Research Article

Fabrication and Characterization of Compressed Solid Dispersion Based Fast Dissolving Tablets of Sildenafil Citrate

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ABSTRACT

Sildenafil citrate is a selective inhibitor of Phosphodiesterase type 5 enzyme (PDE5) extensively used for the treatment of erectile dysfunction (ED). Fast dissolving tablets of Sildenafil citrate were prepared by solvent evaporation method using different grades of PEG as carriers by direct compression technique. The inclusion of solid dispersion process as a step of preparation of fast dissolving tablets had a synergistic effect on the bioavailability of final dosage form by its contribution in improvement in solubility profile. Six batches (F1-F6) of fast dissolving tablets of Sildenafil citrate were prepared from optimized solid dispersion by using PEG 4000 and PEG 6000 in different concentrations. All the formulations were evaluated for weight variation, hardness, friability, drug content, *in-vitro* disintegration time, wetting time, *in-vitro* dissolution and batch F4 shows the values within the limits. The optimized batch of fast dissolving tablets showed drug release 99.78 ± 1.28% within 30 minute. Tablets containing solid dispersion exhibited better dissolution profile than marketed tablet. Thus, the solid dispersion technique can be successfully used for improvement of dissolution profile of Sildenafil citrate.

Keywords: Solid dispersion, Fast dissolving Tablets, Sildenafil citrate, Dissolution rate, Polyethylene glycol.

INTRODUCTION

An ideal dosage regimen in the drug therapy of any disease is the one, which immediately attains the desired therapeutic concentration of drug in plasma (or at the site of action) and maintains it constant for the entire duration of treatment. This is possible through administration of conventional dosage form in a particular dose and at a particular frequency. Drugs are more frequently taken by oral administration.

Approximately one-third of the population, primarily the geriatric and pediatric populations, has swallowing difficulties, resulting in poor compliance with oral tablet drug therapy which leads to reduced overall therapy effectiveness. A new tablet dosage form, the fast dissolving tablet has been developed which offers the combined advantages of ease of dosing and convenience of dosing in the absence of water or fluid. These tablets are designed to dissolve or disintegrate rapidly in the saliva generally less than 60 seconds. Due to the constraints of the current FDDT technologies as highlighted above, there is an unmet need for improved manufacturing processes for fast dissolving tablets that are mechanically strong, allowing ease of handling and packaging with production costs similar to that of conventional tablets.[1,2]

Salient Features of Fast Dissolving Drug Delivery System are Ease of administration to patients who refuse to swallow a tablet, such as pediatric, geriatric and psychiatric patients. No need of water to swallow the dosage from which is highly convenient feature for patients who are traveling and do not have immediate access to water, good mouth feel, rapid absorption and dissolution of drug which may produce rapid onset of action, an increased bioavailability particularly in cases of insoluble and hydrophobic drugs due to rapid disintegration and dissolution of these tablets, stability for longer duration of time since the drug remains in solid dosage form till it is consumed.[3,4]

According to Fincher, the majority of the poorly water-soluble drugs show poor bioavailability due to the poor rate of dissolution, which is further dependent on the surface area of the drug particle available for dissolution. Therefore, the dissolution rate can be enhanced by increasing the surface area. This can be achieved by the process of particle size reduction. Particle size reduction of the active pharmaceutical agent can be achieved by trituration and grinding, Ball milling, Fluid energy micronization, Precipitation under controlled condition which is achieved by changing solvents or temperature, by using ultrasonic waves or spray drying and using gastric fluid to precipitate the drug in the form of fine particles. The above mentioned methods are able to easily achieve the reduction in particle size.[5,6] However, the dissolution rate and absorption may not be increased due to the formation of aggregates and/or agglomerates among the fine particles which can be caused by increased surface energy and stronger Vander wall's interactions. Moreover, the fine drug particles may also have a wettability problem in water, which may lead to a poor dissolution rate. So in present study prepared solid dispersion of poorly water soluble drug dissolved in a carrier with relatively good aqueous solubility of particular interest as a means of improving oral bioavailability.[7-9] A unique technique known as solid dispersion was introduced by Sekiguchi and Obi in 1961

to reduce the particle size of the drug and increase the dissolution rate and rate of absorption.

The first solid dispersion was developed using sulfathiazole (a poorly water soluble drug) and urea (water soluble and physiologically inert) as a carrier to increase the dissolution rate and rate of absorption by reduction in particle size.

The technique used in the preparation of the solid dispersion of sulfathiazole with urea as a carrier included melting the physical mixture to a high temperature followed by rapid solidification. The drug in solid dispersion form was considered to be released as fine and dispersed particles when they come in contact with aqueous fluid.

Levy and Kanig, who worked with a number of drugs using mannitol as a carrier introduced the term solid-solid solution. Chiou and Niazi performed the experiment with sulfathiazole and urea and reported that the fused mixture of sulfathiazole and urea showed an increase in dissolution rates by forming an "amorphous precipitate" or "solid solution". In solid solutions the drug is considered to be dispersed in a soluble carrier.

Tachibana and Nakamura first introduced a new method of preparing a solid dispersion known as the solvent evaporation method. In this method they first dispersed β-carotene in a water-soluble polymer (Poly vinyl pyrollidone). They then dissolved both chemicals in a common solvent and finally completely evaporated the solvent.[10,11]

AIM AND OBJECTIVE

Aim of Study

The aim of the present study was to formulate the solid dispersion based compressed fast dissolving tablets of Sildenafil citrate for masking the taste of drug and to provide fast onset of action than conventional tablets.[12-15]

The overall objective of investigation has a three tier approach as below.

- Procurement, characterization and subsequent formulation of Sildenafil citrate into solid dispersions for fast bioavailability.

- Fabrication and optimization of compressed tablets using the prepared solid dispersion.

- Pharmacotechnical characterization and *in vitro* evaluation of formulated solid dispersions and tablet dosage form using conventional and advanced analytical tools.

MATERIALS AND METHODS

Sildenafil Citrate was procured from Rakshit Drugs Pvt. Ltd. Mannitol was received from Thomas Baker, Micro crystalline cellulose (Avicel 101), PEG 4000 and PEG 6000 from S.D. Fine Chem, Sodium starch glycolate was

procured from Sigma Eldrich.

Analytical Method Development

Determination of λmax

The λmax of Sildenafil Citrate was determined before developing the standard curves. In this study 100 μg/mL solutions of Sildenafil Citrate were prepared in phosphate buffer pH 6.8.

The resultant solution is scanned for maximum absorption from 200 to 400 nm wavelength range.

Calibration curve of Sildenafil Citrate

Calibration curve for Sildenafil Citrate was prepared in phosphate buffer of pH 6.8 at the obtained λ max. At first 1000 μg/ml solution is prepared by dissolving 100mg of pure drug in 100 ml of 6.8 pH phosphate buffer solutions and from this solution 5, 10, 15, 20, 25, 30 μg/ml solutions were prepared by suitable dilutions.

Method of Preparation of Solid Dispersion of Sildenafil Citrate

Solid dispersion of Sildenafil citrate was prepared by solvent evaporation method using different grades of PEG as carriers such as (PEG 4000 and PEG-6000 in different ratio 1:1, 1:2 and 1:3) (Table 1). The weighed quantity of drug and PEG (1:1) was taken in china dish; to which Methanol was added. The solvent was evaporated at room temperature and dried in hot air oven at 50 °C for 4 hrs. The resultant mass was passed through sieve no. 80 and stored in desiccators. The procedure was repeated with other carriers.

Table 1: Composition of solid dispersions and their assigned codes

Composition of Solid Dispersions and their Assigned codes			
S. No.	Drug: Polymer	Carrier	Batch code
1	1:1		SD1
2	1:2	PEG4000	SD2
3	1:3		SD3
4	1:1		SD4
5	1:2	PEG6000	SD5
6	1:3		SD6

Composition of Fast Dissolving Tablets of SILD SD						
Ingredients (mg)	SD1			SD4		
	F1	F2	F3	F4	F5	F6
Solid Dispersion equivalent to 20 mg of SILD	40	40	40	40	40	40
Sodium Starch glycolate	5	10	15	5	10	15
Spray Dried Mannitol	37	32	27	37	32	27
Avicel PH101	10	10	10	10	10	10
Peppermint	1	1	1	1	1	1
Aspartame	5	5	5	5	5	5
Talc	1.5	1.5	1.5	1.5	1.5	1.5
Magnesium stearate	0.5	0.5	0.5	0.5	0.5	0.5

Characterization of Prepared Solid Dispersions[16]

Percentage Yield

Yield was calculated with respect to dry product. Based on the practical yield (P.Y.) obtained and the calculated theoretical yield (T.Y.), % yield was calculated by using the following formula:

$$\% \, Yield = \frac{P.Y. \times 100}{T.Y.}$$

Drug Content

Solid dispersion equivalent to 20 mg of SIDL was taken and dissolved in 100-ml volumetric flask in pH 6.8 Phosphate Buffer. Absorbance was measured at 293 nm in triplicate by suitable dilution.

Solubility Studies

Excess amounts of SILD, SILD-PEG 6000, SILD-PEG 4000 physical mixtures as well as SDs were suspended in distilled water in tightly closed screw-cap vials, equilibrated in a shaking water bath at room temperature for 48 hours, then filtered using a 0.45-μm Millipore filter and assayed spectrophotometrically (Systronics, 2201) at predetermined λ max. Three determinations were carried out to calculate the saturated solubility of SILD.

Micromeritic Properties

Determination of Bulk density and Tapped density, True density, Carr's index and Hausner's ratio

Approximately 10g of Solid dispersion of Sildenafil citrate were separately weighed and passed through a sieve. The powders were sieved in accordance with FDA guidelines that state that the powders must be sieved with apertures to break up agglomerates which may have formed during storage. This must be done gently to avoid changing the nature of the powder. Drug powder was then transferred into a separate 100ml graduated measuring cylinder where the bulk density was determined by measuring the volume that the powder occupied (V_b). The tapped density of each powder was determined with the aid of a Digital tapped density tester. Following the agitation, the volume of the tapped powder was read (V_{tp}). The Carr's index, porosity and Hausner's ratio were calculated using Equations:

$$bulk \, density = \frac{mass}{Bulk \, volume}$$

$$Tapped \, density = \frac{mass}{tapped \, volume}$$

$$Carrs \, Index \, (CI) = \frac{tapped \, density - bulk \, density}{bulk \, density} \times 100$$

$$Hausner's \, ratio \, (HR) = \frac{tapped \, density}{bulk \, density}$$

$$Percent \quad , E = (1 - \rho_{BULK} / \rho_{TRUE})$$

Angle of Repose

The angle of repose was measured using a funnel method. Approximately 10g of powder was weighed and placed in a funnel. The height of the funnel was adjusted to a point where the tip of the funnel was just above the apex of the heap of powder. The powder was allowed to flow freely through the funnel onto a glass plate surface. The angle of repose was calculated using Equation:

$$tan\theta = \frac{h}{r}$$

Where, h = height of the pile of powder

r = radius of the heap of powder

θ = angle of repose

Dissolution Studies

In vitro dissolution studies were carried out in 900 mL of 6.8 pH phosphate buffer solution. Briefly, an amount of 20 mg of SILD free drug and an equivalent amount of drug loaded SDs were transferred to a USP dissolution test apparatus (Electrolab TDT - 08 L Dissolution testers USP) type 2 (paddle) rotating at 50 rpm and maintained at 37 ± 0.5 °C. At predetermined time intervals (5, 10, 15, 30, 45 and 60 min), an aliquot of dissolution medium was withdrawn and analyzed spectrophometerically for drug content. Withdrawn samples were replaced by 6.8 pH phosphate buffer solution for maintaining sink condition.

Preparation of Fast Dissolving Tablets

SILD SD tablets were prepared by the direct compression technique. Each tablet was composed of SD containing an amount equivalent to 20 mg of SILD, Talc and Magnesium stearate as lubricant, Aspartame and Peppermint as sweetening and flavoring agents, respectively. Sodium starch glycolate was used as superdisintegrant, along with other ingredients as shown in Table 1. Before compression, the previously sieved SDs and excipients were mixed in a glass mortar followed by tumbling for 15 min in a Turbula mixer, then lubricant was added and mixing was continued for further 5 min. The powder mix was compressed using a single tablet machine with a flat-faced punch of 7-mm diameter (MiniPress II, Karnavaty, India). Tablet weight was adjusted to 100 mg.

Evaluation of Prepared Tablets

The tablet thickness was determined by using Vernier caliper, while the tablet hardness and friability was determined using Monsanto tablet hardness tester and friabilator (Roche), respectively. The disintegration time was measured by using tablet disintegrator (Electrolab, India).

Wetting Time and Water Absorption Ratio

A piece of whatman filter paper folded twice was kept in a petridish (internal diameter 4 cm) containing 6 ml of purified water. A tablet having a small amount of Rosaline dye powder on the upper surface was placed on the tissue paper. When the upper surface of the tablet acquires a red colour, the time was recorded as wetting time. The same procedure without using Rosaline dye

was followed to determine the water absorption ratio (R) was determined according to the following equation:

$$R = \frac{W_a - W_b}{W_b} \times 100$$

Where, W_a and W_b were the weights of the tablet after and before the tests.

In vitro Drug Release Studies

In-vitro release studies were carried out in the USP dissolution test apparatus (Electrolab TDT - 08 L Dissolution testers USP) type 2 (paddle). 900 ml of dissolution medium (6.8 pH Phosphate buffer) was taken in covered vessel and the temperature was maintained at 37 ± 0.5 °C.

The speed of the paddle was set at 50 rpm. Sampling was done at predetermined time intervals (5, 10, 15, 20, 25 and 30 min). For each sample 5 ml of the dissolution medium was withdrawn and the same amount of dissolution medium at 37 °C was replenished to the dissolution medium.

The sample withdrawn was diluted with buffer solution and analyzed in UV-Spectrophotometer (UV-1700 Shimadzu Japan) at 293 nm.

Fourier Transform Infrared Spectroscopy (FTIR)

Drug (SILD), polymer interactions studies have been examined for the optimized formulations obtained after all the studies by FTIR (Thermo Scientific Nicolet 6700, USA).

Samples of 1-2 mg were mixed with 100 mg of dry potassium bromide powder and compressed into a disc with a hydrolic press.

The scanning range was 400 – 4000 cm^{-1}.

Stability Studies

A three month accelerated stability test was carried out after preparation in which sample were kept in humidity chamber at a temperature of 40 °C ± 2 °C and a relative humidity of 75 ± 5%.

The release profile of optimized formulation was determined at the end of 1, 2 and 3 months, respectively.

RESULTS AND DISCUSSION

Analytical Method Development

Determination of λmax

Characterization of Prepared Solid Dispersions

Percentage Yield, Drug Content and Solubility Studies

In the present study solid dispersions were prepared by solvent evaporation method. All the formulations prepared were found to be free flowing in nature.

The % yield, % drug content and solubility studies of prepared solid dispersion and pure drug are summarized

in Table 2. From the results obtained it has been found that percentage yield of SD1 and SD4 are 86.23 ± 0.002% and 88.25 ± 0.001% respectively. The solubility of SILD SD also increases as compared to pure drug Sildenafil citrate.

The highest solubility was obtained in case of SD2 and SD4 5.0 ± 0.12 and 4.99 ± 0.13 mg/ml respectively.

This shows that the solubility of solid dispersions prepared with PEG 4000 and PEG 6000 shows improved characteristics when compared to pure drug.

The λmax of Sildenafil Citrate was found to be 293nm.

Calibration Curve of Sildenafil Citrate

The calibration curve (Fig. 1), is drawn at the obtained λmax (293 nm). The correlation coefficient was found to be 0.9987, and slope is 0.0268 and intercept was -0.0039.
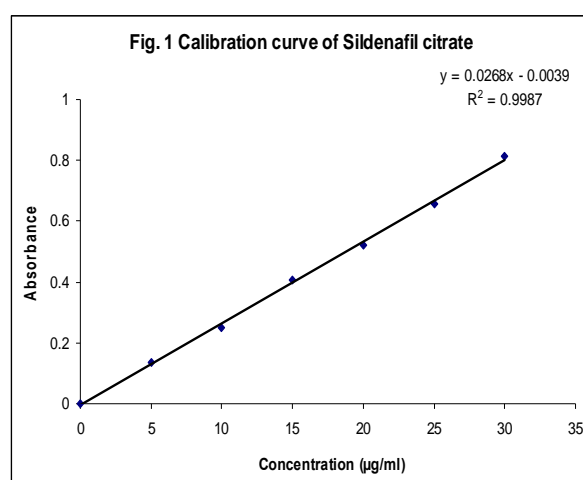
Figure 1: Calibration curve of Sildenafil citrate

Micromeritic Properties

The true density value of a powder provides useful information that can be applied to the characterization of the mechanical properties of powders on which properties of a tablet such as hardness and tensile strength are reliant.

Due to the fact that powders flow under the influence of gravity, dense particles are generally less cohesive than low density particles of similar size and shape.

Determination of the true density of the API and selected solid dispersions is a vital part of preformulation studies with regard to FDTs as these data are used to determine the porosity of a powder. The data is summarized in Table 2.

The bulk and tapped densities calculated along with the true densities determined in these studies were used to calculate Carr's Index, Hausner's ratio and porosity of SILD. These results are summarized in Table 2.

It is generally thought that granules that exhibit a greater degree of porosity will dissolve faster than denser granules as water is known to pass rapidly through porous substances.

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Available online at www.globalresearchonline.net
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Table2: Effect of drug/carrier ratio on % yield, % drug content and solubility of solid dispersion.

Code	Carrier	Drug: PEG ratio	% Yield	% Drug content	Solubility (mg/ml)
6 Effect of drug/carrier ratio on % yield, % drug content and solubility of solid dispersion					
SILD	-	-	-	-	3.3 ± 0.11
SD1	PEG 4000	1:1	86.23 ± 0.002	87.15 ± 0.002	4.92 ± 0.14
SD2	PEG 4000	1:2	84.22 ± 0.001	83.13 ± 0.011	5.0 ± 0.12
SD3	PEG 4000	1:3	80.19 ± 0.002	83.11 ± 0.003	4.97 ± 0.21
SD4	PEG 6000	1:1	88.25 ± 0.001	91.21 ± 0.001	4.99 ± 0.13
SD5	PEG 6000	1:2	86.11 ± 0.002	85.23 ± 0.002	4.85 ± 0.15
SD6	PEG 6000	1:3	83.10 ± 0.003	83.22 ± 0.002	4.3 ± 0.19

Parameters	Pure drug SILD	SD1	SD4	Inference
5 Micromeritic properties of pure drug and selected solid dispersions				
Bulk density (gm/cc)	0.464 ± 0.021	0.596 ± 0.108	0.62 ± 0.07	Increased
Tapped density (gm/cc)	0.546 ± 0.023	0.684 ± 0.095	0.695 ± 0.07	Increased
True density (gm/cc)	1.62 ± 0.04	1.73 ± 0.047	1.81 ± 0.056	Increased
Porosity (%)	53.33 ± 1.42	63.86 ± 0.73	76.96 ± 1.15	Loosely Packed
Carr's index (%)	34.6 ± 1.15	22.91 ± 0.61	18.98 ± 0.35	Excellent
Hausner's ratio	1.51 ± 0.02	1.29 ± 0.02	1.23 ± 0.02	Improved
Angle of repose (^{0})	39 ± 0.89	1.29 ± 0.02	24 ± 0.25	Excellent

Mean ± SD, n=3

Table 3: Dissolution profile of pure drug (SILD) and prepared solid dispersions

Time (min.)	Cumulative % drug release data for SILD and prepared SD (Mean ± SD, n=3)						
	SILD	SD1	SD2	SD3	SD4	SD5	SD6
0	0 ± 0.00	0 ± 0.00	0 ± 0.00	0 ± 0.00	0 ± 0.00	0 ± 0.00	0 ± 0.00
5	10.17 ± 0.15	20 ± 0.19	15.15 ± 0.15	14.89 ± 0.21	22.11 ± 0.54	20.19 ± 0.24	18.24 ± 0.32
10	23.31 ± 0.13	45 ± 0.21	41.11 ± 0.51	39.19 ± 0.28	41.29 ± 0.58	39.32 ± 0.45	38.27 ± 0.73
15	32.5 ± 0.21	67 ± 0.49	61.1 ± 0.87	58.21 ± 0.89	62.15 ± 1.05	59.15 ± 1.11	54.75 ± 0.85
30	45 ± 0.33	78 ± 1.13	68.22 ± 1.01	65.15 ± 1.13	77.23 ± 1.37	69.54 ± 1.31	63.28 ± 0.96
45	58 ± 0.37	89 ± 1.14	81 ± 1.29	78.23 ± 1.27	87.79 ± 1.23	85.4 ± 1.57	83.13 ± 1.19
60	77 ± 1.39	97 ± 1.89	93 ± 1.53	90.76 ± 1.28	98.12 ± 1.67	91.76 ± 1.75	89.15±1.31

Table 4: Evaluation of Fast Dissolving Tablets

| Code	Diameter (mm)	Thickness (mm)	Hardness (Kg/cm²)	Friability (%)	Wetting Time (sec)	Water absorption ratio (%)	Disintegration Time (sec)
F1	6.95 ± 0.01	2.29 ± 0.011	3.3 ± 0.01	0.531	31 ± 0.12	30	30 ± 0.13
F2	6.98 ± 0.02	2.18 ± 0.021	3.8 ± 0.01	0.29	29 ± 0.15	25	38 ± 0.3
F3	6.97 ± 0.02	2.16 ± 0.02	4 ± 0.02	0.17	30 ± 0.11	29	40 ± 0.4
F4	6.99 ± 0.015	2.35 ± 0.03	3.9 ± 0.02	0.15	29 ± 0.21	31	33 ± 0.2
F5	6.97 ± 0.02	2.21 ± 0.02	4.1 ± 0.03	0.19	31 ± 0.2	35	35 ± 0.2
F6	6.98 ± 0.011	2.19 ± 0.02	4.3 ± 0.02	0.09	33 ± 0.21	38	43 ± 0.5

*Mean ± SD, n=3

Table 5: Dissolution profile of Fast Dissolving tablets of SILD

Time (min)	Cumulative % drug release data for SILD and prepared SD (Mean ± SD, n=3)					
	F1	F2	F3	F4	F5	F6
0	0 ± 0.00	0 ± 0.00	0 ± 0.00	0 ± 0.00	0 ± 0.00	0 ± 0.00
1	1.11 ± 0.15	1.3 ± 0.19	1.9 ± 0.15	3.21 ± 0.21	2.5 ± 0.54	2.2 ± 0.24
2	2.2 ± 0.13	2.22 ± 0.21	5.5 ± 0.51	6.8 ± 0.28	6.3 ± 0.25	5.5 ± 0.39
3	3.17 ± 0.21	4.15 ± 0.21	15.19 ± 0.32	14.99 ± 0.39	15.55 ± 0.23	13.55 ± 0.41
4	11.19 ± 0.15	12.17 ± 0.21	24.14 ± 0.31	30 ± 0.47	25 ± 0.42	28.12 ± 0.41
5	21.11 ± 0.22	25.22 ± 0.23	43.13 ± 0.29	45.24 ± 0.43	45.11 ± 0.51	32.9 ± 0.49
7	41.37 ± 0.21	45.1 ± 0.25	65.21 ± 0.37	75 ± 0.45	65.2 ± 0.53	51.3 ± 0.49
10	60.29 ± 0.31	68.12 ± 0.26	70.11 ± 0.45	81.9 ± 0.69	76.7 ± 0.71	66.9 ± 0.56
15	65.11 ± 0.33	75.1 ± 0.85	85.23 ± 0.79	88.15 ± 0.81	85.31 ± 0.89	81.22 ± 0.79
20	71.17 ± 0.33	86.11 ± 1.13	90.11 ± 1.01	96.3 ± 1.13	94.6 ± 1.37	89.11 ± 1.31
25	77.73 ± 0.37	89.12 ± 1.14	93.23 ± 1.29	98.93 ± 1.27	98.12 ± 1.23	93.23 ± 1.57
30	89.11 ± 1.39	91.15 ± 1.89	99.53 ± 1.53	99.78 ± 1.28	99.45 ± 1.67	95.11 ± 1.75

In Vitro Dissolution Studies of Pure Drug and Prepared Solid Dispersions

Results of the *in vitro* dissolution study of pure drug (SILD) and prepared solid dispersion is illustrated in Table 3 and Figure 2. It was found that drug release profile improves in case of solid dispersions when compared to pure drug sildenafil citrate. Within 60mins of study around 77 ± 1.39 % of drug is released in case of SILD when compared to solid dispersions. All the six prepared solid dispersions shows almost 90 % drug release within 60 mins of study. Out of these six formulations of solid dispersion SD1 and SD4 shows maximum drug release i.e. 97 ± 1.89% and 98.12 ± 1.67% respectively. From the results it is evident that as the concentration of carrier increases the release profile decreases accordingly.
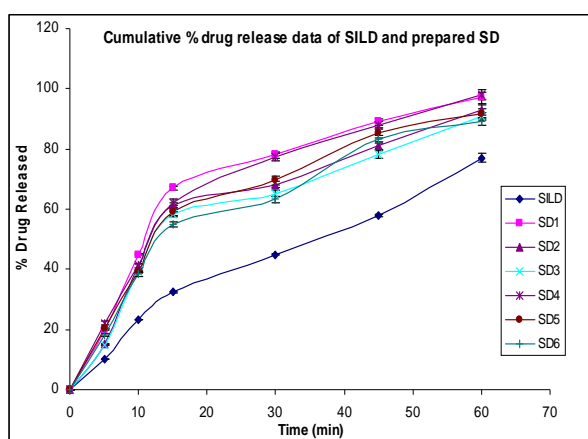
Figure 2: Dissolution profile of pure drug (SILD) and prepared solid dispersions

Based on all the evaluation parameters i.e. % yield, % drug content, solubility studies and dissolution profile formulations SD1 and SD4 has been selected for further preparation of fast dissolving tablets.

Preparation and Evaluation of Fast Dissolving Tablets

Fast dissolving tablets of the optimized solid dispersions i.e. SD1 and SD4 were prepared according to the formula given in Table 1 by direct compression technique. Three different formulations were prepared for each group of optimized solid dispersions with varying concentrations of super disintegrant sodium starch glycolate. For SD1, formulations F1, F2, F3 and for SD4, formulations F4, F5, F6 were prepared respectively.

The compressed tablets were evaluated for different parameters like thickness, friability, hardness, wetting time, water absorption ratio and disintegration time. The details of findings are summarized in Table 4. From the results it has been found that formulation F4 has optimum diameter 6.99 ± 0.015 mm and thickness 2.35 ± 0.03 mm. Formulation F3 has the least tablet thickness amongst all the formulations prepared.

Maximum hardness is obtained in case of F6 and least in case of F1 i.e. 4.3 ± 2 and 3.3 ± 0.01 kg/cm^2 respectively. Similarly wetting time also varies from 29 ± 0.15 sec to 33 ± 0.21 sec for formulations F2 and F6 respectively (Table 4).

In vitro Drug Release Studies

In vitro drug release studies of fast dissolving tablets prepared from optimized solid dispersions SD1 and SD4 had been summarized in Table 5 and Figure 3. It has been found that almost more than 90 % of drug is released from all the formulations within 30 minutes except formulation F1 in which 89.11 ± 1.39 % drug is released within 30 minutes. As the concentration of super disintegrant increases the disintegration of tablets becomes faster which leads to the increased dissolution properties in case of FDT prepared from SD1 i.e. by using PEG 4000. But in case of SD4 i.e. FDT prepared from PEG 6000 the drug release properties decreases significantly.
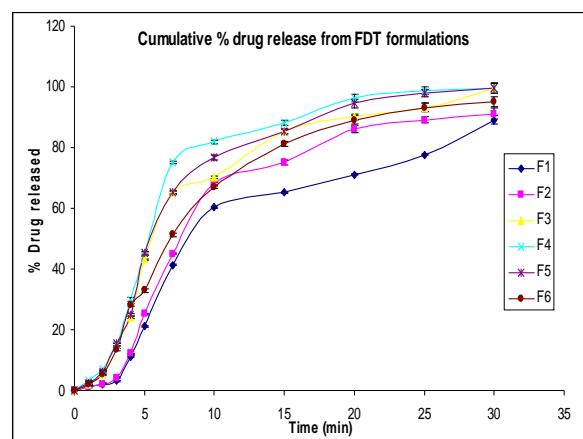
Figure 3: Dissolution profile of Fast dissolving tablets of optimized solid dispersions.

Amongst all the formulations F4 shows the better release properties i.e. within 30 minutes it releases almost 99.78 ± 1.28% of drug from the prepared fast dissolving tablets.

Drug Excipients Interaction Study

IR analysis of Sildenafil citrate pure drug shows peaks at 3613 cm^{-1} for OH stretching, 3293 cm^{-1}, 3028 cm^{-1} for NH and CH (aromatic) stretching respectively.

Similarly peaks at 1358, 1174 cm^{-1}, for SO$_2$ stretching and around 1700 it shows C=O stretching.

Similarly IR analysis of PEG 6000 shows peaks at 3440 cm^{-1} for OH stretching and 2837 cm^{-1} for CH stretching and 1871 cm^{-1} for C=O stretching. And in case of sodium starch glycolate (SSG) IR analysis reveals a broad peak at 3290 cm^{-1} that is attributed to H bonding with the broad band at 1000 cm^{-1} being representative of the C-O bonds.

Stability Studies

Formulated tablets of F4 formulation showed no significant variation in dissolution profile under the test period at different conditions.

All the test results were found to be in limits. Hence the formulations were stable under stated storage conditions. The results are shown in Table 6.

Table 6: Effect of storage condition on dissolution study of SILD tablets

Storage Conditions	Cumulative % drug released in 30 min.			
	Initial	1 month	2 month	3 month
40 °C ± 2 °C / 75 ± 5% RH	99.78	99.79	99.77	99.76

CONCLUSION

Fast dissolving tablet proves its significance for enhancing the bioavailability of water insoluble drug by increasing its dissolution and solubility. The inclusion of solid dispersion process as a step of preparation of fast dissolving tablets have a synergistic effect on the bioavailability of final dosage form by its contribution in improvement in solubility profile. The solid dispersion batch SD4 having drug polymer ratio 1:1 i.e. PEG 6000 respectively showed best % cumulative drug release 98.12 ± 1.67 % within 60 min among the six batches. It follows the order SD4 > SD1 > SD2 > SD5 > SD3 > SD6. SD1, SD2, SD3 are prepared with PEG 4000 as carriers and SD4, SD5, SD6 by using PEG 6000 as carrier. Out of these 6 solid dispersions SD4 and SD1 has been selected basing on the different results obtained, for the preparation of fast dissolving tablets. Six batches of FDT have been prepared, three from each category with varying concentration of super disintegrants sodium starch glycolate. The F4 batch of fast dissolving tablets showed best % cumulative drug release 99.78 ± 1.28% within 30 min among all 6 batches of fast dissolving tablets. It follows the order F4 > F3 > F5 > F6 > F2 > F1. It is observed that wetting time (29 ± 0.21 sec) and disintegration time (33 ± 0.2 sec) of F4 batch was minimum in comparison to other batches of fast dissolving tablets. So it proves that the concentration of superdisintegrants in release profile of fast dissolving tablets. Thus optimization of compressed solid dispersion based fast dissolving tablets containing Sildenafil citrate was done and formulation was developed and it was observed that final formulation shows satisfactory results.

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