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FORMULATION, DEVELOPMENT AND *IN-VITRO* RELEASE KINETICS OF TELMISARTAN TABLET PREPARED BY LIQUISOLID TECHNIQUE

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ABSTRACT
The aim of this study was to improve the dissolution rate of the poorly soluble drug Telmisartan by delivering the drug as a liquisolid compact. Telmisartan is an angiotensin II receptor antagonist (ARB) used in the management of hypertension. Liquisolid technique is a new and promising method that can change the dissolution rate of drugs. The technique of liquisolid preparation is used to formulate drug solution in solid dosage forms. Drug solution is generally, prepared by dissolving the drug in non-volatile water-miscible solvent. The prepared liquisolid formulation contains the drug held in solution. Accordingly, the dissolution step, a pre-requisite for drug absorption, may be by-passed and better bioavailability of poorly soluble drugs is achieved. Liquisolid system refers to formulations formed by conversion of liquid drugs, drug suspension or drug solution in non-volatile solvents into dry, non adherent, free flowing and compressible powder mixtures by blending the suspension or solution with selected carriers and coating materials. To improve the dissolution properties of the poorly soluble drug telmisartan, liquisolid compaction technique has been employed. The study demonstrated with confidence that the liquisolid technique is promising approach for improvement of solubility of poorly soluble drugs. Several batches of formulation are conducted with combination of excipients and polymers like Propylene glycol, Polyethylene glycol-400, Tween 80, Micro crystalline cellulose, Sodium starch glycolate and Neusilin combinations in different proportions. The prepared tablets were evaluated for thickness, weight variation, hardness, drug content uniformity. Also, in vitro drug dissolution study was carried out. The results of dissolution study of F8 (Tween 80 in 1:1 ratio) was compared with marketed and the results shows better dissolution profile. FTIR study revealed that there is no drug excipient interaction. From this study it was concluded that the liquisolid technique is an effective approach to enhance the dissolution rate of telmisartan. The developed formulation was tested for its stability for three months and found to be stable.

Keywords: Telmisartan, Propylene Glycol, Propylene Glycol-400, Tween 80, Micro Crystalline Cellulose, Sodium Starch Glycolate, Neusilin, Telmisartan

INTRODUCTION
The liquisolid technique as described by Spireas (2002) is a novel concept, where a liquid may be transformed into a free flowing, readily compressible and apparently dry powder by simple physical blending with selected carrier and coating material (Spireas, 2002; Merisko, 2002). The liquid portion, which can be a liquid drug, a drug suspension or a drug solution in suitable non-volatile liquid vehicles, is included into the porous carrier material. Inert, preferably water-miscible organic solvent systems with high boiling point such as liquid polyethylene glycols, propylene glycol, or glycerin are most excellent fitting as liquid vehicles. As the carrier is saturated with liquid, a liquid layer is formed on the particle surface which is instantly adsorbed by the fine coating particles (Jarowski *et al.,* 1992; Barzegar *et al.,* 2005). The liquisolid compacts are acceptably flowing and compressible powdered forms of liquid medications. The term 'liquid medication' refers to liquid lipophilic (oily) drugs or water-insoluble solid drugs dissolved in suitable water-miscible non-volatile solvent systems termed as the liquid vehicle (Nokhodchi *et al.,* 2011). Such liquid medication may be converted into a dry-looking, non-adherent, free flowing and readily compressible powders by a simple admixture with selected powder excipients referred to as the "carrier and coating materials".
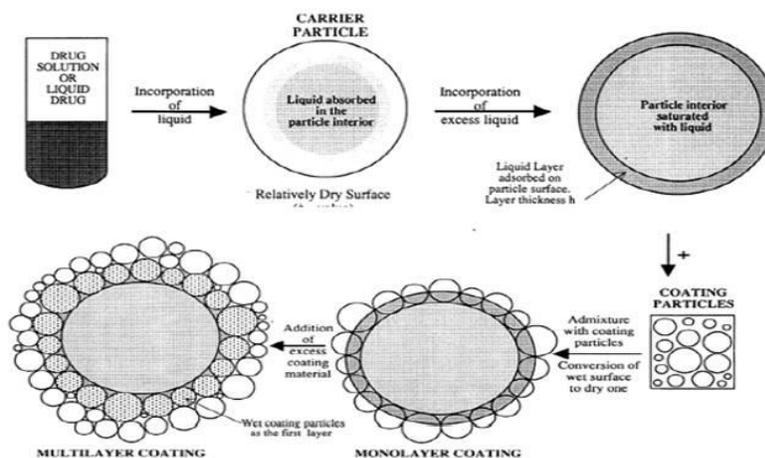
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In the liquisolid systems, even though the drug might be in a solid dosage form, it is held within the powder substrate in solution or in a solubilized, almost molecularly dispersed state (El-Houssieny *et al.,* 2010). Therefore, due to their significantly increased wetting properties and surface area of drug available for dissolution, liquisolid compacts of water-insoluble substances may be expected to display enhanced drug release characteristics and consequently improved oral bioavailability (El-Houssieny *et al.,* 2010; Khaled *et al.,* 2001). In current generation inadequate solubility of drugs, which are demanding issue for industry throughout development of the ideal solid dosage unit. This technique is based upon the admixture of drug loaded solutions or liquid drug with appropriate carrier and coating materials (Naseem *et al.,* 2004; Charman and Charman, 2003).

Telmisartan is an angiotensin receptor blocker (also called an angiotensin-II receptor antagonist (AIIRA) and acts by blocking the effect of angiotensin II and reduces blood pressure. Telmisartan is a class II drug of BCS classification i.e., low solubility and high permeability. One of the major problems with telmisartan is its low solubility in biological fluids, which results in poor bioavailability after oral administration. The solubility of telmisartan in aqueous medium was very low i.e., 0.078 mg/mL in water. Absolute bioavailability of the telmisartan was 42-58% that results into poor bioavailability after oral administration. Poor solubility of telmisartan leads to poor dissolution and hence variation in bioavailability. Thus increasing aqueous solubility and dissolution of telmisartan is of therapeutic importance.
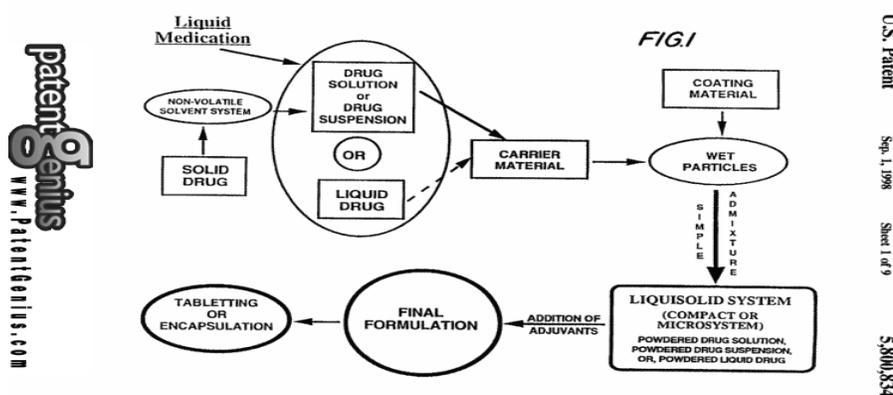
1.   A

1.   B
Figure 1: Mechanism of Liquisolid Compacts

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Applications
1. Rapid release rates are obtained in liquid-solid formulations.
2. These can be efficiently used for water insoluble solid drugs or liquid lipophilic drugs.
3. Application in probiotics.

MATERIALS AND METHODS
Materials Used
The following materials were obtained from commercial sources and used for the formulation. The drug telmisartan was received as gift sample from Torrent Pharma. Other excipients were received from different manufacturer propylene glycol, poly ethylene glycol-400, tween-80, microcrystalline cellulose-102, sodium starch glycolate, aerosil-200, magnesium stearate and talc from S.D fine chemicals limited, Hyderabad, Telagana, India; neusilin from Fuji chemical industry co. ltd, India.

Equipments Used
The following equipments were used for the formulation were M/S Cad mach machinery Co. Pvt. Ltd., digital weigh balance from Shimadzu, Japan; Fluidized bed dryer, double cone blender from Cadmach, Ahmadabad, Gujarat. Rapid mixture granulator from Remi, Mumbai; Monsanto Hardness tester from Pharma lab, Ahmedabad; Roche Friabilator from Tab-Machines, Mumbai, Disintegration tester from Electrolab, Chennai; Dissolution apparatus from Electrolab TDT 08L; UV-VIS Spectrophotometer from Labindia, Mumbai. The hot air oven from Tempo Instruments, Mumbai; and glass wares from Borosil and Anumbra.

Preformulation Studies (Gopinath and Naidu, 2011; Kailash et al., 2013)
The first step in any formulation activity is careful consideration of a complete physicochemical profile of the active ingredients available, prior to initiating a formulation development activity. The basic purpose of the preformulation activity are to provide a rational basis for the formulation approaches, to maximize the chances of success in formulating an acceptable product, and to ultimately provide a basis for optimizing drug product quality and performance. Drug-excipient stability study forms heart of such data. Following receipt of the preformulation information, the formulator may prepare a general summary statement concerning the drug and its properties relative formulation. Before embarking actual experimental run preformulation considerations become important.

The overall objective of preformulation testing is to generate information useful in developing the formulation which is stable and bioavailable.

Further the use of preformulation parameters maximizes the chances in formulating an acceptable, safe, efficacious and stable product. For any drug substances to formulate into a dosage form, it is necessary to study the physicochemical properties of the bulk drug like physical appearance, solubility, bulk density, tapped density, compressibility and melting point.

Micromeritical Properties: The following micromeritical properties of all the formulations were determined like Densities, Compressibility index, Angle of repose and Hausner ratio. They were calculated and all estimated parameters were found within the limits.

Determination of solubility: The solubility study was assessed using shake flask method. The solubility of Telmisartan as pure drug was determined in distilled water, propylene glycol, Poly ethylene glycol-400, Tween -80 and phosphate buffer pH 6.8.

Excess quantities of pure drug was added in 25 mL of solvent in 250 mL conical flask and shaken for 72 hours at room temperature on rotary flask shaker (Secor, India). The entire samples were protected from light by wrapping the flask by aluminum foil. The absorbance of resulting solution was measured by UV spectrophotometer at 257 nm.

Drug Excipients Compatibility Studies: The successful formulation of a stable and effective solid dosage form depends on the careful selection of the excipients that are added to the formulation. The drug and excipients must be compatible with one another to produce a product that is stable, efficacious and safe. Fourier-transform infrared (FTIR) spectra of the Drug and polymer were obtained on Alpha Brooker FTIR (Tokyo, Japan). The spectra were scanned over the wave number range of 4200 to 500 cm^{-1}.

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Analytical Method

Preparation of Standard Curve of Telmisartan: About 100 mg of Telmisartan pure drug was accurately weighed and transferred into a 100 mL clean and dry volumetric flask, dissolved with little quantities of methanol, then the volume was made up to 100 mL with methanol (1000 µg/mL). From this solution, 10 mL of solution was withdrawn into a 100 mL volumetric flask and made up to 100 mL with 6.8 phosphate buffer to get a concentration of 100 µg/mL. From this, again pipetted out 10 mL of solution and diluted to 100 mL with 6.8 phosphate buffer to get a concentration of 10 µg/mL. The absorbance of the resultant solution was measured at 227 nm using UV/VIS spectrophotometer against blank (6.8 phosphate buffer). Further dilutions has been done to prepared 2, 4, 6, 8, 10µg/mL.

Preparation of Telmisartan Liquisolid Compacts (Darwish and El-Kamel, 2001; Lbenberg and Amidon, 2000; Modi and Tayade, 2006; Hiremath et al., 2008; Rasenack and Muller, 2002; Papadimitriou et al., 2008; Smirnova et al., 2004; Fahmy and Kassem, 2008; Sailaja et al., 2015; Poluri et al., 2014; Swamy and Shiny, 2013; Mays et al., 2014)

1. The drug telmisartan was initially dispersed in the non volatile solvent systems (Tween 80, Propylene glycol, PEG 400) termed as liquid vehicles with different drug : vehicle ratio.

2. Then a mixture of carrier and coating materials were added to the above liquid by continuous mixing for a period of 10 to 20 minutes in a mortar. The amount of carrier and coating materials are enough to maintain acceptable flow and compression properties.

3. To the above binary mixture disintegrant like sodium starch glycolate and other remaining additives are added according to their application and mixed in a mortar.

4. The final mixture was compressed to achieve tablet hardness or encapsulated.

5. Characterized the final liquisolid granules for solubility, flowability, compressibility and dissolution.
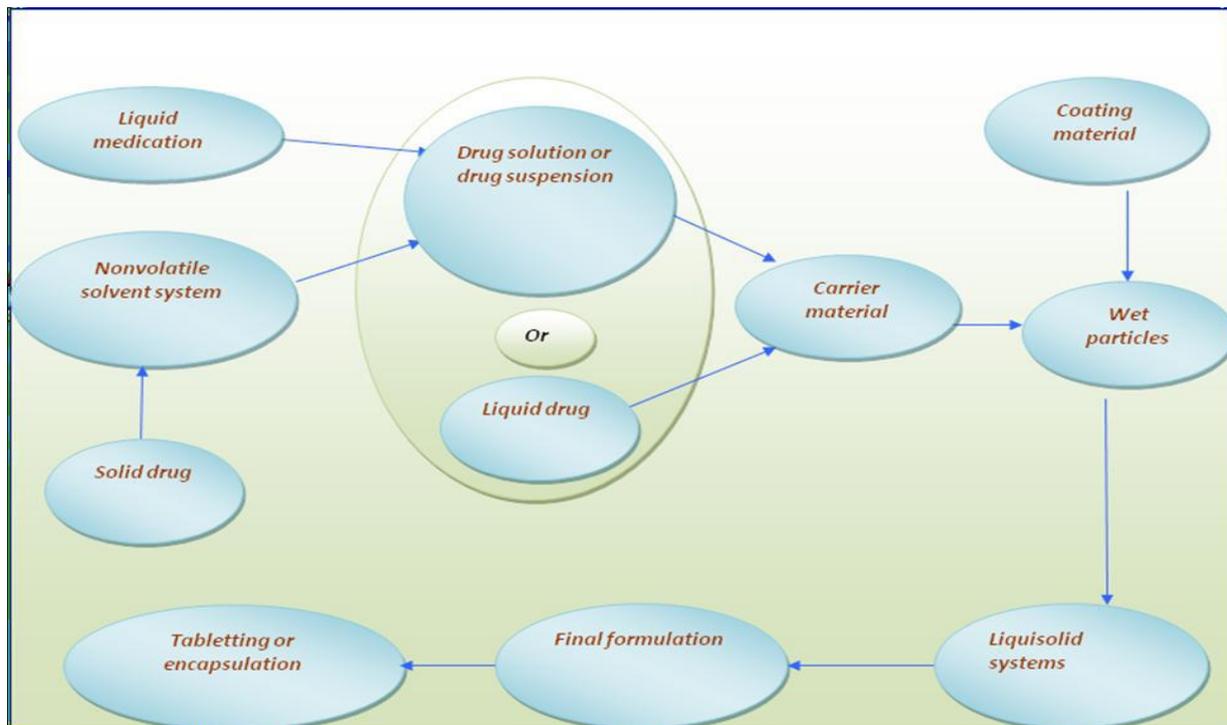

Figure 2: Steps in preparation of Telmisartan Liquisolid compacts

Preparation of Conventional Tablet of Telmisartan

Conventional telmisartan tablet was prepared by mixing 20 mg of drug with micro crystalline cellulose (Avicel pH 102), Aerosil-200 and superdisintegrant (i.e. sodium starch glycolate etc.) and mixed for 10 minutes. Finally, magnesium stearate and talc was added and then the powders were punched into tablet.

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Table 1: Composition of Telmisartan Tablets

Sr. No.	Ingredient	C	F1	F2	F3	F4	F5	F6	F7	F8	F9
1	Telmisartan	20	20	20	20	20	20	20	20	20	20
2	Poly ethylene glycol-400	----	20	----	----	20	----	----	----	**----**	----
3	Propylene glycol	----	----	20	----	----	20	----	----	**----**	----
4	Tween-80	----	----	----	20	----	----	20	20	20	20
5	AVICEL- PH 102 (Microcrystalline Cellulose)	140	120	120	120	120	120	120	100	90	80
6	Neusilin	----	----	----	----	----	----	----	20	30	40
7	Aerosil-200	6	5	5	5	6	6	6	6	6	6
8	Sodium Starch Glycolate	10	10	10	10	10	10	10	5	5	----
11	Magnesium stearate	2	3	3	3	2	2	2	2	2	2
12	Talc	2	2	2	2	2	2	2	2	2	2
	Total weight (in mg)	180	180	180	180	180	180	180	180	180	180

*R value for all formulations is constant (i.e. 20)

Evaluation of Tablets (Pharmainfo.net)
In addition to routine tests for general appearance, Hardness, Friability, Drug content, Weight variation, Uniformity of content and *In-vitro* Drug release must have to be evaluated.

a. Weight Variation Test: To study weight variation, 20 tablets of each formulation were weighed using an electronic balance and the test was performed according to the official method.

$$\% \text{ Deviation} = \frac{\text{Individual weight-Average weight}}{\text{Average weight}} \times 100.$$

Sr. No.	Average mass	Percentage deviation
1.	130 mg or less	± 10
2.	More than 130 mg and less than 324 mg	± 7.5
3.	324 mg or more	± 5

b. Hardness: For each formulation, the hardness of 6 tablets was determined using the Monsanto Hardness Tester and the average was calculated and presented with standard deviation.

c. Thickness: The thickness of the tablets was determined using a Screw guage.

d. Friability: A sample of 6 tablets was taken and was carefully dedusted prior to testing. The tablets were accurately weighed and placed in the drum of the Roche Friabilator. The drum was rotated for 100 times at 25 rpm and the tablets were removed, dedusted and accurately weighed. Friability of tablets was calculated by using following equation.

$$F = \frac{\text{Initial weight –Final weight}}{\text{Final weight}} \times 100.$$

e. Content Uniformity or Assay: The content uniformity test is used to ensure that every tablet contains the amount of drug substance intended with little variation among tablets within a batch. Due to increased awareness of physiological availability, the content uniformity test has been included in the monographs of all coated and uncoated tablets and all capsules intended for oral administration where the range of size of the dosage form available include 50 mg or smaller sizes.

f. Disintegration time: For a drug to be absorbed from a solid dosage form after oral administration, it must first be in solution, and the first important step toward this condition is usually the break-up of the tablet; a process known as disintegration. The disintegration test is a measure of the time required under a

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given set of conditions for a group of tablets to disintegrate into particles which will pass through a 10 mesh screen. Generally, the test is useful as a quality assurance tool for conventional dosage forms.

g. In-vitro drug release: The drug release from the Telmisartan tablets was investigated in a USP-II (paddle) apparatus, 900 mL of Phosphate buffer pH 6.8 (50 rpm, 37°C). At predetermined time intervals, 5.0 mL samples were withdrawn and diluted to suitable concentration and then analyzed with UV spectrophotometry at λmax=227 nm.

h. Stability studies (Wolfgang, 1998]: Selected formulation was subjected to stability studies as per ICH guidelines. Following conditions were used for stability testing.

1. 25°C/60 % RH analyzed every month for period of three months.
2. 30°C/75 % RH analyzed every month for period of three months.
3. 40°C/75 % RH analyzed every month for period of three months.

RESULTS AND DISCUSSION

The physical attributes of the tablet were found to be satisfactory. Typical tablet defects, such as capping, chipping and picking, were not observed. The results of various evaluation studies mentioned above are discussed under the following sections:

1. Pre-Formulation Studies: The Pre-formulation characteristics were evaluated for Telmisartan. The results of Pre-formulation studies are given in Table 2. Melting point of Telmisartan was found to be 263°C. It is within the melting range of Telmisartan. The evaluated powder flow characters indicated that pure drug has poor flow properties.

Table 2: Pre Formulation Study

Sr. No.	Characterization	Results
1.	Physical Appearance	Telmisartan is a white crystalline solid
2.	Melting point	263 ºC
3.	Bulk density	0.376 gm/mL
4.	Tapped Density	0.421 gm/mL
5.	Carr's index/Compressibility index	11.9
6.	Hausner's Ratio	1.119

2. Solubility studies: Solubility of samples was determined by saturated solubility experiments. The data are represented in table 3.

Table 3: Solubility of Telmisartan in different solvents

Solvent	Solubility (mg/ml)
Water	0.08
Polyethylene Glycol-400	80.72
Propylene Glycol	49.09
Tween 80	107.63
Buffer pH (6.8)	0.08

3. Drug Excipients Compatibility Studies: Fourier-transform infrared (FTIR) spectra of the Drug and polymer were obtained on Alpha Brooker FTIR (Tokyo, Japan). The spectra were scanned over the wave number range of 4200 to 500 cm^{-1}. The FTIR spectra of pure Telmisartan showed major band at 3331.07 cm^{-1} for Aromatic –NH stretch, 1743.65cm^{-1} for C=O stretch, 1348.24cm^{-1} for Aromatic -N0$_2$, 2841.5 cm^{-1} for -CH stretch, 2953 cm^{-1} for –CH stretching for methyl group, 3101 cm^{-1} for Aromatic Benzene ring . The Telmisartan in the physical mixture showed the major–band at 3404.36.4 cm^{-1} for NH stretching and 1735.93 cm^{-1} for C=O stretch.

4. Standard graph of Telmisartan in 6.8 phosphate buffer: The standard graph of telmisartan in 6.8 phosphate buffer showed a good linearity with R^2 of 0.999, and the equation of graph was y = 0.062x -

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0.004. The data is represented in table 4. The standard curve of telmisartan in 6.8 phosphate buffer is shown in figure 3.

Table 4: Standard graph of Telmisartan in 6.8 phosphate buffer

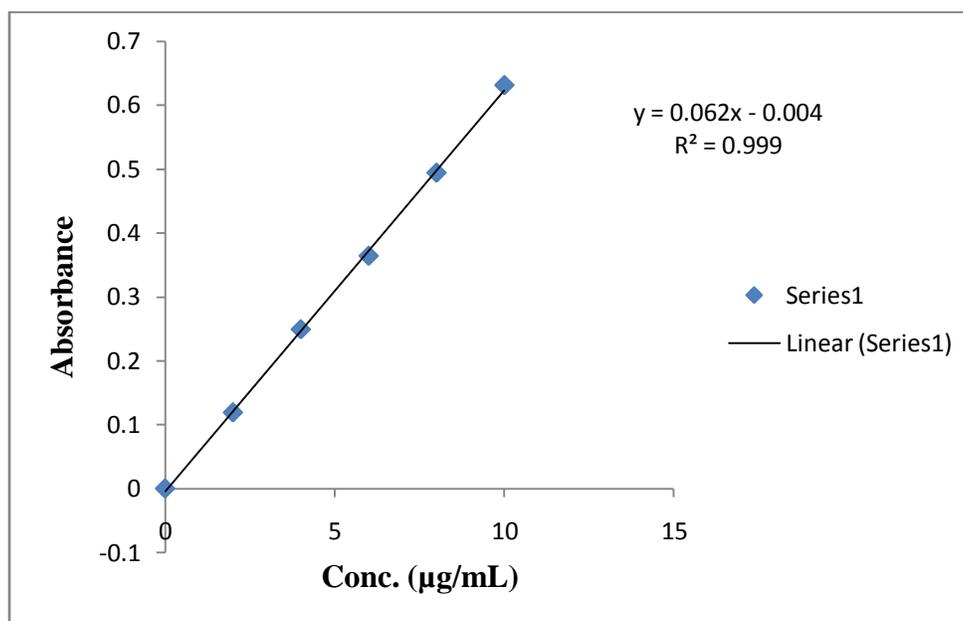| Concentration (µg/ml)	Absorbance (nm)
0	0
2	0.119
4	0.249
6	0.364
8	0.494
10	0.631

Figure 3: Standard curve of Telmisartan in 6.8 phosphate buffer

5. Micromeritical Properties: The following micromeritical properties of all the formulations were determined like Densities, Compressibility index, Angle of repose and Hausner ratio. They were calculated and all estimated parameters were found within the limits. The data are represented in table 5.

Table 5: Micromeritics properties of all formulations

Formulation	Bulk density	Tapped density	Carr's Index	Hausner's Ratio	Angle of Repose
Prepared Conventional	0.371	0.457	18.81	1.231	28.86
F1	0.318	0.389	18.25	1.223	24.93
F2	0.331	0.399	17.04	1.205	24.25
F3	0.329	0.396	16.91	1.203	25.05
F4	0.345	0.409	15.64	1.185	26.40
F5	0.356	0.411	13.38	1.154	25.79
F6	0.389	0.444	12.38	1.141	27.56
F7	0.362	0.410	11.70	1.132	27.66
F8	0.338	0.378	10.58	1.118	28.67
F9	0.337	0.403	16.31	1.195	25.06

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6. Content Uniformity or Assay: The content uniformity test is used to ensure that every tablet contains the amount of drug substance intended with little variation among tablets within a batch. Due to increased awareness of physiological availability, the content uniformity test has been included in the monographs of all coated and uncoated tablets and all capsules intended for oral administration where the range of size of the dosage form available include 50 mg or smaller sizes. The data are represented in table 6.

Table 6: Drug content of all the formulations

Formulation	Drug content
C	97.41
F1	95.69
F2	94.67
F3	96.19
F4	93.67
F5	93.15
F6	94.17
F7	95.18
F8	**98.16**
F9	96.20

7. In-vitro drug release: The drug release from the Telmisartan tablets was investigated in a USP-II (paddle) apparatus, 900 mL of Phosphate buffer pH 6.8 (50 rpm, $37 \pm 5°C$). At predetermined time intervals, 5.0 mL samples were withdrawn and diluted to suitable concentration and then analyzed with UV spectrophotometry at $\lambda max = 227$ nm.

Table 7: Dissolution profile of marketed formulation

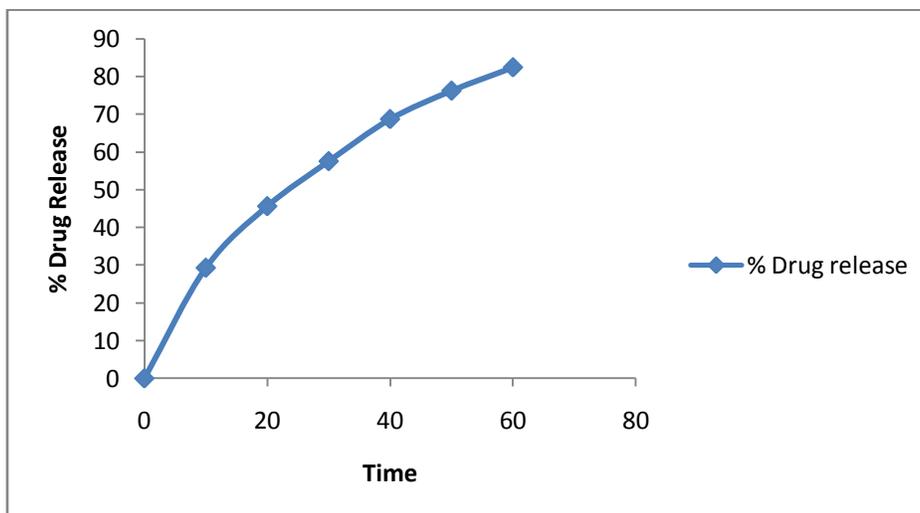| Time (in minutes)	% Cumulative Drug Release
0	0
10	36.53
20	48.39
30	56.94
40	64.13
50	72.44
60	89.39

Figure 4: *In-vitro* release of marketed formulation

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Table 8: Dissolution profile of prepared conventional formulation

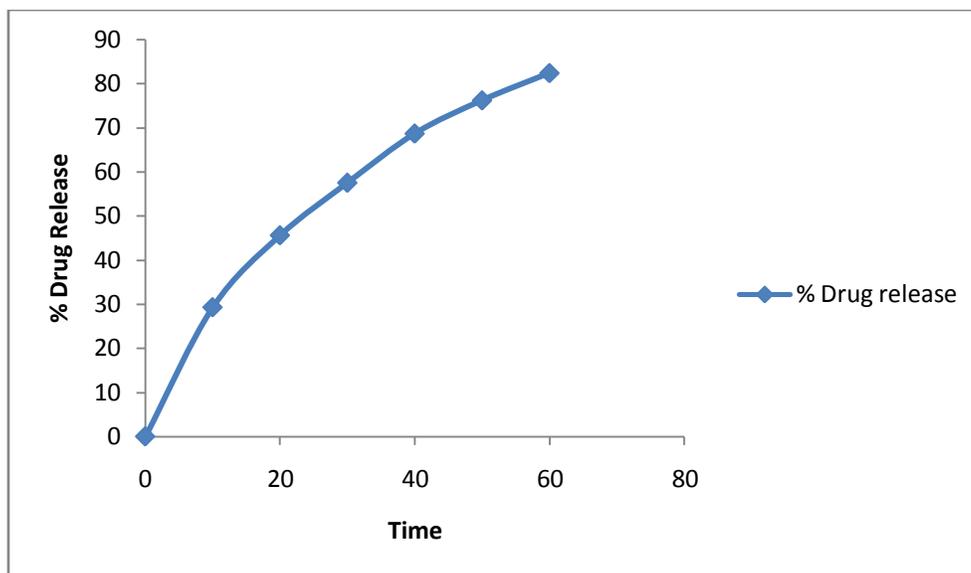| Time (in minutes)	% Cumulative Drug Release
0	0
10	29.3
20	45.63
30	57.55
40	68.71
50	76.24
60	82.43

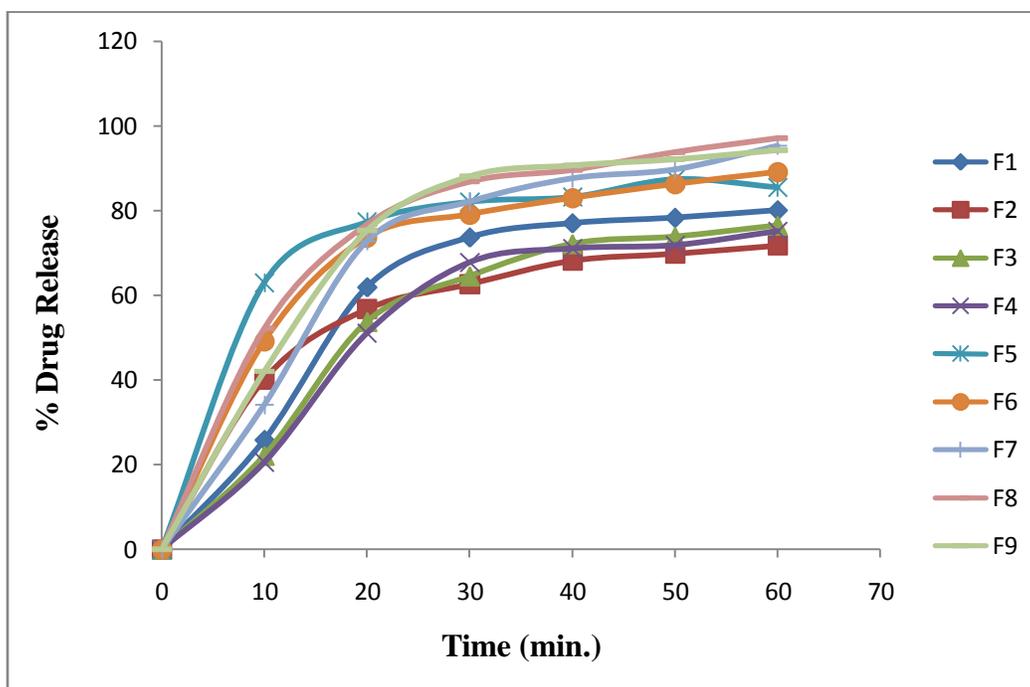**Figure 5:** *In-vitro* **release of prepared conventional formulation**

Figure 6: Comparison of drug release profiles of prepared formulations

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Table 9: Dissolution profile of prepared formulations

Time	F1	F2	F3	F4	F5	F6	F7	F8	F9
0	0	0	0	0	0	0	0	**0**	0
10	25.84	40.15	22.15	20.53	63	49.15	34.15	**52.15**	42
20	61.9	56.75	53.78	51.05	77.31	73.69	72.84	**76.73**	75.23
30	73.66	62.68	64.53	67.76	82.08	79.12	82.18	**86.81**	88.06
40	77.01	68.21	72.16	71.05	83.21	82.99	87.69	**89.6**	90.64
50	78.3	69.87	73.87	71.82	87.42	86.27	89.8	**93.8**	92.08
60	80.07	71.78	76.51	75.13	85.5	89.12	95.38	**97.11**	94.23

Table 10: Dissolution profile of marketed and optimized formulation:

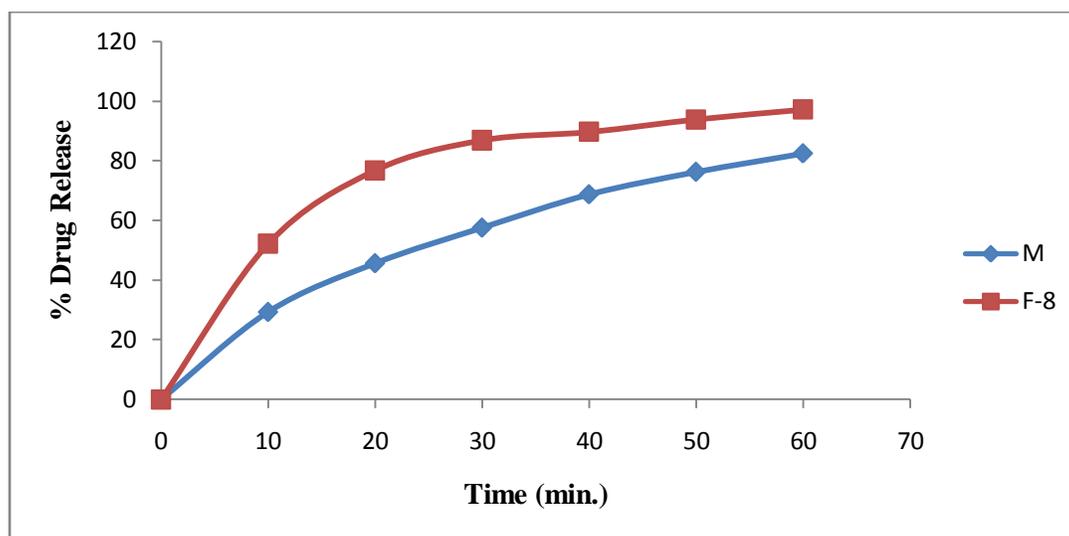| Time (in minutes)	% Cumulative drug release of marketed formulation	% Cumulative drug release of optimised formulation (F8)
0	0	0
10	36.53	52.15
20	48.39	76.73
30	56.94	86.81
40	64.13	89.60
50	72.44	93.80
60	89.39	97.11

Figure 7: *In-vitro* **dissolution profile comparison of marketed and optimized formulation**

Table 11: Dissolution profile of prepared conventional and optimized formulation

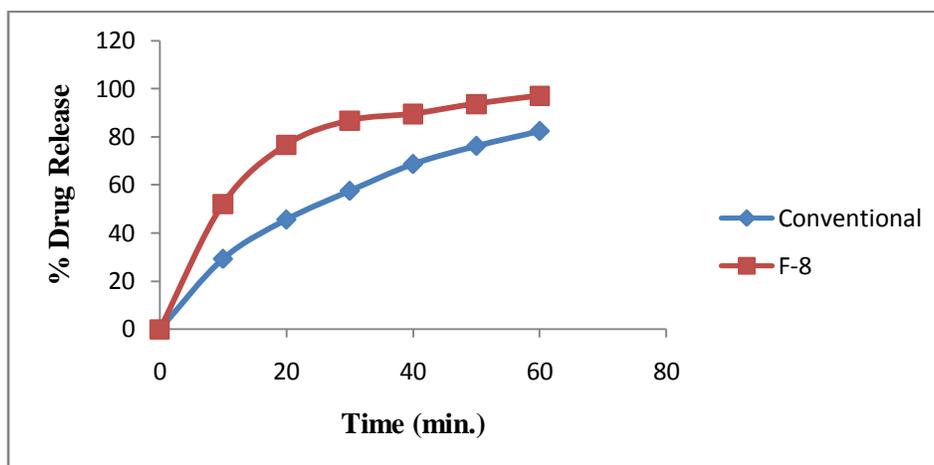| Time (in minutes)	% Cumulative drug release of prepared conventional formulation	% Cumulative drug release of optimised formulation (F12)
0	0	0
10	29.3	52.15
20	45.63	76.73
30	57.55	86.81
40	68.71	89.60
50	76.24	93.80
60	82.43	97.11

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Figure 8: *In-vitro* dissolution profile comparison of prepared conventional and optimized formulation

Table 12: Dissolution profile of marketed, prepared conventional and optimized formulation

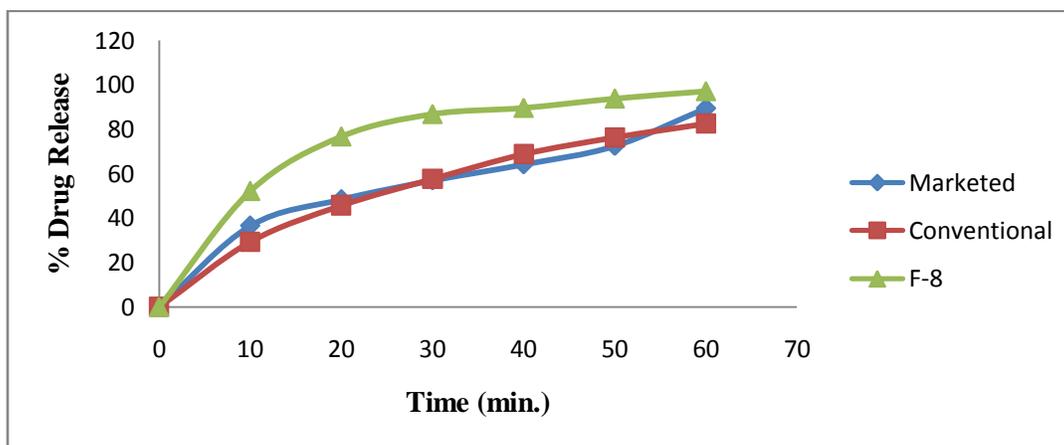| Time (min.)	% Cumulative drug release of marketed formulation	% Cumulative drug release of prepared conventional formulation	% Cumulative drug release of optimised formulation (F8)
0	0	0	0
10	36.53	29.3	52.15
20	48.39	45.63	76.73
30	56.94	57.55	86.81
40	64.13	68.71	89.60
50	72.44	76.24	93.80
60	89.39	82.43	97.11

Figure 9: In-vitro dissolution profile comparison of marketed, prepared conventional and optimized formulation

8. Stability studies: Selected Formulation was subjected to stability studies as per ICH guidelines. Following conditions were used for Stability Testing.
- 25°C/60 % RH analyzed every month for period of three months.
- 30°C/75 % RH analyzed every month for period of three months.
- 40°C/75 % RH analyzed every month for period of three months.

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Table 13: Stability dissolution profile of F8 for 1st month

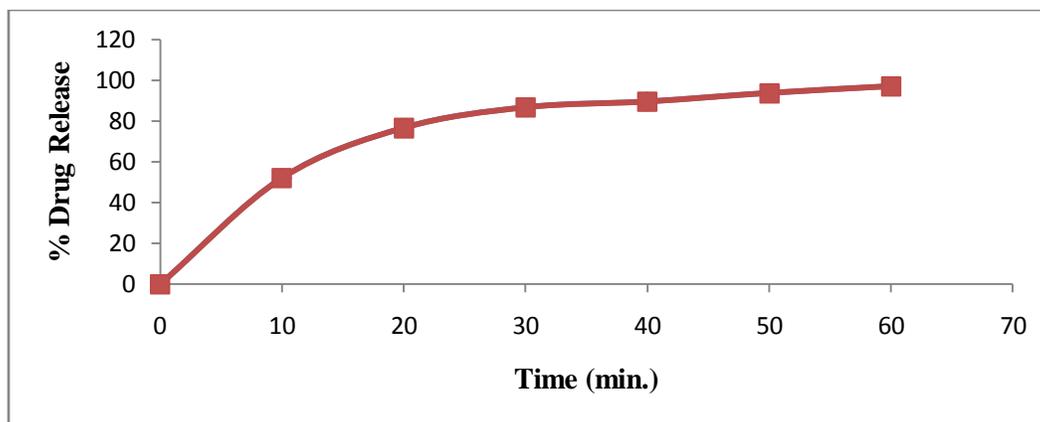| Sr. No.	Time (min.)	F8 1st Month
1.	0	0
2.	10	52.15
3.	20	76.71
4.	30	86.78
5.	40	89.60
6.	50	93.80
7.	60	97.11

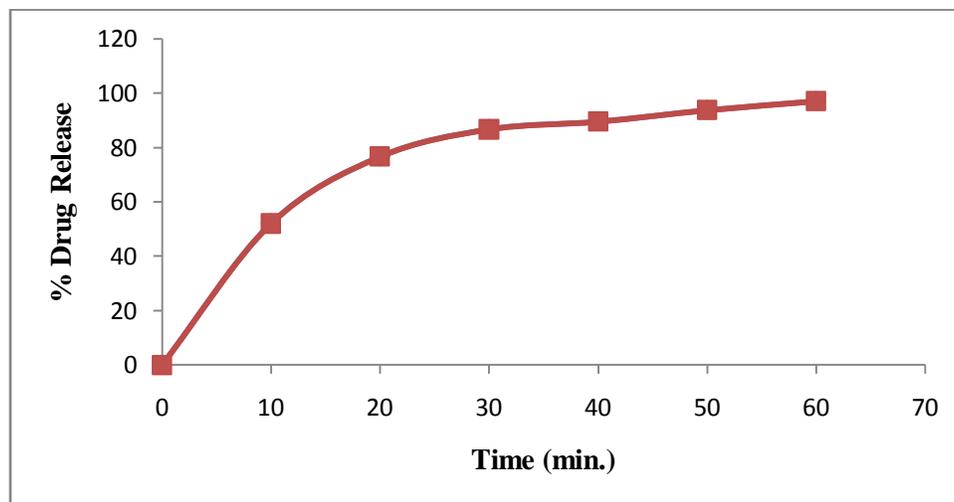**Figure 10: Stability dissolution profile of F-8 for 1st Month**

Figure 11: Stability dissolution profile of F-8 for 2nd Month

Table 13: Stability dissolution profile of F8 for 2nd month

Sr. No.	Time (min.)	F8 2nd Month
1	0	0
2	10	52.05
3	20	76.67
4	30	86.71
5	40	89.56
6	50	93.78
7	60	96.10

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Table 14: Stability dissolution profile of F8 for 3rd month

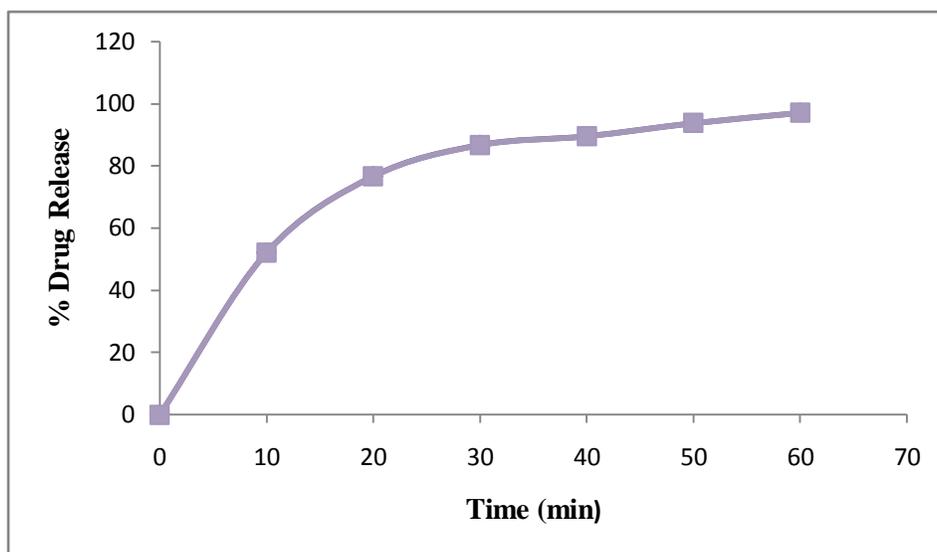| Sr. No.	Time (min)	F8 3rd Month
1	0	0
2	10	51.65
3	20	76.48
4	30	86.54
5	40	89.35
6	50	93.63
7	60	95.28

Figure 13: Stability dissolution profile of F-8 for 3rd Month

There were no significant changes in physical and chemical properties of capsule of formulation F-8 after 2 months. Parameters quantified at various time intervals were shown:

Table 15: Results of stability studies of optimized formulation F8

Formulation code	Parameters	Initial	1st Month	2nd Month	3rd Month	Limits as per specifications
F8	25˚C/60 %RH % Release	97.11	96.87	96.65	95.21	NLT 85%
F8	30˚C/75 %RH % Release	97.05	96.89	96.88	95.45	NLT 85%
F8	40˚C/75 %RH % Release	97.11	96.88	96.63	95.28	NLT 85%

Table 16: Results of stability studies of optimized formulation F8:

Formulation code	Parameters	Initial	1st Month	2nd Month	3rd Month	Limits as per specifications
F8	25˚C/60%RH Assay value	98.16	98.10	98.12	97.89	NLT 90% NMT 110%
F8	30˚C/75%RH Assay value	98.12	98.11	98.10	97.83	NLT 90% NMT 110%
F8	40˚C/75%RH Assay value	98.16	98.10	98.10	97.88	NLT 90% NMT 110%

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Conclusion
The aim of this study was to improve the dissolution profile thereby increase solubility. From the results obtained from executed experiments it can be concluded that; the preformulation studies like melting point, flow properties, UV analysis of Telmisartan were compiled with IP standards. The FTIR spectra revealed that, there was no interaction between polymer and drug. Polymers used were compatible with Telmisartan.

In-vitro drug release of Telmisartan compacts showed increase in dissolution rate of Telmisartan. So PEG 400, PG, Tween 80 could be economic substitute as dissolution enhancing agent. Stability studies showed that there were no significant changes in physical and chemical properties of formulation F8 after 2 months. Tween 80 in 1:1 ratio (F8) was showing best release. F8 was compared with marketed and prepared conventional formulation and result shows better dissolution profile.

REFERENCES
Barzegar JM, Javadzadeh Y, Nokhodchi A and Siahi-Shadbad MR (2005). Enhancement of dissolution rate of Piroxicam using liquisolid compacts. *II Farmaco* **60** 361-365.

Charman SA and Charman WN (2003). Oral modified release delivery systems, In: *Modified Release Drug Delivery Technology,* edited by Rathbone MJ, Hadgraftb J and Roberts MS, New York 1-9.

Darwish AM and El-Kamel AH (2001). Dissolution enhancement of glibenclamide using liquisolid tablet technology. *Acta Pharmaceutica* **51** 173-181.

El-Houssieny BM, Wahman LF and Arafa NMS (2010). Bioavailability and biological activity of liquisolid compact formula of repaglinide and its effect on glucose tolerance in rabbits. *BioScience Trends* **4** 17-24.

Fahmy RH and Kassem MA (2008). Enhancement of Famotidine dissolution rate through liquisolid tablet formulation: In vitro and In vivo evaluation. *European Journal of Pharmaceutics and Biopharmaceutics* **69** 993-1003.

Gopinath R and Naidu RAS (2011). Pharmaceutical Preformulation Studies – Current Review. *International Journal of Pharmaceutical & Biological Archives* **2**(5) 1391-1400.

Hiremath SN, Raghavendra RK, Sunil F, Danki LS, Rampure MV, Swamy PV and Bhosale UV (2008). Dissolution enhancement of gliclazide by preparation of inclusion complexes with cyclodextrin. *Asian Journal of Pharmaceutical Sciences* **2** 73-76.

Jarowski CI, Rohera BD and Spireas S (1992). Powdered solution technology: principles and mechanism. *Pharmaceutical Research* **9** 1351-1358.

Kailash Vilegave, Gali Vidyasagar and Pratibha Chandankar (2013). Preformulation Studies of Pharmaceutical New Drug Molecule and Products: An Overview. *American Journal of Pharmacy and Health Research* **1**(3) 1-20.

Khaled KA, Asiri YA and El-Sayed YM (2001). In-vivo evaluation of hydrochlorothiazide liquisolid tablet in beagle's dogs. *International Journal of Pharmaceutics* **222** 1-6.

Lbenberg R and Amidon GL (2000). Modern bioavailability, bioequivalence and Biopharmaceutics classification system. New scientific approaches to international regulatory standards. *European Journal of Pharmaceutics and Biopharmaceutics* **50** 3-12.

Mays Al-Sarraf A, Ahmed Hussein A and Ahmed Abdul Jabbar S (2014). Dissolution Enhancement of Telmisartan by Liquisolid Compacts. *International Journal of Pharmacy and Pharmaceutical Sciences* **6**(suppl. 2) 743-749.

Merisko E (2002). Liversidge nanocrystals: resolving pharmaceutical formulation issues associated with poorly soluble compounds. In: *Particles,* edited by Matty JJ, Marcel Dekker, Orlando.

Modi A and Tayade P (2006). Enhancement of dissolution profile by solid dispersion (Kneading) technique. *AAPS PharmSciTech* **7**(3) 2-17.

Naseem A, Olliff CJ, Martini LG and Lloyd AW (2004). Effects of plasma irradiation on the wettability and dissolution of compacts of griseofulvin. *International Journal of Pharmaceutics* **269** 443-450.

Research Article

Nokhodchi A, Hentzschel CM and Leopord CS (2011). Drug release from liquisolid system: speed it up, slow it down. *Expert Opinion on Drug Delivery* **8** 191-205.

Papadimitriou SA, Bikiaris D and Avgoustakis K (2008). Microwave-induced enhancement of the dissolution rate of poorly water-soluble tibolone from poly (ethylene glycol) solid dispersions. *Journal of Applied Polymer Science* **108** 1249-1258.

Pharmainfo.net (No Date). Evaluation of tablet, pharmaceutical information by Satheesh Babu. Available: http://www.pharmainfo.net/satheeshbabu/blog/evaluation-tablet.

Poluri Koteswari, Suvarnala Sunium, Puttugunta Srinivasababu, Govada Kishore Babu, and Pinnamraju Durga Nithya (2014). Formulation Development and evaluation of fast disintegrating tablets of Lamotrigine using *liqui-solid* technique. *International Journal of Pharmaceutical Investigation* **4**(4) 207–214, doi: 10.4103/2230-973X.143125.

Rasenack N and Muller BW (2002). Dissolution rate enhancement by in situ micronization of poorly water-soluble drugs. *Pharmaceutical Research* **19** 1894-1900.

Sailaja Gunnam, Sabitha Saini and Madhuri T (2015). Formulation and Evaluation of Liquisolid Compacts of Telmisartan. *World Journal of Pharmacy and Pharmaceutical Sciences* **4**(3) 782-798.

Smirnova I, Suttiruengwong S, Seiler M and Arlt M (2004). Dissolution rate enhancement by adsorption of poorly soluble drugs on hydrophilic silica aerogels. *Pharmaceutical Development and Technology* **9** 443-452.

Spireas S (2002). Liquisolid System and method of preparing same. U.S Patent 6423339B1.

Swamy NGN and Shiny EK (2013). Formulation and Evaluation of Telmisartan Liquisolid Tablets. *RGUHS Journal of Pharmaceutical Sciences* **3**(3) 49-57.

Telmisartan (No Date). DrugBank, Available: http://www.Drugbank.ca/drugs/DB00966.

Telmisartan (No Date). Drugs.com, Available: http://www.drugs.com/monograph/telmisartan.html

Wolfgang G (1998). Extension of the international conference on harmonization guideline for stability testing tripartite of new drug substances and products to countries of climatic zones III and IV**.** *Drug Development and Industrial Pharmacy* **24** 313-325.