ORIGINAL ARTICLE

Formulation and Evaluation of Immediate Release Tablet of Carvedilol using Liquisolid Compacts Technique for Solubility Enhancement

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Abstract

Aim: The aim of this study was to formulate and evaluate liquisolid compact system of carvedilol to give increased dissolution rate of drug by utilizing PEG400 as the non-volatile liquid vehicle. **Materials and Methods:** The liquisolid tablets formulated with PEG400 at different concentrations. The suitable analytical method based on UV-visible spectrophotometer was developed for carvedilol. **Results and Discussion:** The results of differential scanning calorimeter and Fourier transform infrared analysis confirmed that the excipients are compatible with the drug. The liquisolid tablets formulated with PEG400 at drug concentration 20% w/w is the best formulations among the other 10 batches of liquisolid tablet prepared, in terms of superior dissolution profile. LSC3 with *R* value 15 gave the maximum drug release. Short term accelerated stability study of optimized formulation (LSC3) of carvedilol was carried out at 40°C ± 2°C and at 75% ± 5% RH for 1 month. **Conclusion:** Immediate release tablet of carvedilol using liquisolid compacts technique was prepared and evaluated for the compatibility studies. No significant change or variation was observed in any parameters throughout the study.

Key words: Biopharmaceutics classification system, differential scanning calorimeter, dissolution, liquisolid compact, solubility

INTRODUCTION

Over the few decades, various approaches or techniques have been introduced to solve the problem of formulation challenge of poorly soluble substances, with the novel aim of enhancing drug dissolution characteristics, with different degrees of success. For drugs belonging to Biopharmaceutics classification system (BCS) Class II (poor water solubility and high permeability) dissolution rate (D_R) is rate determining step in drug absorption.[1] The challenge for poorly water-soluble drugs is to enhance the rate of dissolution. This in turn subsequently improves absorption and bioavailability.[2] A liquisolid compact is one of the most promising and new technique which promotes D_R of water-insoluble drugs.[3] It is believed that better bioavailability of poorly soluble drugs could be achieved when the drug is present in solution as in liquisolid formulations.[4] The liquisolid technique could be promising strategy in improving dissolution of poorly water-soluble drug and formulating immediate release solid dosage form. The term "liquisolid systems" refers to powdered forms of liquid medications formulated by converting liquid lipophilic drugs or drug suspensions or drug solutions of water-insoluble solid drugs in suitable non-volatile solvent systems, into "dry" non-adherent, free-flowing and readily compressible powder admixtures by blending the suspension or solution with selected carriers and coating materials.[5] Carvedilol is a BCS Class-II drug and it is insoluble in water and bioavailability is only 25-30%.[6] The solubility and bioavailability of carvedilol are increased significantly by liquisolid compact technique. In this case, even though the drug is in a solid dosage form, it is held within the powder substrate in solution or in a solubilized, almost molecularly dispersed state, which contributes to the enhanced drug dissolution properties.[7] Besides drug release enhancement, the liquisolid approach is

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a promising technique because of the simple manufacturing process, low production costs, and the possibility of industrial manufacture due to the good flow and compaction properties of the liquisolid formulations.

MATERIALS AND METHODS

Materials

Carvedilol was obtained as a gift sample from Matrix Laboratories, Hyderabad. Avicel pH 102 was obtained as a gift sample from Maple Biotech, Pvt. Ltd., Pune. Aerosil 200 and sodium starch glycolate were obtained from S.D. Fine-Chem. Ltd., Mumbai. PEG200 and PEG400 were obtained from Mercury Labs Ltd., Baroda.

Selection of excipients

Polyethylene glycol (PEG400) is used as a liquid vehicle to prepare the liquid medication of the different concentrations. Avicel pH 102 is chosen as carrier material because of high surface area of Avicel (1.18 m^2/g) in comparison with other carriers. Aerosil 200 is used as coating material. This has high adsorptive properties and large specific area, imparts good flow properties to the liquisolid systems. Sodium starch glycolate is used as a super disintegrant.

Solubility studies

To find out the best non-volatile solvent for dissolving or suspending of carvedilol in liquid medication, solubility studies of carvedilol were carried out in different non-volatile solvents, i.e., PG, glycerin, PEG200, PEG400, and Tween80. Saturated solutions were prepared by adding an excess drug to the vehicles and shaking on the orbital incubating shaker (Remi International, India) for 24 h at 25°C under constant vibration of speed 50 rpm. After this period, the solutions were filtered through a 0.45 µm Millipore filter, diluted with distilled water and analyzed by UV-spectrophotometer (Shimadzu-1800, Japan) at a wavelength of 242.2 nm against blank sample (blank sample contained the same concentration of specific solvent used without drug). Three determinations were carried out for each sample to calculate the solubility of carvedilol.[8]

Precompression parameters[9]

All the batches of the formulation were evaluated for various parameters, i.e. angle of repose, Carr's index and Hausner's ratio and results are shown in Table 1.

Angle of repose (θ)

Angle of repose was determined by funnel method. The blend was poured through a funnel that can be raised vertically until a maximum cone height (h) was obtained. Radius of the heap (r) was measured, and the angle of repose was calculated. It is the angle produced between the heap of the pile and base.[10]

Angle of repose, $\tan(\theta)=h/r$

Where,
θ=Angle of repose,

Table 1: Flowability parameters of carvedilolliquisolid powder system

Formulation No	Average angle of repose (θ)±SD (*n*=3)	Average Carr's index (*n*=3)	Average Hausner's ratio (*n*=3)
F1	42.80±1.12	33.33	1.50
F2	32.66±0.65	25.00	1.33
F3	31.56±1.82	20.00	1.25
F4	30.76±1.05	18.52	1.23
F5	30.58±1.1	17.39	1.21
F6	35.93±1.6	31.82	1.47
F7	34.63±0.77	29.17	1.41
F8	35.54±0.51	20.00	1.25
F9	32.33±0.69	19.41	1.24
F10	32.66±1.4	20.56	1.26
F11	38.88±0.94	28.75	1.40
F12	34.78±0.86	27.27	1.38
F13	33.62±0.59	25.71	1.35
F14	27.03±0.92	20.00	1.25
F15	26.57±1.32	18.75	1.23
DCT	25.25±0.73	16.67	1.20

SD: Standard deviation, DCT: Dynamic contour tonometry

h=Height of heap and,
r=Radius of pile.

Compressibility index

The simplest way of the measurement of free flow of powder is compressibility. The indication of the ease with which a material can be induced to flow is given by compressibility index.

$$I=[(Vb-Vt)/Vb]\times 100 \quad (c)$$

Where,
Vb=Bulk volume
Vt=Tapped volume.

Hausner's ratio

Hausner found that the ratio tapped density/bulk density was related to interparticle friction as such, could be used to predict powder flow properties. He showed that the powder with low interparticle friction had a ratio of approximately 1.2, whereas more cohesive less free flowing powders have Hausner's ratio greater than 1.6 Hausner's ratio <1.25 indicate good flow.

Preparation of carvedilol liquisolid compacts

Carvedilol liquisolid compacts each containing 12.5 mg of drug was prepared as per the formulae given in Table 2. The desired quantities of the previously weighed of the solid drug and the liquid vehicle (PEG 400) were mixed. The solution was then sonicated for 15 min until a homogeneous drug solution was obtained. Next, the calculated weight (W) of the resulting liquid medications (equivalent to 12.5 mg drug) was incorporated into the calculated quantities of the carrier material (Avicel pH 102) (Q) and mixed thoroughly. The resulting wet mixture was then blended with the calculated amount of the coating material (Aerosil 200) (q) using a standard mixing process to form simple admixture. Several factors were varied like concentration of the drug in liquid vehicle PEG400, i.e., 20%, 30%, 40%, w/w and carrier: Coat ratios (different *R* values) ranging from 5 to 30 was employed. Different liquid load factors (L_f) ranging from 0.657 to 0.113 were employed. Finally, 5% w/w of sodium starch glycolate as the disintegrant was mixed with the above mixture for 10 min.

Preparation of plain tablet of pure drug

Plain tablets of pure carvedilol containing 12.5 mg of dose were prepared using concave faced punch and die, size of 8 mm on multiple punch tablet machinery (Rimek minis press I).

Evaluation of liquisolid tablet[11]

Prepared tablets were subjected to evaluation of different properties including drug content uniformity, weight variation, tablet hardness, friability, tablet dimensions, disintegration time test, and *in vitro* drug release is given in Tables 3 and 4.

Tablet dimensions

Thickness and diameter were measured using vernier caliper. Three tablets from each formulation were used, and average values were calculated.

Table 2: Composition of different carvedilol liquisolid formulation prepared using PEG-400 as a liquid vehicle according to mathematical model

Formula	Drug concentration in PEG-400	R	L_f	Avicel (Q=W/L_f) (mg)	Aerosil (q=Q/R) (mg)	SSG 5% (mg)	Unit dose weight (mg)
1		5	0.657	95.129	19.025	9.297	185.952
2		10	0.331	188.821	18.882	14.221	284.425
3	20%	15	0.222	261.109	18.740	19.071	361.421
4	(50 mg)	20	0.168	342.023	18.601	23.848	446.973
5		30	0.113	409.853	18.328	33.193	523.875
6		5	0.657	63.409	12.681	6.197	123.948
7		10	0.331	125.861	12.586	9.479	189.586
8	30%	15	0.222	187.376	12.491	12.712	254.240
9	(29.16 mg)	20	0.168	247.976	12.398	15.896	317.931
10		30	0.113	366.510	12.217	22.125	442.512
11		5	0.657	47.564	9.512	4.648	92.9764
12		10	0.331	94.410	9.440	7.110	142.212
13	40%	15	0.222	140.554	9.303	9.535	190.710
14	(18.75 mg)	20	0.168	186.011	9.305	11.924	238.486
15		30	0.113	274.926	9.162	16.596	331.937

Table 3: Evaluation of liquisolid tablets

Formulation No.	Thickness (mm)±SD (*n*=3)	Diameter (mm)±SD (*n*=3)	Hardness (kg/cm^2)±SD (*n*=3)	Weight variation (g)±SD (*n*=3)
LS1	3.43±0.057	9.52±0.05	1.83±0.25	182.42±7.16
LS2	4.52±0.057	9.54±0.01	2.76±0.15	286.28±5.13
LS3	4.93±0.057	9.53±0.57	3.5±0.26	358.75±6.40
LS4	5.76±0.057	9.54±0.57	4.4±0.10	442.56±6.25
LS5	6.24±0.057	9.52±0.57	5.53±0.20	525.25±7.27
LS6	3.12±0.057	9.56±0.057	1.9±0.30	127.19±6.1
LS7	3.28±0.057	9.54±0.057	2.6±0.26	184.38±5.1
LS8	4.34±0.057	9.55±0.057	3.6±0.20	258.85±6.24
LS9	4.55±0.057	9.56±0.57	4.73±0.20	314.66±7.5
LS10	5.42±0.057	9.55±0.57	5.66±0.15	448.53±6.24
LS11	2.91±0.057	9.52±0.057	2.1±0.17	98.68±5.77
LS12	3.04±0.057	9.54±0.057	2.86±0.05	146.95±5
LS13	3.16±0.057	9.52±0.1	3.8±0.10	188.33±7.63
LS14	3.74±0.057	9.56±0.057	4.76±0.15	244.56±5
LS15	4.18±0.057	9.54±0.57	5.7±0.1	335.25±5

SD: Standard deviation

Table 4: Evaluation of liquisolid tablets

Formulation No.	Friability (%)	Disintegration time (s)±SD (*n*=3)	% drug content±SD (*n*=3)	% drug release in 20 min±SD (*n*=3)
LS1	0.92	133.67±10.60	97.62±2.52	88.13±2.60
LS2	0.90	112.67±11.2	96.96±1.46	76.71±1.76
LS3	0.78	71.00±3.00	99.45±1.90	99.54±2.82
LS4	0.65	58.00±6.56	98.53±0.080	97.17±2.11
LS5	0.43	48.67±5.51	98.26±1.33	77.67±3.18
LS6	0.76	145.00±11.0	95.68±2.34	86.14±3.00
LS7	0.72	108.19±10.37	97.72±2.55	72.31±1.93
LS8	0.54	96.00±12.77	98.48±1.42	86.14±2.18
LS9	0.69	86.00±10.00	98.40±1.57	96.22±4.21
LS10	0.42	64.67±7.51	97.90±1.25	78.23±2.99
LS11	0.66	126.33±6.62	96.18±4.17	62.03±2.76
LS12	0.72	102.67±9.66	94.45±1.92	70.11±2.81
LS13	0.34	83.67±8.50	97.92±1.45	79.19±3.89
LS14	0.48	74.00±9.54	96.14±1.43	80.77±1.86
LS15	0.38	50.00±6.56	98.45±1.00	65.28±2.74
DCT	0.58	98.00±7.00	98.73±1.61	50.87±2.86

SD: Standard deviation, DCT: Dynamic contour tonometry

Tablet hardness

Tablets should be sufficiently hard to resist breaking during normal handling and yet soft enough to disintegrate properly after swallowing. The hardness of the liquisolid compacts prepared was evaluated using Monsanto hardness tester. It is expressed in kg/cm^2. The mean hardness of each formulation was determined.

Friability[10]

Tablet hardness is not an absolute indicator of strength since some formulations compressed into very hard tablet tend to cap on attrition losing their crown portions. Therefore another measure of tablets strengths, its friability is often measured. Roche friabilator was used for testing the friability using the following procedure. 20 tablets of carvedilol were

weighed and placed in the Roche friabilator, and apparatus was rotated at 25 rpm for 4 min. After revolutions, the tablets were deducted and weighed again is given in Table 5-7.

Weight variation test[12]

The weight of tablet is measured to ensure that a tablet contains the proper amount of drug. Weight variation test was performed as per IP 2007. 20 tablets were selected randomly and weighed. Average weight of the tablet was determined. Not more than the two of the individual weights deviate from the average weight by more than 5% percentage deviation.

Drug content uniformity[13]

The amount of active ingredient(s) is determined by the method described in assay and amount of active ingredient is calculated. 20 tablets were weighed and powdered. The quantity equivalent to 100 mg of carvedilol was weighed accurately and taken in 100 ml volumetric flask in a 100 ml of 0.1N HCl buffer in a 100 ml volumetric flask, sonicated for 5-10 min. This is considered as a stock solution-I (SS-I) of concentration 1000 µg/ml. From SS-I is filtered through Whatmann filter paper and 10 ml was pipette out and add to 100 ml volumetric flask make the volume up to mark as SS-II of 100 µg/ml. From which 0.6 ml was pipetted out in 10 ml volumetric flask which is makeup to the volume (6 µg/ml), and the absorbance was recorded at 242.2 nm. The drug content uniformity was calculated using the following formulae is given in Table 6.

Practical Yield=Absorbance/slope×Dilution Factor

% Drug content=Practical yield/Theoretical yield×100

In vitro disintegration time

The *in vitro* disintegration time of a tablet was determined using disintegrating apparatus as per I.P. specification.

I.P. specification: Place one tablet in each of the 6 tubes of the basket. Add a disc to each tube and run the apparatus using 1.2 pH buffer maintained at 37°C ± 2°C as the immersion liquid. The assembly should be raised and lowered between 30 cycles/min.[14]

In vitro dissolution testing

A dissolution study was conducted for all the formulation using USP XX III dissolution test apparatus (Electrolab, Mumbai, India). The dissolution test was performed using 900 ml of

Table 5: Drug release of liquisolid formulations containing 20% Cd value

Time	LS1 (R=5)	LS2 (R=10)	LS3 (R=15)	LS4 (R=20)	LS5 (R=30)	DCT
0	0	0	0	0	0	0
5	86.54	82.24	90.14	83.66	78.62	52.32
10	94.35	85.35	98.38	88.25	83.74	59.74
15	97.85	89.42	99.24	93.36	86.62	63.84
20	98.62	94.16	99.58	95.96	89.85	65.92

DCT: Dynamic contour tonometry

Table 6: Drug release of liquisolid formulations containing 30% Cd value

Time	LS6 (R=5)	LS7 (R=10)	LS8 (R=15)	LS9 (R=20)	LS10 (R=30)	DCT
0	0	0	0	0	0	0
5	82.35	79.65	84.62	81.16	78.28	52.32
10	85.25	84.14	89.36	87.68	80.46	59.74
15	94.85	92.85	94.54	91.55	87.98	63.84
20	96.12	95.76	96.84	94.58	93.58	65.92

DCT: Dynamic contour tonometry

Table 7: Drug release of liquisolid formulations containing 40% Cd value

Time	LS11 (R=5)	LS12 (R=10)	LS13 (R=15)	LS14 (R=20)	LS15 (R=30)	DCT
0	0	0	0	0	0	0
5	78.25	76.6	73.96	72.85	71.8	52.32
10	81.26	80.54	79.75	77.25	73.56	59.74
15	85.39	83.67	82.52	81.17	78.32	63.84
20	88.12	87.53	89.64	83.48	81.27	65.92

DCT: Dynamic contour tonometry

phosphate buffer pH 1.2 were taken as dissolution media at 75 rpm and 37°C ± 0.5°C. 5 ml of aliquots were periodically withdrawn at 5 min interval, and the sample volume was replaced with an equal volume of fresh dissolution media and samples were analyzed spectrophotometrically at 242.2 nm is given in Table 8.

Stability studies

Stability studies were carried as per ICH guideline. In this study, stability studies were carried out at 40°C ± 2°C and 75% ± 5% RH for a specific time period up to 30 days for the selected formulations is given in Table 9.[15]

Assessment and comparison of drug D_R[16,17]

For assessment and comparison, drug D_R of the drug was used. For this mean amount of drug (in µg) dissolved per min that presented by each tablet formulation during the first 10 min were calculated as follows:

$D_R=(M\times D)/1000$

Where,
M=Total amount of carvedilol in each tablet (in this study, it is 12,500 µg)
D=Percentage of drug dissolved in first 10 min.

RESULTS AND DISCUSSION

Compatibility study

Fourier transform infrared (FT-IR) spectrums of pure carvedilol and in combination with the excipients are shown in Spectra 1 and 2, respectively. From the results, it was concluded that there was no interference in the functional groups as the principle peaks of the carvedilol, which were found to be unaltered in the spectra of the drug-polymer mixture.

Table 8: Comparisons of D_R

Formulation	Q_{10}%	D_R (µg/min)
DCT	59.74	746.75
LS3	98.38	1229.75
LS8	89.36	1117
LS13	79.75	996.87

DCT: Dynamic contour tonometry, D_R: Dissolution rate

Solubility studies

The solubility % w/w of carvedilol was checked in various non-volatile solvents such as glycerin, Tween 80, PG, PEG200, and PEG400. It shows that carvedilol has the lowest solubility in glycerin. The solubility was found to be increased when semi-polar solvents such as polyethylene Glycol 200, 400 were used. The solubility of carvedilol was considerably increased in the presence of PEG400.

Precompression parameters

The effect of liquid load factor (L_f), which is a ratio of mass of liquid (PEG400) added to the mass of Avicel pH 102 on flowability and compressibility of the final admixture of the powder is shown in Table 1. Increasing the L_f value in the range of 0.657-0.20, i.e., increasing the volume of the liquid vehicle resulted in decrease in the flowability of the final admixtures. This is evident from the increase in the angle of repose. With the increase in L_f value flow property was found to be reduced. It also resulted in a decrease in the compressibility of final admixture. As a general guide angle of repose greater than 50°have unsatisfactory flow properties whereas minimum angle close to 25°correspond to very good flow property. Powders showing Carr's index up to 21 are considered of acceptable flow property. Formulations LS3, LS4, LS5, LS8, LS9, LS10, LS14, LS15, and dynamic contour tonometry (DCT) were proven to be acceptably flowing according to angle of repose, Carr's index and Hausner's ratio.

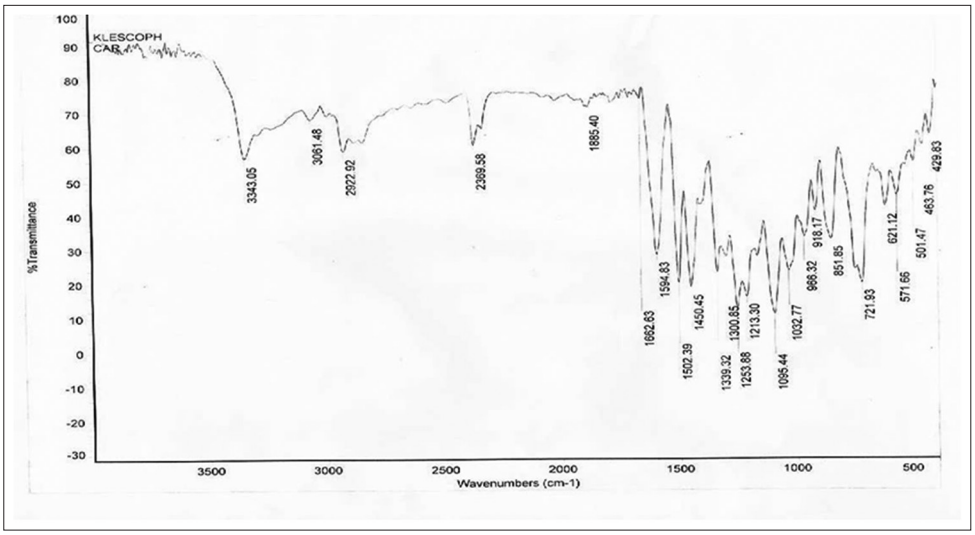
Evaluation of liquisolid compacts

Tablet dimensions

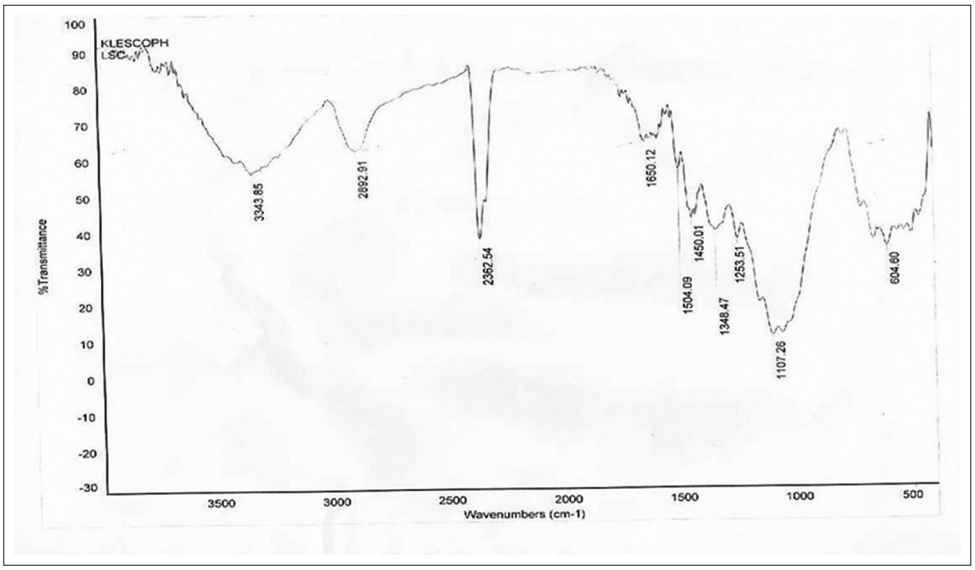
Thickness of liquisolid compacts ranged from 2.36 ± 0.057 to 6.33 ± 0.057 mm and diameter of all the liquisolid compacts was found to be 9.52-9.56 mm.

Table 9: Evaluation parameters of stability batch (LS-3)

Evaluation parameters	Before stability storage	After 15 days storage	After 1 month storage
Ardness (kg/cm^2)	3.5±0.26	3.3±0.75	3.2±0.4
Friability (%)	0.74	0.72	0.70
Weight variation (mg)	307±6.40	306±7.56	306.0±5.67
Disintegration time (s)	71.00±3	70±6	70±8
Drug content (%)	99.45±9	98.78±6.6	98.34±4.5
% Drug release (20 min)	99.54±2.42	98.86±1.34	98.12±2.3



Spectra 1: Infrared spectrum of carvedilol



Spectra 2: Infrared spectrum of LSC

Hardness

The formulation should be directed at optimizing tablet hardness without applying excessive pressure, while at the same time assuring rapid tablet disintegration.

Hardness was found to be in the range of 1.83 ± 0.25-5.66 ± 0.15 kg/cm^2

Weight variation test

Weight variation test revealed that the tablets were within the range of Pharmacopoeial specifications. All the formulations pass weight variation test. Ranges of tablets are in the 98.68 ± 5.77-525.25 ± 15.27.

Friability

All the liquisolid compacts had acceptable friability as none of the tested formulae had percentage loss in tablet's weights that exceed 1%. Friability below 1% is an indication of good mechanical resistance of the tablets.

Disintegration time

All the liquisolid compacts disintegrated within 3 min. The disintegration time test revealed that the liquisolid tablet formulae disintegrated within 15 min which is as per specifications given for the uncoated tablets in the IP. Microcrystalline cellulose has disintegration property, which could facilitate disintegration of tablets and dissolution of the drug.

Drug content

A fundamental quality attribute for all pharmaceutical preparations is the requirement for a constant dose of the drug between individual tablets. Uniform drug content was observed for all the formulations (94.45±1.92% to

99.45±1.90±1.57%), which is as per the IP specification (90-110%).

The *in vitro* dissolution study of carvedilol liquisolid tablet

The results of *in vitro* percentage amount of drug released at different time intervals plotted against time to obtain the release profiles shown in Graphs 1-3. The drug release from DCT as shown in was very poor. From figure, it was apparent that formulations LS3 and LS4 have the highest drug release rate. Among all the formulations, the liquisolid compact having 20% w/w drug concentration, i.e., drug: PEG400 ratio 1:4 exhibits greater release than liquisolid compact containing 30% w/w drug concentration, i.e., the drug:PEG 400 ratio 1:2.34 exhibits greater release and liquisolid compact containing 40% w/w (drug:PEG 400 ratio 1:1.5). From the above results, it is clear that as there was increase in amount of liquid vehicle, there was increase in the D_R.

The formulation containing Cd 40% had lower % drug release than 20%, 30%. However, it still higher than DCT, it shows that liquisolid formulation show enhanced D_R.

Comparisons of D_R

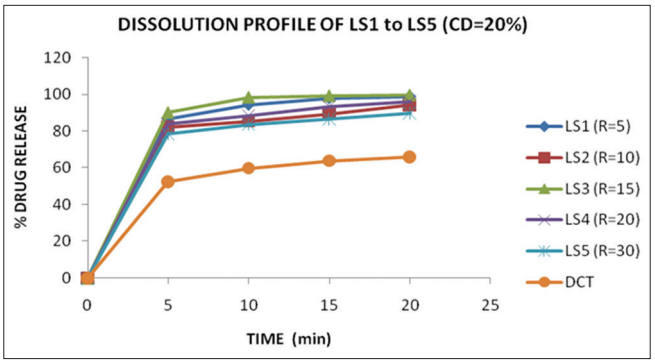
The D_R of LSC3, LSC8, and LSC13 which showed higher dissolution and DCT are compaired. The percent of drug dissolved from each formulation after 10 min (Q_{10}) and the drug release rate (D_R) were taken as a measure of the extent and the rate of drug dissolved from the prepared tablets, respectively.

Stability studies

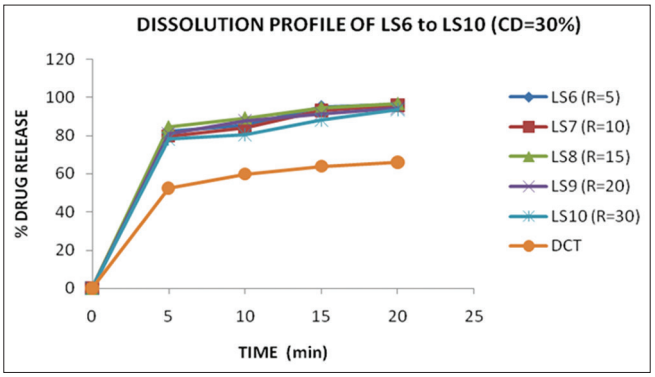
Optimized formulation LSC3 was kept for accelerated stability study at 40°C ± 2°C and 75% ± 5% RH for 1 month in the stability chamber. After storage, the formulation was analyzed for various physical parameters such as hardness, friability, weight variation, drug content uniformity and cumulative % drug released and *in vitro* disintegration time. The results are shown in Table 9. No major difference was found between evaluated parameters before and after ageing/storage and all are in acceptable limits.

CONCLUSION

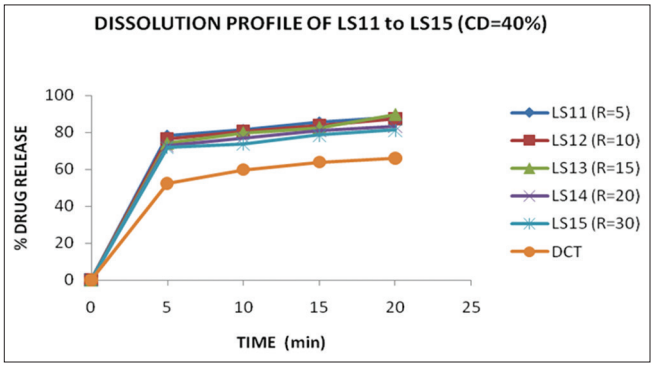
Immediate release tablet of carvedilol using liquisolid compacts technique was prepared and evaluated for the compatibility studies using FT-IR from the data obtained; it can be concluded that carvedilol is compatible with all ingredients used in the formulation. The solubility studies showed that PEG-400 is the best non-volatile solvent in which carvedilol has greater solubility. The *in vitro* dissolution studies of carvedilol liquisolid compacts showed higher



Graph 1: Dissolution profile of batches R=20 containing carvedilol



Graph 2: Dissolution profile of batches R=30 containing carvedilol



Graph 3: Dissolution profile of batches R=40 containing carvedilol

drug release than the DCT. Among all the formulations, the liquisolid compacts having 20% w/w drug concentration, i.e., drug:PEG 400 ratio 1:4 exhibits greater release than liquisolid compacts containing 30% w/w drug concentration (drug: PEG 400 ratio 1:2.34) exhibits greater release and liquisolid compacts containing 40% w/w (drug: PEG 400 ratio 1:1.5). *In vitro* release profile of batch LSC3 (having 20% w/w drug concentration, R=15,) shows 99.58% drug release in 20 min. Based on the drug release profile LSC3 formulation was selected as the optimized formulation and subjected to further evaluation. Formulations containing excipient ratio (R) R=15 showed higher D_R. Hence, this ratio was found to be more successful in formulating the carvedilol

liquisolid compacts. The stability study shows that the dissolution of liquisolid tablets was not affected by ageing significantly.

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