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ENHANCEMENT OF DISSOLUTION RATE OF TELMISARTAN BY SOLID DISPERSION IN STARCH 1500 AND SOLUPLUS ALONE AND IN COMBINATION

N.Tirumalesh[1], K. P. R. Chowdary* [2]

[1] Ph.D Research Scholar, Acharya Nagarjuna University, Guntur

[2] Chairman, BOS in Pharmacy, JNTUK, Kakinada and

Research Director, Vikas Institute of Pharmaceutical Sciences, Rajahmundry-533102

Abstract:

Telmisartan, a widely prescribed antihypertensive drug belongs to class II under BCS and exhibit low and variable oral bioavailability due to its poor aqueous solubility. As such it needs enhancement in the dissolution rate and bioavailability to derive its maximum therapeutic efficacy. The objective of the present study is to prepare and evaluate solid dispersions of Telmisartan in Starch 1500 and Soluplus alone and in combination for enhancing the dissolution rate and dissolution efficiency of Telmisartan. The individual and combined effects of the two carriers, Starch 1500 and Soluplus in enhancing the dissolution rate and dissolution efficiency of Telmisartan were evaluated in a 2^2 factorial study. Solid dispersions of Telmisartan in Starch 1500 alone were prepared using four ratios of drug: carrier namely 2:1, 1:1, 1:2 and 1:3 by solvent evaporation method. Solid dispersions of Telmisartan in Soluplus alone were prepared at three concentrations namely 0.5, 1.0 and 2% by common solvent method. Solid dispersions of Telmisartan in combined carriers namely Starch 1500 and Soluplus were prepared as per 2^2 factorial design. All the solid dispersions prepared were evaluated for drug content uniformity, dissolution rate and dissolution efficiency in comparison to Telmisartan pure drug.

The dissolution rate and dissolution efficiency of Telmisartan could be significantly enhanced by solid dispersion in Starch 1500 and Soluplus alone and in combination. The individual and combined effects of Starch 1500 and Soluplus in enhancing the dissolution rate and dissolution efficiency of Telmisartan are highly significant ($P < 0.01$). Soluplus gave significant enhancement in the dissolution rate of Telmisartan at very low concentrations where as a large proportion of Starch 1500 is required for a similar enhancement in the dissolution rate of Telmisartan. Combination of Starch 1500 and Soluplus resulted in a much higher enhancement in the dissolution rate and dissolution efficiency of Telmisartan than is possible with them individually. Combination of Starch 1500 and Soluplus is recommended for enhancing the dissolution rate and dissolution efficiency of Telmisartan.

Key words: *Telmisartan, Solid dispersion, Dissolution Rate, Starch 1500, Soluplus, Factorial study*

Corresponding author:

Prof. K. P. R. Chowdary,
Chairman, BOS in Pharmacy,
JNTUK, Kakinada and
Research Director, Vikas Institute of Pharmaceutical Sciences,
Rajahmundry-533102
Mobile: 9866283578
E-mail: prof.kprchowdary@rediffmail.com

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INTRODUCTION:

About 95% of all new potential therapeutic drugs (APIs) exhibit low and variable oral bioavailability due to their poor aqueous solubility at physiological pH and consequent low dissolution rate. These drugs are classified as class II drugs under BCS with low solubility and high permeability characters and pose challenging problems in their pharmaceutical product development process. Telmisartan, a widely prescribed antihypertensive drug belongs to class II under BCS and exhibit low and variable oral bioavailability due to its poor aqueous solubility. As such it needs enhancement in the dissolution rate and bioavailability to derive its maximum therapeutic efficacy.

Several techniques [1] such as micronization, cyclodextrin complexation, use of surfactants and solubilizers, solid dispersion in water soluble and dispersible carriers, use of salts, prodrugs and polymorphs which exhibit high solubility , micro emulsions and self-emulsifying micro and nano disperse systems have been used to enhance the solubility, dissolution rate and bioavailability of poorly soluble drugs. Among the various approaches, solid dispersion [2,3] in water soluble and water dispersible excipients is a simple, industrially useful approach for enhancing the solubility, dissolution rate and bioavailability of poorly soluble drugs. In solid dispersions the poorly soluble drug is dispersed in an inert water-soluble carrier such as urea, polyethylene glycol, poly vinyl pyrrolidone and surfactants at solid state. In the case of solvent deposited dispersions the drug is deposited in minuscular form on an inert water insoluble excipient such as silica gel, starch and modified starches at solid state.

Starch 1500 is a modified starch namely Pregelatinised starch used in tablets as diluent and directly compressible vehicle. It is also used as a carrier in solid dispersions in a few studies [4-7]. In the present study Starch 1500 is evaluated as carrier for solid dispersions for enhancing the dissolution rate of Telmisartan.

Soluplus is a polymeric solubiliser with an amphiphilic chemical nature, which was particularly developed for solid solutions. Soluplus is polyvinyl caprolactam - polyvinyl acetate - polyethylene glycol graft co-polymer. Soluplus increased the solubility and enhanced the bioavailability of actives in solid solutions. Itraconazole and fenofibrate showed significant increase in the bioavailability with Soluplus [8]. The solubility and dissolution rate of valsartan was effectively enhanced by using Soluplus in the form of solid dispersions [9].

The objective of the present study is to prepare and evaluate solid dispersions of Telmisartan in Starch 1500 and Soluplus alone and in combination for enhancing the dissolution rate and dissolution efficiency of Telmisartan. The individual and combined effects of the two carriers, Starch 1500 and Soluplus in enhancing the dissolution rate and dissolution efficiency of Telmisartan were evaluated in a 2^2 factorial study.

EXPERIMENTAL:

Materials:

Telmisartan was a gift sample from M/s Hetero Drugs Ltd., Hyderabad. Soluplus and Starch 1500 were procured from commercial sources. All other materials used were of pharmacopoeial grade.

Estimation of Telmisartan:

An UV Spectrophotometric method based on the measurement of absorbance at 296 nm in phosphate buffer of pH 7.5 was used for the estimation of Telmisartan. The method was validated for linearity, accuracy, precision and interference. The method obeyed Beer's law in the concentration range of 0 - 10 µg/ ml. When a standard drug solution was repeatedly assayed (n=6), the relative error and coefficient of variance were found to be 0.65% and 1.4% respectively. No interference by the excipients used in the study was observed.

Preparation of Solid Dispersions in Starch 1500

Solid dispersions of Telmisartan in Starch 1500 using various ratios of drug: carrier were prepared by solvent evaporation method. The required quantity of Telmisartan was dissolved in ethanol (10 ml) to get a clear solution in a dry mortar. Starch 1500 was added to the drug solution in the mortar and mixed. The mixture was triturated continuously for 20 min to evaporate the solvent. Trituration was continued until a dry mass was obtained. The mass obtained was further dried at 50^0 C for 1 h in hot air oven. The dried product was powdered and passed through mesh no 100 in each case.

Preparation of Solid Dispersions in Soluplus:

Solid dispersions of Telmisartan in different concentrations of Soluplus were prepared by common solvent method. The required quantity of Telmisartan and Soluplus were dissolved in ethanol (10 ml) to get a clear solution in a dry mortar. The solution was triturated continuously for 20 min to evaporate the solvent. Trituration was continued until a dry mass was obtained. The mass obtained was further dried at 50^0 C for 1 h in hot air oven. The dried product was powdered and passed through mesh no 100 in each case.

Preparation of Solid Dispersions in Combined Carriers:

Solid dispersions of Telmisartan in Starch 1500 and Soluplus as per 2^2 factorial design were prepared by kneading method. The required quantities of drug and

Soluplus were dissolved in the solvent ethanol to get a clear solution in a dry mortar. Starch 1500 was added to the drug- surfactant solution in the motor and mixed. The mixture was kneaded for 30 min by continuous trituration. Small volume of the solvent was added to maintain the mixture as thick slurry during kneading process. Trituration was continued until a dry mass was obtained. The mass obtained was further dried at 50°C for 1 hour in a hot air oven. The dried product was powdered and passed through mesh no. 100 in each case.

Estimation of Drug Content of Solid Dispersions:

From each batch four samples of solid dispersion equivalent to 20 mg of the medicament was taken into a 100 ml conical flask and extracted with 3 x 10 ml quantities of ethanol. The ethanolic extracts were filtered and collected into 50 ml volumetric flask and the volume was made up to 50 ml with ethanol. The solution was subsequently diluted with Phosphate buffer pH 7.5 and assayed for the Telmisartan content at 296 nm.

Dissolution Rate Study:

Dissolution rate of Telmisartan from various solid dispersions prepared was studied in water (900 ml) employing USP 8 station Dissolution Rate Test Apparatus (M/s Lab India Disso 8000) with a paddle stirrer at 50rpm. A temperature of 37±1°C was maintained throughout the study. Telmisartan or its solid dispersion equivalent to 20 mg of Telmisartan was used in the test. Samples of dissolution fluid (5 ml) were withdrawn through a filter (0.45 µm) at different intervals of time, suitably diluted and assayed for Telmisartan at 296 nm. The dissolution fluid withdrawn at each sampling time was replaced with fresh dissolution fluid and suitable correction is made in calculating the amount of drug dissolved. All dissolution rate experiments were conducted in triplicate (n=3).

RESULTS AND DISCUSSION:

The objective of the present study is to prepare and evaluate solid dispersions of Telmisartan in Starch 1500 and Soluplus alone and in combination for enhancing the dissolution rate and dissolution efficiency of Telmisartan, a BCS class II drug. Solid dispersions of Telmisartan in Starch 1500 alone were prepared using four ratios of drug: carrier namely 2:1, 1:1, 1:2, and 1:3 by solvent evaporation method. Solid dispersions of Telmisartan in Soluplus alone were prepared using three concentrations of carrier namely 0.5, 1.0 and 2% by common solvent method.

Solid dispersions of Telmisartan in combined carriers namely Starch 1500 and Soluplus were prepared as per 2^2 factorial design by kneading method with a view to evaluate the individual main effects and combined (interaction) effects of Starch 1500 (factor A) and Soluplus (factor B) on the dissolution rate and dissolution efficiency (DE_{30}) of Telmisartan. For this purpose two levels of Starch 1500 (0 and 1:2 ratio of drug : carrier) and two levels of Soluplus (0 and 1%) were selected and the corresponding four treatments involved in the 2^2 factorial study were Telmisartan pure drug (1); Telmisartan - Starch 1500 (1:2) solid dispersion (a); Telmisartan - Soluplus (1.0%) solid dispersion (b) and Telmisartan - Starch 1500 (1:2) - Soluplus (1.0%) solid dispersion (ab). The above mentioned solid dispersions were prepared by kneading method.

All the solid dispersions prepared were found to be fine and free flowing powders. Low C.V (< 1.0%) in the percent drug content indicated uniformity of drug content in each batch of solid dispersions prepared. The dissolution of Telmisartan as such and from various solid dispersions was studied in water. The dissolution profiles of various solid dispersions prepared are shown in Figs.1-3.The dissolution parameters of Telmisartan and its solid dispersions prepared are given in Tables 1 and 2.

Table 1: Dissolution Parameters of Telmisartan in Starch 1500 and Soluplus

SD	System	PD_{10} (%)	$K_1 \times 10^2$(min -1)	Increase in K_1 (No of folds)	DE_{30}(%)
1	T	47.4	6.45	-	41.1
2	T:St(2:1)	69.3	15.45	2.40	71.3
3	T:St(1:1)	82.2	30.2	4.68	76.1
4	T:St(1:2)	91.6	42.1	6.52	79.8
5	T:St(1:3)	98.6	48.2	7.47	84.2
6	T:Sol (0.5%)	58.5	9.4	1.45	52.1
7	T:Sol (1%)	68.4	16.16	2.50	65.5
8	T:Sol (2%)	97.2	35.8	5.55	85.5

SD – Solid dipersion ; T- Telmisartan ;St-Starch 1500 ; Sol - Soluplus

Table 2: Dissolution Parameters of Telmisartan Solid Dispersions in Starch 1500 and Soluplus Prepared as per 2^2- Factorial Design

SD	System	PD_{10} (%)	K_1x10^2 min^{-1}	Increase in K_1 (No. of folds)	DE_{30} (%)	Increase in DE_{30} (No. of folds)
1	T	47.4	6.45	---	41.09	---
a	T-St (1:2)	91.6	42.1	6.53	79.8	1.94
b	T-Sol (1%)	68.4	16.16	2.50	65.45	1.59
ab	T-St (1:2) - Sol (1%)	99.2	52.6	8.15	94.6	2.30

SD -Solid dipersion; T- Telmisartan; St-Starch 1500; Sol - Soluplus

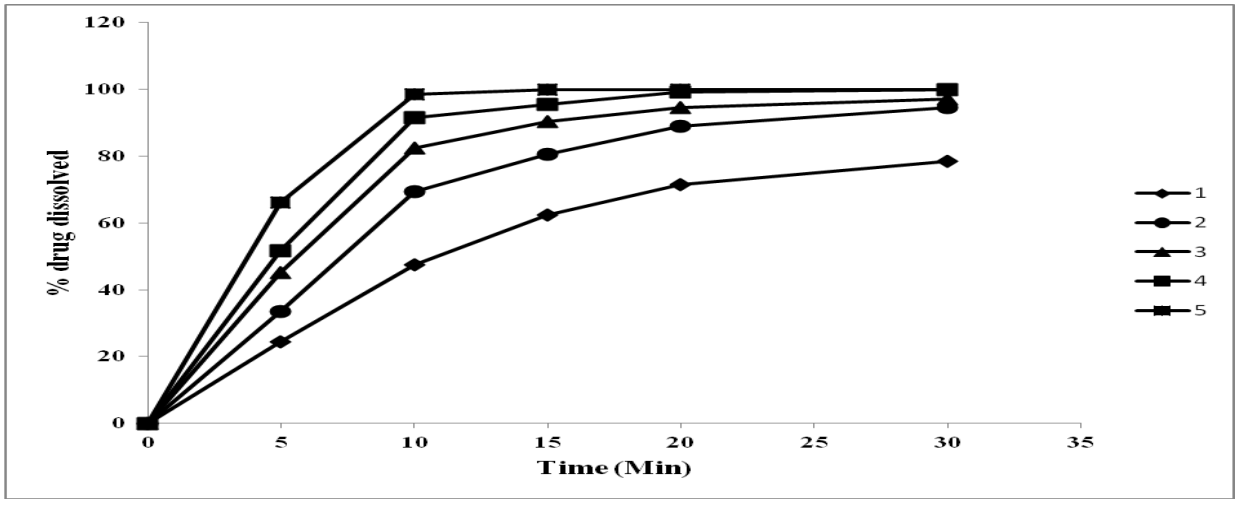

Fig .1: Dissolution Profiles of Telmisartan and Its Solid Dispersions in Starch

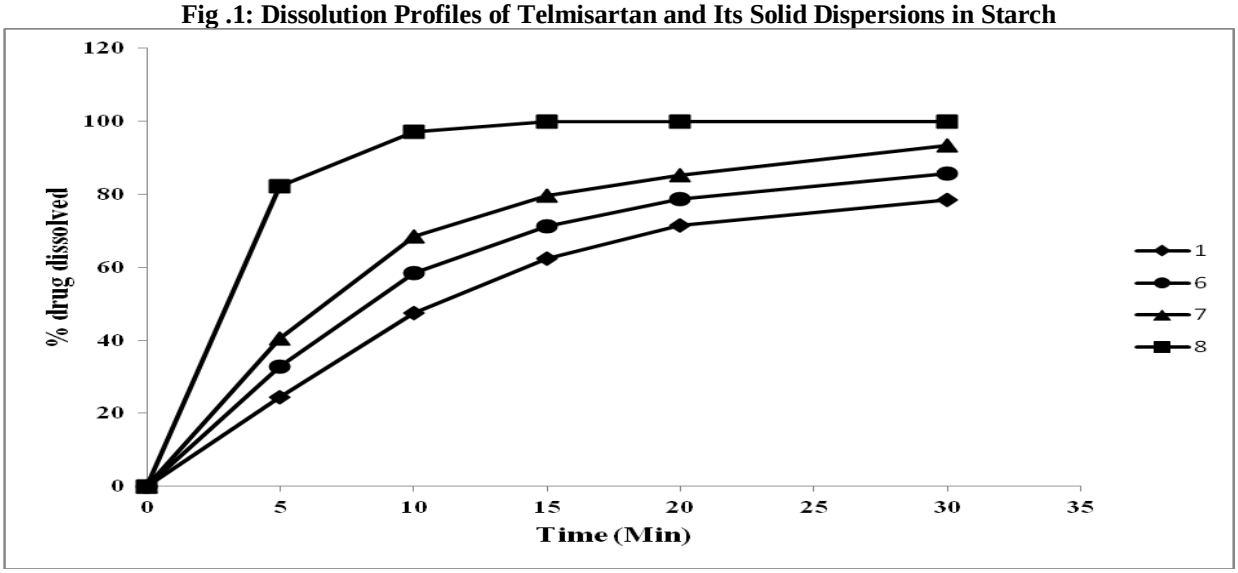

Fig. 2: Dissolution Profiles of Telmisartan and Its Solid Dispersions in Soluplus 1500

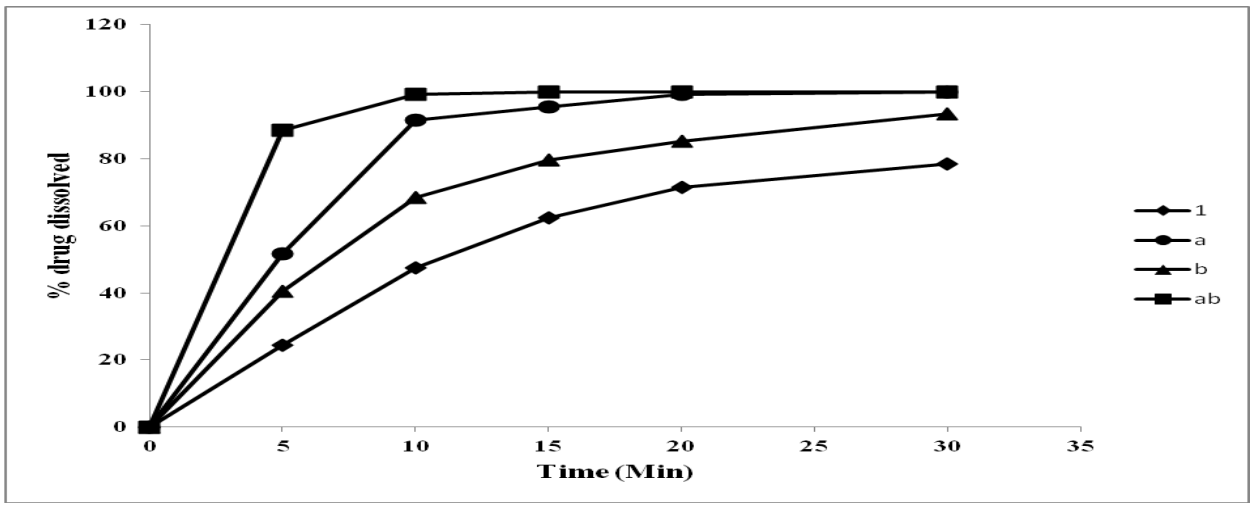

Fig. 3: Dissolution Profiles of Telmisartan Solid Dispersions in Starch 1500 and Soluplus Prepared as per 2^2- Factorial Design

All solid dispersions prepared gave rapid and higher dissolution of Telmisartan when compared to Telmisartan pure drug. The dissolution data were analyzed as per zero order and first order kinetics in each case. The correlation coefficient (r) values were higher in the first order model than in zero order model indicating that the dissolution of Telmisartan as such and from its solid dispersions followed first order kinetics. The correlation coefficient (r) values in the first order model were found to be in the range 0.910 - 0.980. The corresponding dissolution rate (K_1) values of various products were estimated. Dissolution Efficiency (DE_{30}) values were calculated as described by Khan [10].The dissolution parameters of various solid dispersions are summarized in Tables 1 and 2.

All dissolution parameters (PD_{10}, K_1 and DE_{30}) indicated rapid and higher dissolution of Telmisartan from all solid dispersions when compared to Telmisartan. With both Starch 1500 and Soluplus the dissolution rate and dissolution efficiency of Telmisartan was increased as the concentration of carrier in the solid dispersion was increased. In the case of Starch 1500 the dissolution rate was increased by 2.4, 4.68, 6.52 and 7.47 Folds respectively, in the case of SDs prepared at drug: carrier ratio of 2:1, 1: 1, 1:2 and 1:3. In the case of SDs prepared with Soluplus, 1.45, 2.50 and 5.55 folds increase in the dissolution rate was observed at 0.5, 1.0 and 2.0 percent concentration of carrier. In the case of Soluplus (Surfactant) a low concentration of carrier gave a significant increase in the dissolution rate when compared to Starch 1500.

The results of factorial study given in Table 2 indicated that the dissolution rate and dissolution efficiency of Telmisartan were markedly increased by solid dispersion in Starch 1500 and Soluplus alone and in combination. Analysis of Variance (ANOVA) indicated that the Individual and combined effects of Starch 1500 (Factor A) and Soluplus (Factor B) are highly significant ($P< 0.01$). Solid dispersion in Starch 1500 alone gave a 6.53 fold increase in the dissolution rate of Telmisartan at a drug: carrier ratio of 1:2. Soluplus at 1.0 percent concentration gave a 2.50 fold increase in the dissolution rate of Telmisartan whereas in combination they (dispersion ab) gave a 8.15 fold increase in the dissolution rate of Telmisartan. In combination Starch 1500 and Soluplus gave higher enhancement in the dissolution rate of Telmisartan than is possible with them individually. The higher enhancement in the dissolution rate is due to the combined effects of the two carriers. The drug is deposited in miniscular form on the carrier Starch 1500 particles, which increases the surface area of drug resulting in the enhancement of Dissolution rate of Telmisartan. Soluplus being a surfactant increases the wettability of drug particles by reducing interfacial tension and thus increases the dissolution rate of Telmisartan. Hence a combination of Starch 1500 and Soluplus are recommended for enhancing the dissolution rate and dissolution efficiency of Telmisartan, a BCS class II drug..

CONCLUSIONS:

1. The dissolution rate and dissolution efficiency of Telmisartan could be significantly enhanced by solid dispersion in Starch 1500 and Soluplus alone and in combination.
2. The individual and combined effects of Starch 1500 and Soluplus in enhancing the dissolution rate

and dissolution efficiency of Telmisartan are highly significant ($P < 0.01$) .

3. Soluplus gave significant enhancement in the dissolution rate of Telmisartan at very low concentrations; where as a large proportion of Starch 1500 is required for a similar enhancement in the dissolution rate of Telmisartan.

4. Combination of Starch 1500 and Soluplus resulted in a much higher enhancement in the dissolution rate and dissolution efficiency of Telmisartan than is possible with them individually.

5. Combination of Starch 1500 and Soluplus is recommended for enhancing the dissolution rate and dissolution efficiency of Telmisartan.

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