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Solid Dispersion: A Technology for Improving Aqueous Solubility of Drug

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ABSTRACT: Solubility of a drug is a surface physical phenomenon. The aqueous solubility is an important perquisite factor for one drug to exhibit better pharmacological response if administered orally. As one drug with good aqueous solubility will have better dissolution accordingly that drug has good absorption and bioavailability properties. This good absorption and bioavailability properties shall favors for one drug to have desired pharmacological plasma drug concentration at target site for therapeutic action. Thus good aqueous solubility is a challenging criterion for designing oral drug formulations. This review study shall cover the basic ideas of solubility, solid dispersion with its ideas of manufacturing, applications, evaluations and its future development trend.

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INTRODUCTIONS:

The Biopharmaceutical study demonstrated that the absorption as well as therapeutic effectiveness of drugs is significantly dependent on aqueous solubility of drug. The poor aqueous solubility of drugs may leads to failure in development of conventional dosage form or alternation in formulation design which may leads to increased formulation cost. The occurrence of inadequate bioavailability is due to the low solubility and dissolution rate of drug substances in aqueous gastric fluid [1]. In designing of oral dosage form, the aqueous solubility is the most required criteria for the drug to have good dissolution and absorption rate and accordingly better bioavailability.

SOLUBILITY:

The solubility of drug is defined as the surface physical phenomenon in which given amount of drug which gets dissolved in specific amount of solvent under standard condition of pressure, temperature and humidity. The solubility of drug is a static process. In the first step of drug formulation as well as development, always the Formulation Scientist attempt to increase the the solubility as well as the dissolution of the hydrophobic drugs which favours to increase the therapeutic action of drug [1].

Factor affecting solubility [1,2]:

***Nature of the solute and solvent*:**

The solubility of a drug in one particular solvent depends on nature of solute as well as solvent. Various research studies demonstrated that in same amount of solvent, varying amount of solute may dissolve. Similarly in the same amount of solute, the different volume of solvent may dissolves.

***Temperature*:**

The solubility of drug directly related with the temperature that is with increases in temperature the solubility of drug is significantly increases. But in few cases are there, drugs are less soluble in warmer solutions. In the case of gases, the solubility is inversely related with temperature that is the solubility of gases decreases as the temperature of the solution rises.

***Pressure*:**

The effect of the pressure on solubility is only applicable in case of gas. The does not affect the solubility of solid and liquid solutes. With the increase in pressure increases solubility of gaseous solute and vice versa.

***Polarity*:**

The good solubility of drug is favoured by the similar polarity of drug and solvent. The polar solutes do not dissolve in non-polar solvents and vice versa.

Molecular/ particle size:

The solubility of drug is not favors by larger size and molecular weight of drug molecule in solvents. The solubility will be more if the size of the drug will be small as much as possible.

Stirring increases the speed of dissolving:

The agitated solvent always put one positive impact on solubility of drug. Thus the stirring accelerate the solubility rate of drug. The mechanism behind it that the agitated solvent continuously come in contact with drug surfaces which favors more solubility.

BCS CLASSIFICATION DRUGS [2,3]:

Class I - High Solubility, High Permeability:

Class I drugs characterize with the high solubility and permeability. This category drugs shows high dissolution and absorption. For those Class I compounds formulated as immediate release products, dissolution rate generally exceeds gastric emptying. About 100 % absorption can be predictable if at least 85 % of a product dissolves inside 30 min of *in vitro* dissolution testing across a range of pH values. The examples of drugs comes under this category are Metoprolol, Diltiazem, Verapamil and Propranolol.

Class II - High Solubility, Low Permeability:

Class II drugs characterize with the high solubility and low permeability. This category drugs shows high dissolution and low absorption. The absorption and bioavailability of these drugs is permeation rate limited. The examples of drugs comes under this category are Phenytoin, Danazol, Ketoconazole, Mefenamic acid and Nifedinpine.

Table 1. Solubility characteristics of various drug in solvent.

Descriptive Level	Parts of solvent per 1 part of solute (material)
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	More than 10,000

Class III – High Solubility, Low Permeability:

Class III drugs characterize with the low solubility and high permeability. This category drugs shows low dissolution and high absorption. In this class, the drug

absorption is dissolution is rate limiting step. These drugs show a high variation in the rate and amount of drug absorption into the systemic circulation. The examples of drugs comes under this category are Cimetidine, Acyclovir, Neomycin B and Captopril.

Class IV- Low Solubility, Low Permeability:

Class IV drugs characterize with the low solubility and low permeability. This category drugs shows low dissolution and absorption. In this class, the drug absorption is dissolution and permeation rate limiting step. Those compounds have a poor bioavailability usually they are not well absorbed over the intestinal mucosa and a high variability is expected with very poor oral bioavailability. The examples of drugs comes under this category are Hydrochlorothiazide, Furosemide and Meloxican.

POORLY WATER SOLUBLE DRUGS [3,4]:

The various poorly water soluble drugs are Albendazole, Danazole, Ketoconazole ,Itraconazole, Atovaquone, Troglitazone, Valsartan, Nimesulide, Loratadiene, Griseofulvin, Felodipine, Probucol, Cefixime, frusemide, Salicyclic acid, Ketoprofen, Tinidazole, Aceclofenac, Ofloxacin, Hydrochlorthiazide, Ibuprofen, Nevirapine, Amoxicillin, Celecoxib, Roficoxib.

PROBLEMS OF POORLY WATER SOLUBLE DRUGS [5]:

The drug with poor aqueous solubility will face lot of formulation difficulties in the flow path of gastrointestinal tract that is the drug will face various formulation problems in *in vivo* manner like the drug will have low absorption through biological membrane. These properties may leads to the low bioavailability and obviously will possess low therapeutic value.

SOLID DISPERSION:

The solid dispersion term can technically be defined as the group of solid solute particles. This group of particles will consists of at least two verities of components that are one is a hydrophilic matrix (Crystalline or amorphous) and another is a hydrophobic drug. The hydrophobic drug can be dispersed molecularly either in amorphous or crystalline particles form.

Definition:

The solid dispersion is defined as the solid core particle (either in amorphous or crystalline form) which may be dispersed or coated by polymeric (Carrier) coat (Carrier matrix) materials. Alternatively the solid dispersion is the dispersion of one or more active hydrophobic ingredients (Drugs in solid/ liquid state) in an inert hydrophilic carrier which may be prepared either by melting or solvent or melting solvent method [4].

Advantages of solid dispersion [4,5]:

The solid dispersion increases dissolution rate, thus improves the bioavailability of drug. The solid dispersion increases the wettability characteristics of the particles, thus increases solubility. Solid dispersion reduces the particle size. The solid dispersion enhances absorption of drug. The solid dispersion improves therapeutic effectiveness of drug (s). The porous nature of drug is increased by solid dispersion technology. The solid dispersion retains the drugs in amorphous state. In solid dispersion drugs are presented as supersaturated solutions which are considered to be metastable polymorphic form. Thus presenting the drug in amorphous form and increases the solubility of the particles.

Disadvantages of solid dispersion [4,5]:

The high melting point carriers cannot be used in solid dispersion technology. If the carrier melting temperature reaches the melting point of the drug then thermal degradation or instability of the drug may takes place. The decomposition of drug may take place, which dependent upon composition, fusion time and rate of cooling. The solid dispersion temperature may cause sublimation or evaporation. Solidified melt may be tacky and unhand able, which may leads to the poor scale-up for the purposes of manufacturing. The preparation of solid dispersion is a laborious and expensive method. The solid dispersion may leads to the low reproducibility of physicochemical characteristics. It is difficult to incorporate the solid dispersion into formulation of dosage forms. Difficulties in scale-up of manufacturing process. Sometimes the stability problem of the drug and vehicle may take place. The solid dispersion might be more deteriorate by the temperature and moisture.

Mechanism of solid dispersion [5-7]:

The several review and research studies revealed that several factors that are particle size, crystalline or polymorphic forms and wettability of drug etc. attributing the increase in dissolution rate of the drugs in solid dispersion as mentioned below.

***Reduction of Particle Size*:**
The solid dispersion techniques like glass solution, solid solution and amorphous dispersions reduces the particle size that leads to increase in particle surface area, thus enhances the dissolution rate.

***Solubilisation effect*:**
In the manufacturing of solid dispersion the carriers can improve the wettability as well as solubility of drug. Hence solid dispersion enhances the solubilisation effect of poorly soluble drugs.

***Wettability and dispersibility*:**
The surface action of carrier materials used in the solid dispersion may also have wettability and dispersibility enhancing effect. Thus carrier reduces the interfacial tension between hydrophobic drug particle and aqueous solvent phase, which increases the effective surface area of drug particle exposed to the dissolution medium.

***Conversion of polymorphic nature of solute*:**
Considerable more energy is required to transfer a molecule from crystal lattice of a purely crystalline solid than the energy required for non-crystalline (amorphous) solid. Thus a higher dissolution rate is shown by the amorphous state of a drug. Also the amorphous solids possess a demerit of physical instability due to natural tendency to form crystals. Thus formation of metastable dispersions with reduced lattice energy and comparatively acceptable stability would result in faster dissolution rate.

Types of solid dispersion [6-8]:

***Simple Eutectic Mixture*:**
When a sparingly water-soluble drug and a highly water-soluble carrier are blended, the physical mixture of its two crystalline components forms Eutectic mixture (Fig 1). The eutectic mixture is prepared by melt fusion method. In the solubilisation mechanism, the eutectic mixture is on contact with water, where the soluble carrier dissolves leaving the drug in a microcrystalline state which gets solubilised rapidly. It increases the surface area, which results in increased dissolution rate.

***Solid Solutions*:**
When a solid solute dissolved in a solid solvent, this mixture leads to formation of Solid solutions which is also referred as co-precipitates or co-evaporates. The solid solutions are prepared by solvent evaporation or co-precipitation method. This method proceeded with mixing of the solid drug and carrier in common volatile solvent. Then solvent get evaporated by flash evaporation. This results in formation of a mixed crystal containing amorphous drug in crystalline carrier. This is because the two components crystallize together in a homogenous single phase system. Depending on the extent of miscibility between the two components or the crystalline structure of the solid solution, Solid solution is of four types.

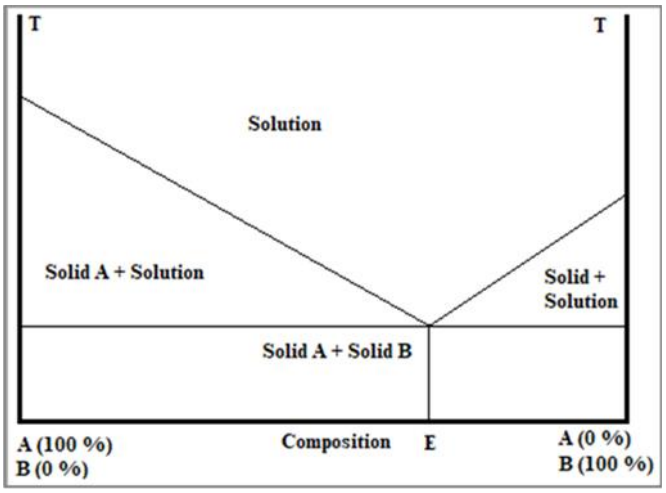

Fig 1. Hypothetical Phase Diagram of Eutectic Mixture.

Continuous solid solutions: This type of solid solution consists of the two components which are miscible at solid state in all proportions (Fig 2). Though theoretically this type of solid solution exhibit faster dissolution but practically does not show faster dissolution rate.

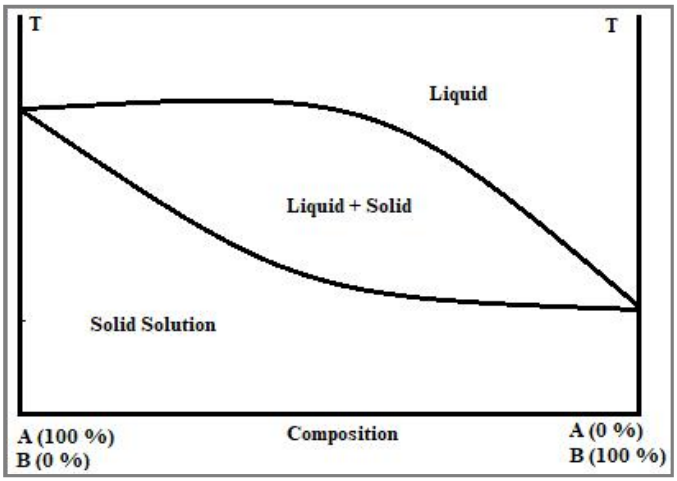

Fig 2. Hypothetical phase diagram of continuous solid solution.

Discontinuous solid solution: This type of solid solution (Fig 3) corresponds to only limited solubility of a solute in a solid solvent. Each component is capable of

dissolving the other component to a certain degree above the eutectic temperature.

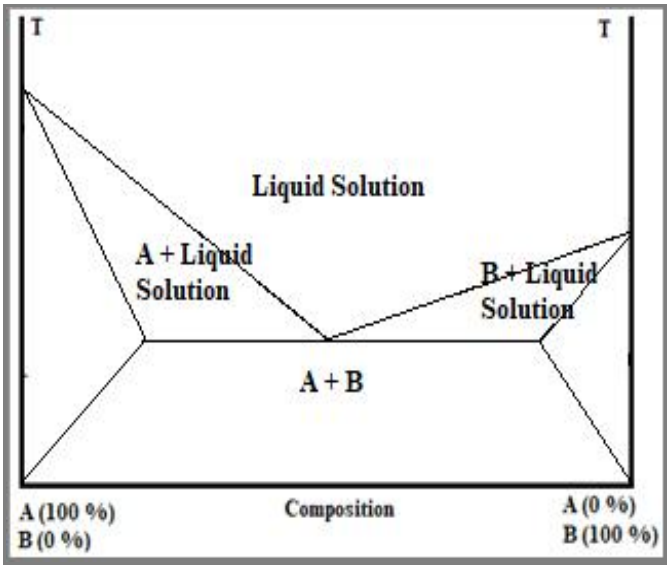

Fig 3. Hypothetical phase diagram of discontinuous solid solution.

Substitutional solid solution: This type of solid solution (Fig 4) includes substitution of the solute molecule for the solvent molecules in the crystal lattice of the solid solvent, which forms either continuous or discontinuous solid solution. The size and steric factors of the solute play a critical role in the formation of solid solution.

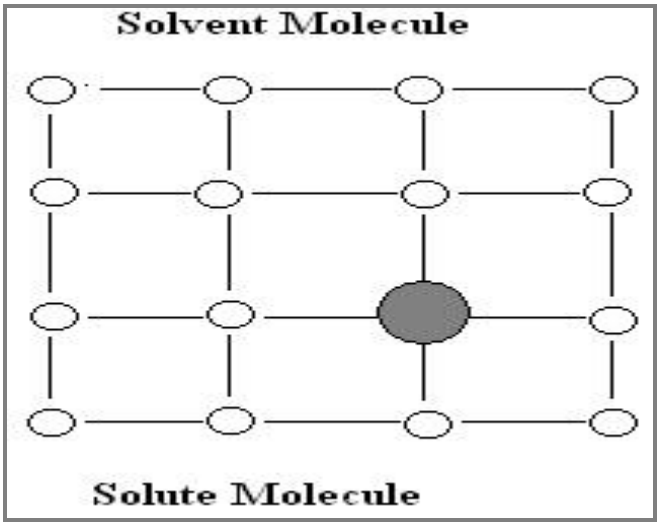

Fig 4. Substitutional solid solution.

Interstitial Solid Solution: This type of solid solution, the solute molecule lies in the interstitial space of the solvent (host) lattice (Fig 5), forming a discontinuous (limited) solid solution. The size of the solute is significant factor in order to fit into the interstices. The apparent diameter of the solute molecules should be less than that of the solvent to achieve an extensive interstitial solid solution of metals.

***Glass Solution*:**

It is a homogenous system. In this type of solid dispersion a glassy carrier solubilises drug molecules in its matrix. The Polyvinylpyrrolidine dissolved in organic solvents which undergoes a transition to a glassy state upon evaporation of the solvent. The glass solution has properties of transparency and brittleness below the glass transition temperature (Tg). It get softens at its melting point on heating.

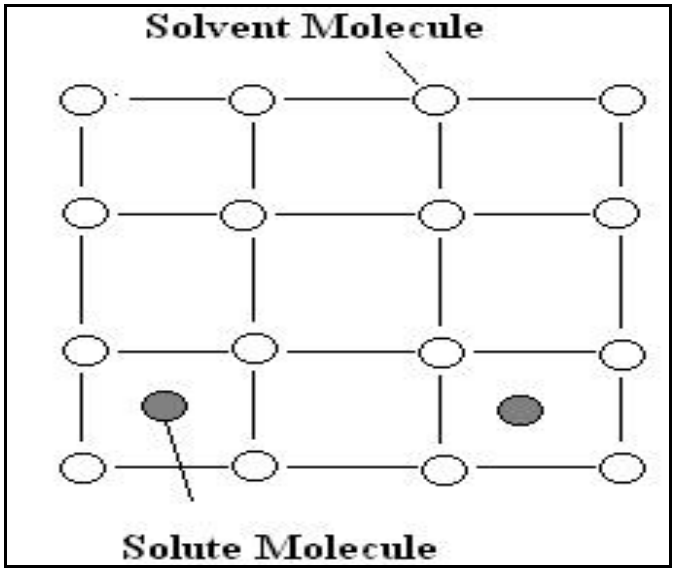

Fig 5. Interstitial Solid Solution.

***Compound or complex formation*:**

In this type of solid dispersion, the two components get complexes in a binary system. The drug gets available from complex which depended on the factors like solubility, association constant and intrinsic absorption rate of complex. The dissolution rate and gastrointestinal absorption can be enhanced by the formation of a soluble complex with low association constant.

***Amorphous precipitation*:**

The amorphous precipitate is form when drug precipitates as an amorphous form in the inert carrier. The higher energy state of the drug in this system facilitates the greater dissolution rates. It is observed that a drug with high super cooling tendency has more tendency to solidify as an amorphous form in the presence of a carrier, thus the amorphous precipitation is rarely observed.

Carriers used in solid dispersion[9,10]:

***Ideal Characteristics of Carriers*:**

- Freely water-soluble with intrinsic rapid dissolution properties.

- Non-toxic and pharmacologically inert.
- Heat stable with a low melting point for the melt method.
- Soluble in solvents and pass through a vitreous state upon solvent evaporation for the solvent method.
- Able to preferably increase the aqueous solubility of the drug.
- Chemically compatible with the drug and not form a strongly bonded complex with the drug.

***First generation carriers*:**
The crystalline carriers (Urea, organic acids and sugar) are used to develop the first generation solid dispersions. These carries have limitations of forming crystalline solid dispersion, which were thermodynamically more stable and cannot release the drug as quickly as amorphous ones.

***Second generation carriers*:**
The amorphous carriers (Synthetic polymers) are used for forming the solid dispersions. These polymers are poly vinyl pyrolidone (PVP), polyethylene glycols (PEG), ethyl cellulose polymethacrylates, natural product based polymers such as hydroxylpropylmethyl-cellulose (HPMC) and hydroxyl propyl cellulose or starch derivatives like cyclodextrins.

***Third generation carriers*:**
The inclusion of self-emulsifying properties in carriers, improves the dissolution profile of drugs. Such carriers are inutec SP1, inulin, compritol 888 ATO, gelucire 44/14 and poloxamer 407.

***Other carriers*:**
The solid dispersion of oxazepam by spray drying using hydrolysis products of collagen and Gelita Collagel was found to increase the dissolution rate by six folds.

Solvents used in preparation of solid dispersions:
- Solvent to be included for the formulation of solid dispersion should have the following criteria [10]:
- Both drug and carrier must be dissolved in the solvent.
- Toxic solvents to be avoided due to the risk of residual levels after preparation e.g. chloroform and dichloromethane.
- Ethanol can be used as alternative as it is less toxic. Water based systems are more preferred.
- Surfactants are used to create carrier drug solutions but as they can reduce glass transition temperature, so care must be taken in to consideration.

The mostly used solvents which are used for the preparation of solid dispersions are water, methanol, ethanol, acetic acid, 1-propanol, 2-propanol, chloroform and dimethyl sulfoxide.

Methodology [10-14]:

***Fusion Process*:**
The fusion method is the simplest process which forms dispersions of the drug and carrier. This dispersions are miscible in the molten state. Drug and carrier mixture of eutectic composition is molten at temperature above its eutectic temperature. Then molten mass is solidified on an ice bath and pulverized to a powder. Since a super saturation of the drug can be obtained by quenching the melt rapidly, rapid congealing is favoured. The solidification is often performed on stainless steel plates to facilitate rapid heat loss.

***Lyophilization*:**
This process involves in the transfer of heat and mass from and to the product. Lyophilization process also referred as solvent evaporation method in which molecular mixture technique is used where the drug and carrier is dissolved in common solvent, frozen and sublimed.

***Melt Agglomeration technique*:**
In melt agglomeration method the binder is use as carrier. This method correspond two steps for preparation of solid dispersion that is first the drug is sprayed on the melted binder plus excipients and second step is the melting of binder drug and excipient above the melting temperature of binder used. For using high binder content rotary process might be preferable for controlling temperature.

***Electrosipinnig method*:**
In this method, the electric force is used to withdraw a nano size fibre thread from the polymer sol/polymer melt. This a combination of solid dispersion with nanotechnology use in polymer industry. Stream of polymer solution /melt is subjected to electric force (5 to 30kv) which cause body of the liquid becomes charged, and electrostatic repulsion counteracts the surface tension. This made a strong cohesive force between the particle and droplets of polymer and a stream of fibre is formed. Then thinning and stretching of fibre to nano diameter is done by using whipping process called electrostatic repulsion. This process all depend on rate of feeding surface tension and electric force used.

Table 2. Types and details of various solid dispersions (SDs).

S.N.	Solid Dispersion Type	Matrix	Drug	Remarks No	Phase
1.	Eutectics	C	C	The first type of solid dispersion prepared	2
2.	Amorphous precipitations in crystalline matrix	C	A	Rarely Encountered	2
3. Solid solutions					
A.	Continuous Solid Solutions	C	M	Miscible at all composition, never prepared	1
B.	Discontinuous solid solutions	C	M	Partially miscible, 2 phases even though drug is molecularly dispersed	2
C.	Substitutional solid solutions	C	M	Molecular diameter of drug differs less than 5% from the matrix diameter. The drug and matrix are substitutional. Can be continuous or discontinuous.	1or 2
D	Interstitial solid solutions	C	M	Drug molecular diameter less than 59% of matrix diameter. Usually limited miscibility, discontinuous.	2
4.	Glass suspension	A	C	Particle size of dispersed phase dependent on cooling/evaporation rate. Obtained after crystallization of drug in amorphous matrix	2
5.	Glass suspension	A	A	Particle size of dispersed phase dependent on cooling/evaporation rate many SDs are of this type	2
6.	Glass solution	A	M	Requires miscibility or solid solubility, complex formation or upon fast cooling or evaporation during preparation, with PVP.	1

Table 3. Various carriers used for solid dispersion of different drugs.

Carriers	Drugs
Sugars	Dextrose, sucrose, galactose, sorbitol, maltose, xylitol mannitol, lactose.
Acids	Citric acid, succinic acid.
Polymeric materials	Povidone (PVP), polyethylene glycol (PEG), hydroxypropyl methyl cellulose, methyl cellulose, hydroxy ethyl cellulose, cyclodextrin, hydroxy propyl cellulose, pectin, galactomannan.
Enteric polymer	HPMC phthalate, eudragit L100, eudragit S100, Eudragit RL, Eudragit RS.
Surfactants	Polyoxyethylene stearate, renex, poloxamer 188, texafor AIP, tweens, spans.
Miscellaneous	Pentaerythritol, pentaerythrityltetraacetate, urea, urethane.

Table 4. The commercialized solid dispersions available in market [18-20].

Products	Dispersion Carrier	Technology	Company
Gris-PEG® (Griseofulvin)	Polyethylene glycol	Melt process; exact process unknown	Novartis
Sproramax capsules (Itraconazole)	Hydroxypropylmethyl cellulose (HPMC)	Spray layering	JanseenPharmaceutica
Cesamet® (Nabilone)	Povidone	process unknown	Lilly
Kaletra (lopinavir and ritonavir)	Polyvinylpyrrolidone (PVP)/polyvinyl acetate	Melt-extrusion	Abbott Laboratories
Torcetrapiba	HPMC acetate succinate	Spray drying	Pfizer
Ibuprofen	Various	Melt-extrusion	Soliqs
Isoptin SRE-240 (Verapamil)	Various	Melt-extrusion	Soliqs
Rezulinb (Troglitazone)	PVP	Melt-extrusion	Pfizer
LCP-Tacro(Tracrolimus)	HPMC	Melt-granulation	Life Cycle Pharma
Intelence (Etravirine)	HPMC	Spray drying	Tibotec
Certican (Everolimus)	HPMC	Melt or Spray drying	Novartis
Afeditab (Nifedipine)	Poloxamer or PVP	Melt/absorb on carrier	Élan Corp

***Solvent evaporation process*:**

This method prepares solid dispersion (Co-precipitates) uses organic solvents. The solvent intimately mix the drug and carrier molecules and then solvent is evaporated by vacuum evaporation. The choice of solvent and its removal rate are critical parameters affecting the quality of the solid dispersion. Since the chosen carriers are generally hydrophilic and the drugs are hydrophobic, the selection of a common solvent is difficult and its complete removal, necessitated by its toxic nature, is imperative.

***Supercritical Fluid Process*:**

Supercritical CO_2 is a good solvent for both water-insoluble as well as water-soluble compounds under suitable conditions of temperature and pressure. Therefore, it has potential as an alternative for conventional organic solvents used in solvent based processes for forming solid dispersions due to its favourable properties of being non-toxic and inexpensive. The process consists of the charging the bioactive material and suitable polymer into the autoclave, addition of supercritical CO_2 under precise conditions of temperature and pressure, that causes polymer to swell, mechanical stirring in the autoclave and rapid depressurization of the autoclave vessel through a computer controlled orifice to obtain desired particle size.

Characterization of solid dispersions:

Several methods are employed for the characterization of solid dispersions that are dissolution testing which is done to evaluate the drug release of drug from solid dispersion by using USP XIII dissolution apparatus. The transition temperature of solid dispersion is measured by the Thermo analytical methods that are Differential thermo Analysis and Hot Stage Microscopy. The crystalline structure of solid dispersion is detected by using X-Ray diffraction (XRD) and Differential Scanning Calorimetry (DSC). The drug carrier compatibility study is carried out by Spectroscopic methods (IR spectroscopy) and DSC. The particle size of solid dispersion is analysed by Microscopic methods including Polarization Microscopy and Scanning Electron Microscopy. The drug content is determined by using UV-Visible spectrophotometer. The solubility of solid dispersion is also determined. The stability of the solid dispersion is tested by Accelerated stability studies [12-15].

Applications of solid dispersions (SDs) [15-17]:

- It increases the solubility of poorly water soluble drugs and thus increases the dissolution rate, which enhances the absorption and bioavailability of the drug.
- The solid dispersion stabilizes the unstable drugs against various decomposition procedures like hydrolysis, oxidation etc.
- The solid dispersion reduces the side effect of certain drugs.
- The solid dispersion masks the unpleasant taste and smell of drugs.
- The solid dispersion avoids undesirable incompatibilities.
- The solid dispersion obtains a homogeneous distribution of a small amount of drug in solid state.
- The solid dispersion helps in dispensing of liquid (up to 10 %) or gaseous compounds in a solid dosage
- The solid dispersion formulates the sustained release dosage forms.
- The solid dispersion can be used as prod rug which reduces the inactivation of drugs like morphine and progesterone in pre systemic circulation.
- Polymorphs in a given system can be converted into isomorphous, solid solution, eutectic or molecular addition compounds.

MARKETED PRODUCTS OF SOLID DISPERSION:

Gris-PEG, a griseofulvin-PEG fusion method solid dispersion, was manufactured initially by Dorsey/ Sandoz and reached the market in the mid- 1970s. Gris-PEG was developed as tablet product, and this led to two USP monographs for griseofulvin tablets. Griseofulvin solid dispersion. Tablets are currently marketed by a number of manufacturers and contain corn starch, lactose, magnesium stearate, PEG, and sodium lauryl sulfate as inactive ingredients. Cesamet, a nabilone-PVP solvent method solid dispersion manufactured by Eli Lilly and Co. has been marketed internationally since 1982. Eli Lilly discontinued marketing Cesamet contains PVP and corn starch as inactive ingredients and is presented as a capsule product. Solid dispersion formulation of Troglitazone (Rezulin) is marketed by Parke-Davis. Solid Solutions of lopinavir and ritonavir in polyvinylpyrrolidone-vinyl acetate. Co-polymer successfully enabled a reformulation of Kaletra (Abbott Laboratories, Abbott Park, IL). In addition to reducing the dosage burden

from six softgel capsules to four tablets, tablets made with the solid solutions eliminate the need for refrigeration. Sporanox (Janssen Pharmaceutica, Titusville, NJ) is a solid dispersion of itraconazole in hypromellose that has been layered onto sugar spheres. The most recently approved product is the nonnucleoside reverse transcriptase inhibitor Intelence (Tibotec, Yardley, PA), an amorphous, spray-dried solid dispersion of etravirine, hypromellose, and microcrystalline cellulose. Troglitazone solid dispersion is marketed by Parke Davis [17-19].

FUTURE TREND OF SOLID DISPERSION:

Now a days the availability of relatively low melting points surface-active and self-emulsifying carriers might be responsible for the successful development in solid dispersion. The beneficial properties like easy manufacturing process and improved bioavailability and enhanced dissolution rate, drug along with carrier are filled into hard gelatin capsules. The crystallization of drugs from super-saturated systems can be prevented by exploring new vehicles or excipients. The solid dispersion could be developed as the extended release dosage forms with greater physical and chemical stability of both drug and carrier in solid dispersion [19,20].

CONCLUSION:

Therapeutically effective concentration of a drug at the target site of action depends on the bioavailability, which ultimately depends on the solubility of drug molecules. Solubility is one of the important parameters to achieve desired concentration of drug in systemic circulation for pharmacological response. The solid dispersion is a novel technique for enhancement of solubility of poorly water soluble drugs. Further development is required for modification in Technology for preparation of solid dispersion to overcome the existing associated problems of solid dispersion.

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