution, advanced SCF dispersion solution (SEDS), large-scale antisolvents (SAS) processes and aerosol supercritical extraction system (ASES) [26,27].

(h) Solid Dispersion

The concept of solid dispersion was originally proposed by Sekiguchi and Obi, who investigated generation performance and elimination of eutectic soluble sulfonamide and water-soluble carrier in the early 1960s [28]. Strong dispersion represents an effective treatment to increase the solubility, absorption, and efficacy of drug treatment in dosage forms. The term solid dispersion refers to a group of solid products consisting of at least two different components, usually a hydrophilic matrix and a hydrophobic drug. The most widely used hydrophilic carriers for solid dispersion include polyvinylpyrrolidone (Povidone, PVP), polyethylene glycols (PEGs), Plasdone- S630. Surfactants such as Tween-80, docusate sodium, Myrj-52, Pluronic-F68, and sodium lauryl sulphate (SLS) also find a place in the formation of solid dispersions. The solubility of celecoxib, halofantrine, and ritonavir can be enhanced by strong dispersion using appropriate hydrophilic carriers such as povidone-containing celecoxib (PVP) and gelucire-containing ritonavir. Various techniques for preparing for the strong dispersion of hydrophobic drugs with the aim of improving their aqueous solubility are listed here: [29].

1. The Fusion Process [30]

In the preparation process, the carrier is heated to a temperature just above the melting point and the tree is placed in a matrix. The mixture is cooled by stirring constantly to dissolve the tree evenly throughout the matrix. Several methods can work during dispersion. If the drug has a high melting point in the carrier, the drug can remain "soluble" in a solid state, providing what is known as a solid solution. The reduction in particle size under these conditions extends to the final stage leading to the dissolution of drug cells in the network company matrix. These systems show significantly higher drug reduction rates compared to control samples. If, on the other hand, the solubility of a tree in a solid state is not so high, the crystals of the tree disperse into the matrix. Such systems only show an average increase in the rate of decline. The third method is the conversion of a tree into an amorphous form in front of the matrix, and it shows different levels of melting and melting. Other potential factors include the settling effect provided by the carrier itself, the improved irrigation or deterioration of local hydrophobicity, complexity, and tree crystals in the form of a metastable polymorphic of modified thermodynamic structures. An important limitation of the composite method for preparing drug exposure at high temperatures, especially if the carrier has the ability to dissolve and the drug is sensitive to heat.

2. The melting point [31]

Through the solvent preparation process, the carrier and the active ingredient are dissolved in a suitable organic solvent. This solvent evaporates at high temperatures or under vacuum. As the solvent is removed, excessive conditioning conditions occur following simultaneous precipitation of nutrients leading to solid residues. Mix and dry under a vacuum to remove any solvent ph that adheres freely to the particle surface. However, there is a possibility of solvate formation within the crystal lattice. This raises the issue of drug adoption as most of the solvents used are water-free (organic) and toxic. Therefore, the removal of small amounts of solvent is explained. Sensitive techniques such as different scanning calorimetry (DSC), differential temperature analysis (DTA), thermogravimetric analysis (TGA), and less sensitive processes such as gravimetry and spectroscopy can be used to demonstrate complete solvent removal.

3. Fusion-Solvent Method [32]

In the process of merging the company / shipping companies disintegrate and the drugs / drugs are packaged in the form of a solution. If the carrier is able to hold a certain portion of the liquid yet retain its solid properties, and if the liquid is innocent, the need for solvent removal is eliminated. Otherwise, this method faces the same criticism of the previously described solvents. This method is especially useful for drugs with high melting points or thermolabile. The feasibility of the method has been demonstrated in spironolactone and griseofulvin dispersions in polyethylene glycol 6000.

4. Spray Drying [33]

In this type of preparation, the carrier and the active ingredient are dissolved or suspended in a suitable solvent. The solvent evaporates by drying the hot air to remove the solvent. Due to the large surface area of the droplets, the solvent evaporates rapidly and solid dispersion is carried out rapidly.

5. Lyophilization [Sprinkle Freezing Freeze) [34 - 36]

This method is used to avoid heat during the preparation of thermosensitive drugs; Spray freeze drying (SFD) has been successfully developed to prepare for solid dispersion at ambient temperature, which has made great strides in William III's research work. SFD technology involves the manufacture of atoms in a feed containing water-soluble or insoluble APIs and auxiliary components into cryogenic liquids at ambient temperature to produce frozen frozen powders. This process offers various advantages compared to conventional solid dispersion techniques, which include amorphous structure and surface area.

6. Hot-melt Extrusion [37]

It is the most common method used in the polymer industry. But Speiser [38,39] and Huttenrach [40] were the first to use this technology for therapeutic purposes. The melt extrusion consists of the following components: The feed core, a hot container containing exhaust screws for transmitting and connecting the feed equipment, and an exit hole, which includes a voluntary die to maintain the output weight. The active ingredients and the carrier are placed in a hot extruder barrel at a continuous rate. When a mixture of the active ingredient and the carrier pass through hot screws, it is converted into a "liquid form". This condition allows to close and even mix with the top screws of the shear screw extruder. The exit hole, which contains the die of choice, makes melting in the required manner such as granules, pellets, films, or powders. An important advantage of the hot melt extrusion method is that the drug / network mixture is at a low temperature for about one minute, causing the molabile drug to be processed in a certain way.

(i) Installation Complex [41]

In all solvent development techniques, a complex formulation has been used precisely to improve water solubility, solubility rate, and the presence of bioavailability of soluble drugs. Embedded computers are made by inserting a non-globe or non-globular molecule of one molecule (known as a visitor) into another molecule or group of molecules (known as host). The main requirement for the integration of buildings is the proper balance of the visitor in the area of the host molecule. The hosting source should be large enough to accommodate the visitor and be small enough to draw water, in order to minimize the total contact between the water and the non-white areas of the host and the visitor. Various techniques are used to prepare dissolved drug mixtures for the purpose of improving their solubility in water classified as follows:

a. Mixing

The process involves the formation of cyclodextrin attachments and molecules to visitors using a small amount of water or ethanol to form a mixed residue. The crushed weight can be set at 45 ° C and ground.

b. Melts

The excess amount of dissolved visitor, mixed with cyclodextrin powder, after cooling the excess amount of the application is removed by washing with a weak solvent solvent. The route is limited to a visitor that is as easy to use as menthol.

c. Improved dispersion of the solution by Supercritical fluids (SEDS)

SEDS is a novel, one-step method, that can produce strong drug-cyclodextrin properties. Adjustment of processing conditions is important in order to achieve complex efficacy and to compare complex drug-cyclodextrin methods described earlier in the literature (e.g., mixing, freezing, spray drying etc.).

The advantages over other methods are

a) Preparation of solid-cyclodextrin complexes in one step,

b) Effective efficacy of complexation (avoiding excessive cyclodextrin in powder).

c) Opportunities to reduce drug interactions with cyclodextrin during the procedure.

d) The effectiveness of improved drug elimination rate (compared to the elimination behavior of the micronized drug-cyclodextrin complex).

d. Co-evaporation / Solvent evaporation method

In the alcoholic solution of the visitor, the aqueous solution of the host is added and stirred occasionally and evaporated at room temperature until a dry residue is obtained, filtered and filtered and the fraction collected.

e. Microwave Irradiation

This method is designed for rapid organic formation and reaction, which requires a short reaction time and a highly targeted product.

f. Freeze Drying / Lyophilisation technique [

The required stoichiometric value of the host and visitor is added to the aqueous solution of cyclodextrin and this suspension is magnetically stirred for 24 hours, and the resulting mixture is cooled and dried at 60 ° C for 24 hours. g. Spray Drying / Performing Atomization In this method, a management solution specially formulated with ethanol: water 50% v / v. To this visitor is added and the resulting mixture is stirred for 24 hours. at room temperature and the solution is dry considering the following conditions - air flow rate, atomizing air pressure, entry temperature, exit temperature, solution flow rate etc. The product is obtained by passing a granulometric filter of 63-160 micrometer.

(j) Imitation or Self-Micro Emulsifying Systems

Self-emulsifying or self-micro emulsifying systems use the concept of in situ formation of emulsion in the intestinal tract. A mixture of oil, surfactant, co-surfactant, one or more hydrophilic solvent and co-solvent forms a clear isotropic solution known as the self-emulsifying drug delivery system (SEDDS), [42] if without external (water) category and form. fine emulsions or automatic micro-emulsions when purified with water in GIT and used to improve lipophilic solubility and absorption. The easy application of emulsification may be associated with the easy penetration of water into various layers of crystals or gels formed on the droplet. One of the benefits of SEDDS in terms of measurement and automation when it integrates its components under minimal turbulence is thermodynamically stable. Barriers to this system include drug chemical instability and high concentration of surfactant. The large amount of surfactant in the formulation that makes it emulsifying (30-60%) irritates GIT. Many firming systems are limited to handling soft gel tablets or with hard shells due to product fluids. The interaction between the capsule shell and the emulsion should be considered to prevent the hygroscopic content from dehydrating or to the capsule shell. Neoral-R is an example of a self microemulsfying drug delivery system (SMEDDS). Depending on the dose level, the related bioavailability of cyclosporine-α is controlled. Neoral-R is approximately 174-239% of the bioavailability of cyclosporine-α from Sandimmune-R, a formulation originally advertised. Emulsion droplet size is a major factor influencing drug availability in emulsion production, with small droplet radii improving drug plasma levels, in part due to direct lymphatic absorption. Since SMEDDS contains high concentrations of surfactants, it should be limited to oral use and may not be recommended for long-term use due to its strong anti-diarrheal properties [43].

(k) Liquid Methods [44-50]

When the drug dissolved in a liquid vehicle is placed in a load-bearing area with holes and closely related fibers such as cellulose, both absorption and advertising occur; that is, the initial fluid absorbed inside the particles is trapped by its internal structure, and after the completion of this process, the insertion of the liquid into the inner and outer part of the porous carrier particles takes place. Then, coating materials with high attractive structures and a large surface area provide the liquisolid system with the desired flow characteristics. The solid Liquisolid system flows smoothly with powdered forms of liquid drugs. In the theory of the liquisolid system, a liquid containing soluble chemicals containing aqueous in suitable solvents solvents, which is converted into a liquid and radially compressible powder with a simple admixture and selected powder excipients called carrier and solvents. Microcrystalline and amorphous cellulose and silica powders can be used as dressings.

CONCLUSIONS

In this article we conclude that, Solubility is the most important component of the body due to oral bioavailability, composition, development of different types of different dosages, efficacy of drug treatment and dosage analysis. Proper selection of a solution to improve solubility is key to ensuring the goals of good formulation such as good oral hygiene, reduced volume frequency and better patient compliance combined with lower production costs. The different techniques described above alone or combined can be used to improve tree melting. Solubility can be improved with many techniques and the amount of coating increases with melting. Due to the problem of melting of many drugs its bioavailability is affected and that is why the development of soluble is necessary. It is now possible to increase the solubility of soluble drugs with the help of various techniques as mentioned above.

REFERENCES

1. Bittner B, Mountfield R.J. Formulations and related activities for the oral administration of poorly water soluble compounds in early discovery animal studies. Pharm. Ind. 2002; 64: 800–807

2. Bittner B, Mountfield R.J. Intravenous administration of poorly soluble new drug entities in early drug discovery: the potential impact of formulation on pharmacokinetic parameters.Current opinion in drug discovery & development. 2002; 5: 59–71.

3. Meyer, M, C. “Bioavailability of drugs and bioequivalence In: Encyclopedia of Pharmaceutical Technology” New York. Marcel Dekker Inc.; 1998; 2, 33-58.

4. Shargil, L, & Yu, “Applied Biopharmaceuitcs” Appleton-Century Crofts, Norwalk, C.T, 1985; 2, 193-203.

5. Martin, A, “Physical pharmacy,” Lippincott Williams & Wilkins, A. Walters Kluwer Co, Philadelphia, 2003; 5, 410-418.

6. Carstensen, J, T, “Pharmaceutical Preformulation” Teelinomoc Publishing Co. Inc, 1998; 14-47.

7. Brahmankar D.M. et al, Bio pharmaceutics and Pharmacokinetics 2009; 349-357.

8. Martin, A, Bustamanate, P, and Chun, A, H, C, “Physical Pharmacy” B.I. Wavely Pvt. Ltd, New Delhi, 1994; 4, 223.

9. Osol, A, (Eds.) in: “Remington’s Pharmaceutical sciences” Mack Publishing Company, Eastern Pennsylvania, 1990; 18, 203.

10. Neuberg, C, Hydrotrophy, Biochem J. Pharm, 1989; 75(7), 577.

11. Vemula VR, Lagishetty V, Lingala S. Solubility enhancement techniques, International Journal of Pharmaceutical Sciences Review and Research. 2010; 5(1):41-51.

12. Savjani KT, Gajjar AK, Savjani JS. Drug Solubility: Importance and Enhancement Techniques. ISRN Pharmaceutics Article ID195727, 2012, 1-10, doi:10.5402/2012/195727.

13. N. Blagden, M. de Matas, P.T. Gavan, P. York. Crystal engineering of active pharmaceutical ingredients to improve solubility and dissolution rates, Advanced Drug Delivery Reviews, 2007; 59(7):617-630.

14. M. Vogt, K. Kunath, J.B. Dressman. Dissolution enhancement of fenofibrate by micronization, cogrinding and spray-drying: comparison with commercial preparations, European Journal of Pharmaceutics and Biopharmaceutics. 2008; 68(2):283-288.

15. Chaumeil JC. Micronization: a method of improving the bioavailability of poorly soluble drugs, Methods and Findings in Experimental and Clinical Pharmacology. 1998; 20(3):211-215.

16. Ahmad Z, Maurya N, Mishra KS, Khan I. Solubility Enhancement of Poorly Water Soluble Drugs: A Review. International Journal of Pharmacy & Technology. 2011; 3(1):807-823.
17. Riehemann K, Fuchs H, Schneider SW, Luger TA, GodinB, Farrari M. Nanomedicine-Challenge and Perspectives. Chem. Int. Ed. Engl. 2009; 48:872-897.
18. Md. MofizurRahman, Abul Bashar Ripon Khalipha, Jamal Ahmed, Md. AbShuaibRafshanjani, ShanjidaHaque, Methods of Solubility and Dissolution Enhancement for Poorly Water-Soluble Drugs: A Review. 2014; 3(5):107-130.
19. Sareen S, Mathew G, Joseph L. Improvement In Solubility of Poor Water-Soluble Drugs By Solid Dispersion, International Journal of Pharmaceutical Investigation: Review Article. 2012; 2(1):12-17.
20. Mohanachandran PS, Sindhumol PG, Kiran TS. Enhancement of Solubility and Dissolution Rate: An Overview, PharmacieGlobale International Journal of Compehensive Pharmacy. 2010; 1(4):1-10.
21. Rantakyla M. Particle production by supercritical antisolvent processing techniques, Licentiate's Thesis, Helsinki University of Technology, Department of Chemical Technology, Espoo, 2004.
22. Phillips EM, Stella VJ. Rapid expansion from supercritical solutions, application to pharmaceutical processes, International Journal of Pharmaceutics. 1993; 94:1-10.
23. Subramaniam B, Rajewski R.A, Snavely K. Pharmaceutical processing with supercritical carbon dioxide, Journal of Pharma Sciences. 1997; 86:885-890.
24. Manna L, Banchero M, Solta D, Ferri A, Ronchetii S, Sicrdi S. Impregnation of PVP microparticles with ketoprofen in the presence of supercritical CO2. Journal of Supercritical Fluids. 2006; 78:67-69.
25. Sunkara G, Kompella U.B. Drug delivery applications of supercritical fluid technology. Drug Delivery Technology, 2002; 2:44-50.
26. Wong DH, Kim MS, Lee S, Jeong SP, Hwang SJ. Improved physicochemical characteristics of felodipine solid dispersion particles by supercritical anti-solvent precipitation process, International Journal of Pharmaceutics. 2005; 301:199-208.
27. Dohrn R, Bertakis E, Behrend O, Voutsas E, Tassios D. Melting point depression by using supercritical CO2 for a novel melt dispersion micronization process, Journal of Molecular Liquids. 2007, 131-132.
28. Sekiguchi K, Obi N. Studies on absorption of eutectic mixtures. I.A. comparison of the behaviour of eutectic mixtures of sulphathiazole and that of ordinary sulphathiazole in man, Chemical and Pharmaceutical Bulletin. 1961; 9:866-872.
29. Kumar P, Singh C. A Study on Solubility Enhancement Methods for Poorly Water Soluble Drugs, American Journal of Pharmacological Sciences. 2013; 1(4):67-73.
30. Habib MJ. Pharmaceutical solid dispersion Technology, Technomic Publishing Company, Inc. Lancaster, Pennsylvania (U.S.A.), 2001, 1-36.
31. Higuchi T, Ikeda M. Rapidly dissolving forms of digoxin: hydroquinone complex, J Pharm Sci. 1974; 63(5):809-811.
32. Vasconcelos T, Sarmento B, Costa P. Solid dispersions as strategy to improve oral bioavailability of poor water soluble drugs, Drug Discov. Today, 2012; 12(23-24):1068-1075.
33. Rogers TL, Hu JH, Yu ZS, Johnston KP, Williams RO, III A novel particle engineering technology: spray-freezing into liquid. Int J Pharm. 2002; 242:93-100.
34. Rogers TL, Nelsen AC, Hu JH, Brown JN, Sarkari M, Young TJ et al. A novel particle engineering technology to enhance dissolution of poorly water soluble drugs: spray-freezing into liquid, Eur J Pharm Biopharm. 2002; 54:271-280.
35. Hu JH, Rogers TL, Brown J, Young T, Johnston KP, Williams RO. Improvement of dissolution rates of poorly water soluble APIs using novel spray freezing into liquid technology. Pharm Res. 2002; 19:1278-1284.
36. Speiser P. GalenischeAspecte der Arzneimittelwirkung. Pharm Acta Helv. 1966; 41:321-342.
37. Adel EI-Egakey M, Soliva M, Speiser P. Hot extruded dosage forms. Pharm Acta Helv, 1971; 46:31-52.
38. Huttenrauch R. SpritzgießverfahrenzurHerstellungperoralerRetardpraperate. Pharmazie, 1974; 29:297-302.
39. Akhilesh D, Mehta H, Prabhakara P, Kamath JV. Enhancement of Solubility by Complexation with Cyclodextrin and Nanocrystallisation, International Research Journal of Pharmacy. 2012; 3(5):100-105.
40. Devil NKD, Rani AP, Javed M, Kumar KS, Kaushik J, Sowjanya. Cyclodextrins in pharmacy-An overview, Pharmacophore, 2010; 1(3):155-165.
41. StijnKoolen MJ, Alwin Huitema, Jan Schellens, Beijnen J. BastiaanNuijen Development of an oral solid dispersion formulation for use in lowdosemetronomic chemotherapy of Paclitaxel. European Journal of Pharmaceutics and Biopharmaceutics. 2013; 83:87-94.
42. Prabhakar Ch, Bala Krishna K. A Review on Nanosuspensions in Drug Delivery, International Journal Pharma and Bio Sciences. 2011; 2(1):549-558.
43. Patel M, Shah A, Dr. Patel NM, Dr. Patel MR, Patel Dr. KR. Nanosuspension: A Novel Approach for Drug Delivery System, Journal of Pharmaceutical Science and Bioscintic Res. 2011; 1(1):1-10.
44. Nagabandi VK, Tadikonda R, Jayaveera KN. Enhancement of dissolution rate and micromeritics of poorly soluble drug ketoprofen by liquisolid technique, Journal of Pharmaceutical and Biomedical Sciences. 2011; 9(9):1-6.
45. Khalid ME, Ahmed M. Samy, Mohamed I. Fetouh for mulation and evaluation of RofecoxibLiquisolid Tablets, International Journal of Pharmaceutical Sciences Review and Research. 2010; 3(1):135-142.
46. Chandel P, Raj K, Kapoor A. Liquisolid technique: an approach for enhancement of solubility, Journal of Drug Delivery & Therapeutics. 2013; 3(4):131-137.
47. Gavali SM, Pacharane SS, Sankpal SV, Jadhav KR, Kadam VJ. Liquisolid Compact: A new technique for enhancement of drug dissolution, International Journal of Research In Pharmacy And Chemistry. 2011; 1(3):705-713.
48. Syed IM, Pavani E. The Liquisolid technique: based drug delivery system, Int. J PharmSci and Drug Research. 2012; 4(2):88-96.
49. Vajir S. LiquisolidCompct: a novel approch to enhance bioavailability of poorly soluble drug. Int. J Pharmacy. 2012; 2(3):586-590.
50. SpiridonSpireas, Bolton SM. Liquisolids: Liquisolid system and methods of preparing the same. United States Patent, 1998.