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Liquisolid technology for dissolution rate enhancement or sustained release

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Importance of the field: Most of the drugs that have been invented are of BCS Class II. Therefore, dissolution rate enhancement is the key aspect for absorption of these drugs. Liquisolid technology is very efficient in the dissolution rate enhancement of these drugs. Moreover, use of other polymers such as Eudragit and hydroxypropyl methylcellulose in the liquisolid approach can cause sustained release of drugs. This review focuses on the formulation approaches of liquisolid tablets or compacts along with its fundamental principles.

Areas covered in this review: The review focuses on the developments in liquisolid technology from 1998 to 2009 with *in vitro* and *in vivo* performance of the dosage forms prepared using this technology.

What the reader will gain: Benefits of this review include a concise evaluation of this technology by focusing on the scope of future developments to be done using this technique.

Take home message: Liquisolid technology, the next generation of powder solution technology, can be helpful for enhancing dissolution rates of poorly water-soluble drugs as well as effective at sustaining drug release.

Keywords: dissolution rate enhancement, liquisolid tablets, poorly water-soluble drugs, sustained release

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1. Overview of the market

Many of the newly developed drugs have bioavailability problems owing to their poor water solubility. Thus far, ~ 40% of drugs in the development pipeline and 60% of the newly synthesized drug molecules are poorly water soluble [1,2]. Such drugs are included in BCS Class II according to Amidon *et al.* [3]. Dissolution remains an important factor for absorption of drugs, especially in the case of water-insoluble drugs [4]. For drugs whose absorption is dissolution rate limited, suitable innovative formulation approaches should be designed to solve the bioavailability problem after oral administration. For water-insoluble drugs with poor solubility in both aqueous and organic media, the formulation development remains a challenging task [2].

Therefore, to enhance dissolution rates of the drugs, the following approaches can be used. The solid dispersion technique is one of the most widely used techniques for improving dissolution rate of the drugs [5]. Out of the many polymers, hydrophilic synthetic polymers are widely used as carriers for solid dispersion systems [6]. Another very simple approach is inclusion complex with β-cyclodextrin [7]. Many of the pharmaceutical products such as orally disintegrating tablets were formulated using this approach. Micronization [8], microwave-induced dissolution

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Article highlights.

- Liquisolid technology is an improved version of powder solution technology that converts liquid medication into free flowing, non-adherent, dry looking and readily compressible powders.
- Owing to the presence of the drug in the form of liquid medication (either solubilized or in a molecularly dispersed state), it can provide increased wetting and surface area for dissolution, getting improved dissolution and bioavailability.
- Understanding the theoretical aspects such as liquid medication, flowable liquid retention potential (Φ), compressible liquid retention potential (ψ), liquid load factor (L_f), and so on, is critical in the design and development of liquisolid systems.
- High-dose drugs can be conveniently formulated using liquisolid technology by the inclusion of some additives that can reduce the amounts of carrier and coating materials.
- Non-volatile solvents have effects on different phenomena, ranging from availability of drug molecules to dissolving medium, disintegration and deaggregation of carrier molecules, diffusion of liquid medication through primary carrying particles during dissolution process, and also compactness of liquisolid compacts.
- Molecularly dispersed drug, increased surface area, low drug concentration and non-volatile solvent contribute to the increased dissolution rates of liquisolid compacts.

This box summarizes key points contained in the article.

rate improvement [9], adsorption onto silica aerogels [10], nanosuspension [2], antisolvent precipitation [11] and evaporative precipitation into aqueous solution [12] are the other approaches used to enhance dissolution rates of the poorly water-soluble drugs.

All the above techniques have high production costs, and are technologically demanding, patenting and advanced preparations. A recently developed technique of 'powdered solution technology' was thought to improve the release of water-insoluble drugs from dosage forms [13]. Powdered solutions involve converting drug solutions or drugs into acceptably flowing powders. The concept of powder solution technology involves simple admixture of drug solution or liquid drug with selected carrier and coating materials. Powder solutions also give improved drug release as the drug is in its solution form, like that of soft gelatin capsules [13]. This technique had low industrial applicability owing to poor and erratic flow behavior as well as compressibility of these liquid/powder admixtures. Spireas [14] and Spireas and Bolton [15] developed mathematical expressions for calculating the optimum amounts of ingredients required to produce liquid/powder admixtures processing, to a prespecified desirable degree, with acceptable flow properties. A newly developed technique of liquisolid systems by Spireas and Bolton [14,15] has proved to be an important technique for the dissolution rate improvement in the case of water-insoluble drugs. The liquisolid systems show acceptable flow properties and compressibility. This technique is thus considered to be an improved version of powder solution technology.

Apart from dissolution rate enhancement, this technology can also be used for sustaining drug release in the case of water-soluble drugs [16,17].

2. How the technology works

The basic concept involved in the liquisolid technology is the use of liquid lipophilic drugs or water-insoluble solid drugs dissolved in non-volatile solvent and conversion of this liquid medication into free-flowing, non-adherent, dry looking and readily compressible powders with the use of different carrier and coating materials. Owing to the presence of the drug in the form of liquid medication, it is in either a solubilized or a molecularly dispersed state. This can provide increased wetting and surface area for dissolution. Liquisolid tablets of water-insoluble drugs show improved dissolution properties and in turn an increase in bioavailability [18]. However, use of hydrophobic carriers such as Eudragit [16] and adjuvant such as hydroxypropyl methylcellulose (HPMC) [17] leads to sustaining drug release.

3. Theoretical considerations

The liquisolid technology was considered to be an advanced version of powdered solution technology, as described above [13]. It gives mathematical equations for formulating the actives and excipients so as to get formulations with desired flow and compression characteristics [14,15]. Some theoretical concepts that formulators should know are described as follows.

3.1 Liquid medication

The term 'liquid medication' is defined as liquid lipophilic drugs and drug suspensions or solutions of water-insoluble drugs in suitable non-volatile solvent systems. Examples of drug candidates include digoxin, digitoxin, prednisolone, hydrocortisone, spironolactone, hydrochlorothiazide, polythiazide, and other liquid medications such as chlorpheniramine, water-insoluble vitamins, fish oil, and so on [14,15]. Various non-volatile solvents used for the formulation of liquisolid systems include Polyethylene glycol 200 and 400, glycerin, polysorbate 80 and propylene glycol [19].

3.2 Liquisolid systems

These are the powdered forms of liquid medications prepared by conversion of liquid lipophilic drugs, or drug suspensions or solutions of water-insoluble solid drugs in suitable non-volatile solvent systems, into 'dry' (i.e., dry looking), non-adherent, free flowing and readily compressible powder admixtures by blending with selected carrier and coating materials. The process involved in this includes

heating a suitable amount of the drug with suitable non-volatile solvent so that drug dissolves or disperses in the solvent. This liquid medication is added to the mixture of carrier and coating materials to form the liquisolid system.

Liquid medications contained in these systems can be used to classify liquisolid systems into three subgroups, such as powdered drug solutions, powdered drug suspensions, which can be produced from conversion of drug solutions, or suspensions and powdered liquid drugs, which can be produced from the formulation of liquid drugs [14,15].

3.3 Liquisolid compacts

These are immediate or sustained release tablets or capsules that are prepared using the technique of 'liquisolid systems' with the use of adjuvants required for tableting or encapsulation, such as lubricants, and for rapid or sustained release action, such as disintegrants or binders, respectively [14,15]. Disintegrants such as sodium starch glycolate (Primogel) are used. For achieving sustained release, adjuvant such as HPMC K4 M is used [17].

3.4 Flowable liquid retention potential (Φ) or holding capacity of sorbent

This is the maximum weight of liquid that can be retained per unit weight of powder material in order to produce an acceptably flowing liquid/powder admixture [14,15]. The mechanism occurs as follows:

1) Liquid absorption in the interior of the particles.
2) After saturation of absorption, adsorption of the liquid onto the internal and external surfaces of the porous carrier particle.

$$\Phi = \frac{W_{\text{liquid}}}{W_{\text{solid}}} \quad (1)$$

As the Φ of the carrier approaches, the liquid is held entirely in the interior of the particles, which keeps their surfaces relatively dry, yielding powders with acceptable flow properties. Exceeding the Φ value causes saturation of the interior of the particles, resulting in the formation of a liquid layer on the carrier particles' available surface.

The Φ value can be determined by first determining the angle of slide and then the value of Φ is determined. These methods are described as follows.

3.5 Determination of angle of slide

Powder excipient or its mixture is accurately weighed and placed at one end of a metal plate (with a polished surface). This end is raised gradually until the plate makes an angle with the horizontal at which the powder is about to slide. This is called the angle of slide (θ). It is taken as a measure for the flow characters of powders. An angle of slide corresponding to 33° is regarded as optimal flow behavior [13].

3.6 Determination of flowable liquid retention potential

When determining the Φ value, powder excipients are mixed with varying concentrations of liquid paraffin or any non-volatile solvent such as light mineral oil and the angle of slide of these liquid–powder admixtures is determined as per Equation 1. The Φ values are plotted against corresponding angle of slide. The Φ value corresponding to an angle of slide of 33° is regarded as Φ of the excipient [13].

3.7 Compressible liquid retention potential

The compressible liquid retention potential (ψ value) is the maximum weight of liquid that can be retained per unit weight of the powder material to produce an acceptably compressible liquid or powder admixture [14,15]. In fact, this is the weight of liquid that can yield tablets of satisfactory mechanical strength without presenting any liquid squeezing out of liquisolid mass during compression.

3.8 Liquid load factor

Liquid load factor (L_f) is defined as ratio of weight of liquid medication (W) to weight of carrier material (Q) in the system [14,15].

$$L_f = W/Q \quad (2)$$

3.9 Preparation of liquisolid systems

Carrier and coating materials in their calculated amounts are blended in a mortar pestle. Simultaneously, drug and non-volatile solvent in calculated amounts is taken in a beaker and heated either to dissolve or to disperse the drug completely within the solvent. This hot medication is poured onto a blend of carrier and coating materials. The mixing process is carried out as explained by Spireas and Bolton [14,15]. This liquisolid medication is then compressed or encapsulated along with suitable excipients.

Advantages of liquisolid formulations:

1) Lower cost formulations than softgel capsules.
2) Production of them is similar to that of conventional tablets.
3) Modification of drug release achievable using suitable formulation ingredients.
4) Molecularly dispersed drug offers greater dissolution rate or drug release.
5) Enhanced bioavailability can be obtained as compared with conventional tablets.

4. Stability studies

Javadzadeh *et al.* [19] studied the effect of ageing on hardness and dissolution rate of carbamazepine liquisolid compacts. Tablets were kept for 6 months period at 25°C/75% relative humidity conditions. Results obtained after 6 months showed no significant difference in hardness of fresh and aged tablets, indicating $p > 0.05$. A comparison of the dissolution profiles

of aged versus fresh liquisolid tablets showed lower dissolution of aged tablets, but similarity factor (f_2) > 50 indicated acceptably similar dissolution profiles. Also, dissolution rate of aged tablets compared with conventional tablets indicated high dissolution rate, thus confirming superiority of liquisolid compacts. Similar observations were reported for piroxicam liquisolid tablets in another study by Javadzadeh *et al.* [20].

5. Formulation factors affecting performance of liquisolid formulations

5.1 Drug candidate and concentration of drug in liquisolid systems

The liquisolid technique was applied successfully to low-dose water-insoluble drugs such as prednisolone [21] and hydrocortisone [22]. Javadzadeh *et al.* [19] studied liquisolid tablets prepared using the high-dose water-insoluble drug carbamazepine, with the inclusion of some additives that can reduce the amounts of carrier and coating materials.

Drug concentration in liquisolid systems has a significant effect on dissolution rate. At certain concentration levels depending on solubility of drug in non-volatile solvent, the drug release remains similar; but at increasing concentrations, the drug release declines. This can also be proved from the fraction of molecularly dispersed drug, which is a fraction of saturation solubility of drug in liquid vehicle and drug concentration in liquid medication [21,22].

5.2 Effect of solvent/liquid vehicle

Various non-volatile solvents used for the formulation of liquisolid systems include Polyethylene glycol 200 and 400, glycerin, polysorbate 80 and propylene glycol [19]. Tiong and Elkordy formulated liquisolid tablets of naproxen using carriers such as Cremophor EL (polyoxyl 35 castor oil), Synperonic PE/L61 (poloxamer 181, polyoxyethylene-polyoxypropylene copolymer) and polyethylene glycol 400 (PEG 400) [23]. Before formulating active substances into liquisolid systems, it becomes necessary to determine solubility of the drug candidate in solvents. This can be determined using conventional procedures of saturation solubility studies. Solvent with greater solubility is selected for the formulation of liquisolid systems. Low solubility of the drug candidate confers low dissolution rates of formulation [21,22]. Not only the solubility in solvents but also the physicochemical characteristics such as polarity, viscosity, molecular mass, chemical structure and hydrophilicity have contributory effects on different phenomena, ranging from availability of drug molecules to dissolving medium, disintegration and deaggregation of carrier molecules and diffusion of liquid medication through primary carrying particles during the dissolution process.

In addition to the effect on dissolution, use of solvents can contribute to compactness in liquisolid compacts. This was attributed to hydrogen bonding owing to the presence of hydroxyl groups [24]. Also, non-volatile solvent can act as a binder in low concentration, and shows a negative effect on mechanical properties of liquisolid compacts in higher concentrations. Excessive non-volatile solvent causes generation of the capillary state of powder aggregation, and hence the surface tension effect becomes less significant in bringing the particles together, leading to poor bonding between powder particles. Also, decrease in tensile strength at high levels of solvent causes the formation of multilayers of solvent at particle surfaces. These layers disturb or reduce intermolecular attraction forces and hence decrease tablet strength. Therefore, in higher concentrations, non-volatile solvent covers contact points between particles and acts as a lubricant and does not allow particles to bind each other [20].

5.3 Effect of carriers

Generally used carriers include grades of microcrystalline cellulose such as PH 102, PH 101 and PH 200 [20], lactose [19], Eudragit RL and RS (to sustain drug delivery) [16], and so on.

Javadzadeh *et al.* [20] compared liquisolid formulations prepared using different carriers such as lactose, starch and sorbitol instead of microcrystalline cellulose. It was observed that carriers other than Avicel were required in higher amounts for conversion of liquid medication to dry, non-adherent, freely flowing powder. This was attributed to the high specific surface area of Avicel. Hence, specific surface area of the carrier seems to be an important factor in the formulation of liquisolid systems.

In formulations of tocopherol acetate using different carriers, Fujicalin and Neusilin mixtures showed improved flowability with increasing liquid drug content [25]. Javadzadeh *et al.* used different grades of carrier for formulation of liquisolid compacts of piroxicam. Microcrystalline cellulose (MCC) grades with particle sizes (micrometers) 47.92 (MCC PH 101), 108.8 (MCC PH 102) and 182.51 (MCC PH 200) were used. It was observed that there was no significant difference in dissolution profile in simulated intestinal fluid medium in liquisolid tablets prepared using different grades of MCC. This might be because of the high solubility and fast dissolution rate of piroxicam in this medium. However, in simulated gastric fluid, drug release was found to be dependent on particle size of the carrier. MCC PH 200-containing tablets showed lower drug release than that of the other two grades. This might be due to its large particle size.

It has already been proved that the tensile strength of tablets prepared using large particle size substances is less as compared with those prepared using small particle sizes. The same fact has been observed in the case of piroxicam liquisolid compacts prepared using different MCC grades [20].

Also, formulations containing MCC PH 101 showed better flow rate than that of MCC PH 200. Owing to the large particle size of MCC PH 200, carrier particles have low surface area that can accommodate a thicker layer of liquid medication distributed around its surface. Hence, liquid medication around these particle surfaces will be thicker for MCC PH 200 than for the smaller particles of MCC PH 101. This will increase

the tendency of particles to stick together, therefore causing poor flowablity of powder [20].

5.4 Effect of additives or adjuvants

To have acceptable flowability and compactability for liquisolid powder formulation, high levels of carrier and coating materials should be added, which will increase the weight of tablet above 1 g, leading to difficulty in swallowing. To reduce the amounts of carrier and coating materials in liquisolid formulations, additives such as polyvinylpyrrolidone (PVP), HPMC and polyethylene glycol (PEG 35000) were used. From the formulations prepared using these additives, the formulations using PVP showed increased dissolution rates.

Karmarkar *et al.* [17] used HPMC K4 M as a release-retarding adjuvant in addition to carrier and coating materials. Prepared liquisolid tablets were compared with marketed formulations and it was found that liquisolid tablets showed sustained release behavior.

6. Dissolution studies and analysis of dissolution data

Generally, dissolution studies of liquisolid compacts were carried out using USP Apparatus at constant r.p.m. at 37 ± 0.5°C. According to the 'Diffusion layer model' for dissolution, dissolution rate is in proportion to concentration gradient in a stagnant diffusion layer [21,22]. Drug dissolution is directly proportional to surface area available for dissolution [21,22]. If dissolution tests for liquisolid formulations were conducted at constant r.p.m. and in the same dissolution medium, the thickness of stagnant diffusion layer and diffusion coefficient for drug dissolution may be almost identical. Hence, surface area can be considered as a major factor responsible for enhancing dissolution rate. As liquisolid formulations contain a drug dissolved in non-volatile solvent (in the form of molecular dispersion), the drug surface available for dissolution is highly increased. Hence, molecularly dispersed drug in liquisolid tablets may be responsible for greater dissolution rates. Also, it has been proved previously that with low drug concentration in liquid medication, a more rapid drug release will be observed. This is because drugs in high concentration tend to precipitate within the silica pores (Aerosil 200). As stated by Spireas and Sadu [21], the solid/liquid interface between an individual liquisolid primary particle and the dissolving fluid involves minute quantities of aqueous medium clinging onto the particle surface. In such a microenvironment, it is quite possible that the infinite amounts of liquid vehicle diffusing with the drug molecules out of a single liquisolid particle might be adequate to enhance solubility of drug acting as cosolvent with aqueous dissolution medium.

Spireas and Sadu studied the effect of volume of dissolution medium on drug release from hydrocortisone and prednisolone liquisolid tablets [21,22]. It was observed that a decrease in volume of dissolution medium caused significantly decreased drug release from conventional tablets, whereas for liquisolid tablets drug release was independent of volume of dissolution fluid. Thus, liquisolid formulations could offer more consistent and enhanced *in vivo* dissolution and absorption characteristics.

6.1 Model-independent approach to compare dissolution profiles

According to US FDA guidance for dissolution data equivalence, a model-independent approach is recommended. Use of a pair-wise procedure such as similarity factor (f_2) provides a simple means to compare the data. The similarity factor (f_2) is a logarithmic reciprocal square root transformation of the sum of squared error and is a measurement of the similarity in the percentage dissolution between the two curves [26].

$$f_2 = 50 \times \log\left\{[1 + (1/n)\textstyle\sum_{t=1}^{n}(R_t - T_t)^2]^{-0.5} \times 100\right\} \quad (3)$$

where n is the number of time points, R is the dissolution value of the reference at time t, and T is the dissolution value of the test at time t.

6.2 Model-dependent methods to compare dissolution profiles

Liquisolid compacts release kinetics was analyzed by various mathematical models, which were applied considering the amount of drug released in time periods. Based on these estimations, mathematical models were described for dissolution profiles. The model fitting is represented in the form of the following plots: cumulative per cent drug release versus time (zero-order kinetic model); log cumulative per cent drug remaining versus time (first-order kinetic model); cumulative per cent drug release versus square root of time (Higuchi model); and cube root of per cent of drug remaining versus time (Hixon-Crowell cube root law).

6.3 Statistical methods

Two-way analysis of variance (ANOVA) is used to determine how dissolution is affected by two factors. ANOVA-based statistical methods provide simple ways to discriminate dissolution profiles. The percentage dissolved is a dependent variable and time is a repeated factor. Further analysis can be carried out by the Turkey test and paired sample t-test. For estimation of differences between batches, post tests such as the Turkey test were found to be useful. A paired sample t-test was used to compare each formulation with a marketed formulation.

7. Clinical profile findings

The clinical profile of liquisolid formulations was studied exhaustively by Khaled *et al.* [18]. They studied absorption characteristics of hydrochlorothiazide using six male Beagle dogs. The oral route of administration and two-way

Table 1. Competing technologies with liquisolid technique.

Serial No.	Technique	Mechanism	Ref.
1	Solid dispersion	Hydrophilic polymers	[29,30]
2	Processing with excipients using mills	Increase in surface area owing to size reduction	[31]
3	Inclusion complexation	Inclusion of active into clycodextrin structure	[32]
4	Ultrafine active development	Solidification process from emulsion	[33]
5	Micronization	Particle size reduction increasing surface area	[34]
6	Nanosizing	Processing through bead mill and subsequent spray drying	[34]
7	Evaporative precipitation into aqueous solution	Precipitation of the drug dissolved in volatile solvent into aqueous surfactant solution	[12]

crossover design was used for study. The results of liquisolid formulation when compared with commercial conventional tablets indicated a significant difference in pharmacokinetic parameters; 15% greater bioavailability was observed as compared with commercial oral dosage form. The parametric 90% confidence intervals for the different parameters were higher than the commonly expected intervals for bioequivalency, which indicated greater bioavailability of the liquisolid tablets.

Also, anticonvulsant activity of carbamazepine in liquisolid tablets as well as Tegretol® (Novartis, USA) 200 tablets and Tegretol suspension was determined by Tayel *et al.* [27] using the maximal electroshock method. Male albino mice, weighing 20 – 25 mg/kg, were fasted overnight and divided into 4 groups, each consisting of 6 animals. Drug in the dosage forms was given to mice in a dose of 35 mg/kg body weight. Absence of the hind limb tonic extensor component indicated that the drug received could prevent maximal electroshock seizure (MES) spread. From the results, it was observed that liquisolid tablets were of poorer potency compared with Tegretol suspension and tablets. This might be owing to high concentration of the drug, which caused its precipitation in the silica pores and therefore hindered the rapidity of dissolution on oral administration to the animals.

Fahmy and Kassem [28] studied performance of famotidine liquisolid tablets in 6 healthy male volunteers aged between 20 and 40 years. The dosage forms were administered following a single dose, randomized, crossover design. The volunteers were divided into two groups, each containing three volunteers. This bioavailability study indicated that the prepared optimal liquisolid formula did not differ significantly from the marketed famotidine tablets concerning C_{max}, t_{max}, and $AUC_{(0-8)}$ at $p < 0.05$.

8. Alternative technologies

The techniques that compete with the liquisolid technique are as shown in **Table 1**. Solid dispersion technology involves the use of different solubilizers or hydrophilic polymers [29,30]. Solid dispersions can be prepared by different methods, such as melting, solvent evaporation, condensation or cooling, and so on; but the drawback in this type of system involves the use of volatile solvents and the higher cost of solubilizers.

Jain *et al.* [31] studied the effect of powder processing performance on dissolution rate of Fenofibrate formulations. It was discovered that milling a blend of Fenofibrate/excipient (process C) was advantageous over milling the raw drug alone (process B). A rapid release rate was observed in process C. However, this method involves the use of jet milling for size reduction of the active constituent.

The process of inclusion complexation with cyclodextrins as a carrier seems to be very efficient [32]. The process, involving simple stirring for a few hours and then filtering the complex, which is dried further, is very useful in terms of scale-up aspects. However, the effectiveness of this method is limited because of the cost incurred in cylodextrins.

Huang *et al.* [33] prepared ultrafine Fenofibrate powder using a solidification process from emulsion. The solidification process from emulsion that consisted of emulsifier, water and molten drug as oil phase without use of any organic solvent was used. The effects of stirring speed and volume ratios of hot emulsion to cold water on the particle size and morphology were discussed as well as the impacts of different emulsifiers on emulsion. The dissolution property was found to be sufficiently improved than bulk fenofibrate. Although this process seems to be simple, it requires high expertise during emulsification and also higher cost of emulsifier.

Technologies such as micronization using jet milling and then media milling by ball mill to obtain nanosized particles were used by Vogt *et al.* [34]. Subsequently, spray drying was also carried out. Their limitations include high-end technologies of milling and spray drying.

Use of an evaporative precipitation [12] technique seems gives much smaller particle size down to nanometers, but this involves use of a HPLC pump, heat exchanger and specially fabricated nozzle.

Considering the limitations of the above technologies, it could be said that liquisolid formulations are less expensive, easy to formulate and are high-performance systems in terms of dissolution and bioavailability. The above advantages of the liquisolid technique are based on the literature data available and subject to case-to-case differences.

9. Conclusion

Liquisolid technology is effective in terms of its low-cost formulation, production capability similar to conventional tablets, and improved dissolution or sustained dissolution rate. It is an efficient way of converting liquid lipophilic drugs or solid drugs into dry, free flowing powders. Drug release can be modified using suitable formulation ingredients. Also, molecularly dispersed drugs can lead to enhanced bioavailability, as is evident from clinical studies.

10. Expert opinion

For dissolution rate enhancement or sustained release of drugs, many common technologies are available today; but these involve high production cost, sophisticated machinery, complicated technologies, intellectual property issues, and advanced preparation methods. However, liquisolid technology overcomes these barriers. As the administration route of liquisolid formulations is oral, they are easy with respect to patient acceptance. Many of the carriers and coating materials used in this technique are easily available in the market, and cost-effective. Liquisolid formulation is not just a mixture of liquid medication and carrier coating material blend, knowledge of the mathematical model by Spireas and co-workers is essential. The authors opine that extensive research regarding different sources and grades of carrier materials, for example microcrystalline cellulose grades, silica grades and lactose grades, and their different particle sizes and their effect on dissolution and absorption characteristics need to be studied. Also, in terms of sustained release dosage forms, the use of different adjuvants or carriers such as polyvinyl acetate copolymers, hypromellose, povidone, and so on, needs to be evaluated. There is also scope for evaluation of the effect of various disintegrants such as sodium starch glycolate, crospovidone, and croscarmellose sodium on dissolution behavior. In future, liquisolid technology will continue to advance, and will represent a viable alternative to conventional dosage forms.

Declaration of interest

The authors state no conflict of interest and have received no payment in preparation of this manuscript.

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