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RESEARCH ARTICLE

DEVELOPMENT AND CHARACTERIZATION OF TASTE MASKED FAST DISSOLVING LISINOPRIL TABLETS

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Abstract:

Objective: Fast Dissolving Tablets are solid dosage form containing medicinal substances or active ingredients which disintegrates rapidly within few seconds when placed up on tongue. Lisinopril is a long-acting, non sulfhydryl angiotensin-converting enzyme (ACE) inhibitor that is used for the treatment of hypertension and congestive heart failure.

Methods: Fast dissolving tablets of Lisinopril were prepared using different synthetic super disintegrants like croscarmellose sodium, microcrystalline cellulose PH102 and sodium starch glycolate by direct compression method. Here microcrystalline cellulose PH102 was used as a superdisintegrant. Each formulation was composed of drug and excipients in various proportions. The blends of all formulations were evaluated for various pre-formulation factors. Tablets were evaluated for weight variation, hardness, *in vitro* dispersion time, disintegration time, drug content, friability and *in vitro* dissolution.

Results: The results showed that disintegration time of tablets of sodium starch glycolate is comparatively lower than the crosscarmellose sodium. Formulation F4 disintegrated in 48 seconds. The increase in disintegrant SSG (10%) in F6 decreased the disintegration time to 43 seconds. But the drug release was only 89.96 % after 30 minutes. In the F7 formulation concentration of Avicel PH 102 was decreased to 15% and a little increase in the release profile (92.63%) was observed. So in the F8 formulation Avicel PH 102 was reduced further to 10% and this showed marked increase in the drug release (98.34%) and hence optimized. *In vitro* drug release showed that formula F8 had better 98.34% drug release within 30 minutes as compare to other formulations. The results showed that super disintegrants used in combinations shows better disintegrating property. The FTIR spectra showed no interactions among them.

Conclusion: Among all formulations, promising formulation F8 which contains SSG (10%) and Avicel PH 102 (10%) appeared to be the best formula as it showed good wetting time (23 sec), fastest disintegration time (38 sec) and maximum drug release of 98.34% within 30 minutes.

Keywords: Lisinopril, Fast dissolving tablets (FDT), Croscarmellose sodium (CCS),Sodium starch glycolate (SSG)

Introduction

Recent advances in novel drug delivery systems (NDDS) aim to enhance safety and efficacy of drug molecule by formulating a convenient dosage form for administration and to achieve better patient compliance. One such approach is fast dissolving tablets[1-3]. Fast dissolving tablets are gaining prominence as new drug delivery systems. These dosage forms dissolve or disintegrate in oral cavity within a minute without the need of water or chewing. Thus the absorption is faster and more complete than with conventional tablet. These are not only useful in administration of drugs in pediatric and geriatric patients but in patients suffering from stroke, thyroid disorder, Parkinson's diseases and multiple sclerosis, patients with nausea, vomiting and motion sickness . The advantages of fast dissolving tablets include easy

manufacturing, accurate dosing and easy handling by patients, no requirement of chewing and water for swallowing. These dosage forms have been investigated for their potential in improving bioavaibility of poorly soluble drugs through enhancing the dissolution profile of the drug and also for hepatic metabolism drugs[4-7].

The excipients employed in fast dissolving tablets are always hydrophilic in nature whereas drug may be either hydrophilic or hydrophobic. If the drug is hydrophilic, the dosage form is known as fast dissolving tablets otherwise if drug is hydrophobic it is known as fast disintegrating tablets. The various synonyms used for fast dissolving tablets include mouth dissolving tablets, orally disintegrating tablets, melt in-mouth tablets, porous tablets, orodispersible, quick dissolving and rapid disintegrating tablets.

The basic approach in development of fast dissolving tablets is the use of superdisintegrants like Cross linked carboxymelhylcellulose (Croscarmellose), Sodium starch glycolate (Primogel, Explotab). Polyvinylpyrrolidone (Polyplasdone) etc. which provide instantaneous disintegration of tablet after putting on tongue, thereby releasing the drug in saliva. Superdisintegrants provide fast disintegration due to collective effect of swelling and water absorption by the formulation. Due to swelling of superdisintegrants, the wetted surface of the carrier increases, this promotes the wettability and dispersibility of the system, thus enhancing the disintegration and dissolution. The various techniques used for manufacturing of rapidly disintegrating or dissolving tablets are Freeze drying, Spray drying, Molding, Mass extrusion, Melt granulation, Sublimation and Direct compression. Direct compression is one of these techniques which require incorporation of a superdisintegrant into the formulation, or the use of highly water-soluble excipients to achieve fast tablet disintegration[8-10].

Lisinopril is lysine derivative of enalapril. It is competitive inhibitor of angiotensin converting enzyme.ACE is peptidyldipeptidase which inhibits conversion of angiotensin I into angiotensin II which is potent vasoconstrictor. Angiotensin II causes the release of aldosterone from adrenal cortex. It also decreases the vesopressor activity. Formula of lisinopril is $C_{21}H_{31}N_3O_5$. Lisinopril belongs to BCS Class III drug (High solubility and low permeability).The present study involved the comparison between various synthetic superdisintegrants in combination[11-16].

MATERIALS AND METHODS:

Lisinopril was generously gifted by Unimark remedies Ltd. All the superdisintegrants and microcrystalline cellulose were kindly supplied by Maple Biotech Pvt Ltd, Partially pregelatinized starch, Dibasic calcium phosphate, Partially pregelatinized starch, Aerosil, Magnesium stearate were purchased from Yarrow Chemicals Ltd. All the other chemicals used were of high analytical grade.

Taste masking and Preparation of fast dissolving tablets of Lisinopril by Kneading technique[17-22]

Fast dissolving tablets of Lisinopril were prepared by direct compression method, using synthetic disintegrant crosscarmelose sodium and sodium starch glycolate. Required quantity of lisinopril was weighed and sifted through # 60 SS sieve. Complexation with Beta-cyclodextrin was done. Initially, Drug: Beta-cyclodextrin ratio was 1:5. Slurry of Betacyclodextrin was prepared by taking Betacyclodextrin: water (5 gm: 5 ml), stirred for 30 minutes. Drug was added, stirred for 2 hours, dried it. Mixed the above powder base with sifted superdisintegrants, Avicel PH 102, Dicalcium Phosphate, Partially pregelatinized starch and Aerosil, Magnesium stearate and talc by tumbling.. Finally the colorant Iron oxide red was sieved through sieve no.100 # and then mixed with the dry mixture homogenously to get uniform blend without mottling. This mixed blend of drug and excipients was compressed using single punch tabletting machine to produce tablet weighing 100 mg having a diameter of 9 mm. Following above procedure, eight batches of Fast Disintegrating Tablet (FDT) of Lisinopril in different ratio of superdisintegrants were prepared.

Preformulation Studies :[23-26]

Angle of repose:

Angle of repose (θ) was determined by measuring the height (h), radius of the heap(r))of the powder blend. A cut system funnel was fixed to a stand and bottom of the funnel was fixed at a height of 2 cm from the plane. Powder blend was placed in funnel and allowed to flow freely and measured the height and radius of the heap.

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

Bulk density:

The bulk density of a powder is dependent on particle packing and changes as the powder consolidates. Apparent bulk density (gm/ml) was determined by pouring bulk powder into a graduated cylinder via a large funnel and measuring the volume and weight. Bulk density can be calculated by the following formula,

$$\text{Bulk density} = \frac{\text{Weight of powder}}{\text{Bulk volume}}$$

Tapped density (D_t)

Tapped density is the bulk density of a powder which has been compacted by tapping or vibration. Tapped density was determined by placing a graduated cylinder containing a known mass of powder on a mechanical tapping apparatus, which is operated for a fixed number

of taps (100) or until the powder bed volume has reached a minimum. The tapped density was computed by taking the weight of drug in cylinder and final volume.

$$\textbf{Tapped densit } (D_t) = \frac{\textbf{Weight of powder}}{\textbf{Tapped volume}}$$

Hausner's ratio:

Hausner Ratio is an indirect index of ease of powder flow. It is calculated by using formula

$$\textbf{Hausner's ratio} = \frac{\textbf{Tapped density of powder}}{\textbf{Bulk density of powder}}$$

Compressibility Index (Carr's Index)

Another indirect method of measuring powder flow form bulk densities was developed by Carr. The percentage compressibility of a powder is a direct measure of the potential powder arch or bridge strength and stability. It is calculated according to the following equation,

$$\textbf{Carr's Index} = \frac{\textbf{Tapped density – bulk density}}{\textbf{Tapped density}} \times 100$$

Evaluation of the Fast Dissolving tablets (FDT)[27-30]

Quality control tests for FDTs of all formulations were performed, and the average values were calculated. All the tablets were evaluated for different parameters as weight variation, hardness, friability, drug content, wetting time, water absorption ratio, disintegration time and *in vitro* dissolution study.

Weight Variation:

Twenty tablets were selected randomly from each batch and weighed individually on electronic balance (Shimadzu). The individual weighed is then compared with average weight for the weight variations.

Hardness:

The strength of tablet is expressed as tensile strength (kg/cm^2). The tablet crushing load, which is the force required to break a tablet into pieces by compression. It was measured using a tablet hardness tester (Monsanto hardness tester). Three tablets from each formulation batch were tested randomly and the average readings were noted.

Friability:

Friability of the tablets was determined using Roche Friabilator. This device consists of a plastic chamber that is set to revolve around 25 rpm for 4 min dropping the tablets at a distance of 6 inches with each revolution. Pre weighed sample of 20 tablets was placed in the friabilator and were subjected to 100 revolutions. Tablets were dusted using a soft muslin cloth and reweighed. The friability (F %) is given by the formula

$$\textbf{F (\%)} = (1 - W_0 / W) \times 100$$

Where, W is weight of the tablets before the test

W_0 is the weight of the tablets after test.

Drug content

Twenty tablets were weighed and powdered. An amount of the powder equivalent to 10mg of Lisinopril was dissolved in 100ml of 0.1N hydrochloric acid, filtered, diluted suitably and analyzed for drug content at 205.5nm using UV-Visible spectrophotometer (Shimadzu1700, Tokyo, Japan).

Wetting time[31-33]

A piece of tissue paper (12cmx10.75cm) folded twice was placed in a Petri dish (Internal Diameter=9cm) containing 9ml of buffer solution simulating saliva pH 7.4, which had the following to the petridish. A tablet was carefully placed on the surface of tissue paper. The time required for water to reach the upper surface of the tablets was noted as the wetting time. Six tablets from each formulation batch were tested randomly and the average reading noted.

***In vitro* disintegration time**

10 ml of water at 25°C was placed in a petridish of 10 cm diameter. The tablet was then carefully positioned in the center of the petridish and the time required for the tablet to completely disintegrate into fine particles was noted.

***Invitro* drug release studies**

In vitro drug release of Lisinopril fast disisolving tablets was determined using USP XXIII Dissolution Apparatus II (Paddle type) [Electrolab Tablet Dissolution Tester] at 50 rpm. The drug release profile was studied in 900 ml of 0.1N HCl by maintaining at 37 ± 0.5º C. Aliquots of 5ml of dissolution medium were withdrawn at specific time intervals (5, 10, 15, 20, 25, 30, 45 minutes), filtered and the amount of drug released was determined spectrophotometrically at 205.5 nm. Three trials for each batch were performed and average percentage drug release with standard deviation was calculated and recorded.

Stability studies[34-35]

Stability studies were carried out for the optimized formulation according to ICH guidelines. An optimize formulation were sealed in aluminium packaging coated inside with polyethylene, and samples were kept in humidity chamber (Remi, India) at 40°C and 75% RH for one month. At the end of the period, samples were analyzed for drug physical changes, properties, drug content and in vitro release studies.

Calibration Curve for Lisinopril

Calibration curve of Lisinopril was prepared in 0.1N HCl

containing at 205.5 nm. The absorbance values (mean of three determinations) with their standard deviations at different concentration in the range of 0.5-15 µg/mL. Drug was found to obey Lambert Beer's law with the high value of R^2 (0.998), (0.998), (0.997) and (0.997) indicates linearity of the drug between 0.5-15 µg/ml.

Applying the similarity factor f2

Similarity factor f2 is used to check the similarity between release profile of optimized formulation before and after the stability testing. Its value is from 50 to 100, the value larger than 50 shows the similarities.

For this purpose CPR of optimized formulation F8 of Fast Dissolving tablets of lisinopril before stability period was taken as a reference standard,While same formulation after stability period was taken as a test formulation.

RESULT AND DISCUSSION

The supplied drug passed the various tests of identification and analysis. The pure drug Lisinopril and the solid admixture of drug and various excipients used in the preparation of fast dissolving tablet formulations were characterized by FT-IR spectroscopy to know the compatability, figure-2 & 3. The FT-IR study did not show any possibility of interaction between Lisinopril and superdisintegrants used in the fast dispersible tablets.

The formulation and results for evaluation of different batches of Lisinopril FDT's prepared by direct compression method are shown in Table 1, 3 and 4.Since the flow properties of the powder mixture are important for the uniformity of the mass of the tablets, the flow of the powder mixture was analyzed before compression of the tablets. The angle of repose of all the formulations blend were found to be in the range of 25^0 to 30^0 indicates good flow property and acceptable characteristics. The compressibility index percentage is determined from the bulk and tapped densities. The percentages of compressibility Carr's index of all formulations blend were found to be in the range of 11^0 to 20^0, which is also within the acceptable limit. The Hausner's ratio of was found to be near 1.25 indicates good flow properties. Hence all the components used in the formulation can be directly compressed.

The hardness of all formulations was found to be in acceptable range. The Hardness for the formulation containing crosscarmellose sodium and sodium starch glycolate decreases with increasing concentration of superdisintegrant and decrease in concentration of MCC. This shows that the more the concentration of superdisintegrant the minimum it attains the hardness. It shows and assures MCC to be a direct compressible diluent.

The percentage friability for all the formulations came in the range of 0.48 % to 0.56%, which was found to be in limit (i.e. maximum 1%). Wetting time is the time taken for the tablet to disintegrate when kept on the tissue paper in a petridish. This method will duplicate the *in vivo* disintegration, as the tablet is going to the stomach. It has been reported that wetting is closely related to the inner structure of the tablets and the hydrophillicity excipients. The superdisintegrants show its disintegrant effect by swelling action. Thus the result indicates that these tablets would disintegrate almost instantaneously when they will come in contact with even slight amount of saliva in the mouth. All the formulations were evaluated for the wetting time and *invitro* disintegrating time. The average wetting time and *invitro* disintegrating time of all the formulations was observed in the range of 23 to 52 seconds and 38 to 63 second respectively as shown in figure 4 and 5. Formulation F8 showed the minimum wetting time as well as *invitro* disintegrating time of 23± 3.00 seconds and 38± 2.18 where as formulation F1 showed the maximum wetting time of 52± 3.15 second and 97.9±0.18 respectively.

The drug content values for all the formulations came in the range of 95 % to 102%. As per USP standard, lisinopril tablets must contain not less than 90% and not more than 110.0% of the stated amount of Lisinopril. Thus, all the FDT formulations of lisinopril comply with IP limits for assay.

The results of *in vitro* drug release studies of FDT of lisinopril prepared by addition of different superdisintegrants were given in Tables 5. Percentage amount of cumulative drug release of FDT of lisinopril was plotted against time to obtain drug release profiles as given in Figures 6.The disintegration time of tablets of sodium starch glycolate are comparatively lower than the crosscarmellose sodium. The faster disintegration of sodium starch glycolate tablets may be attributed to its rapid absorption of water leading to an enormous increase in volume that result in rapid and uniform disintegration.

In formulation F4, SSG was selected as superdisintegrant and it disintegrated in 48 seconds. The increase in disintegrant SSG (10%) in F6 decreased the disintegration time to 43 seconds. But the drug release was only 89.96 % after 30 minutes. In the F7 formulation concentration of Avicel PH 102 was decreased and a little increase in the release profile (92.63%) was observed. So in the F8 formulation Avicel PH 102 was reduced further and this showed marked increase in the drug release 98.34% at 30 min. From the overall observations, formulation F8 containing 10% w/w Sodium starch glycolate and 10 % microcrystalline cellulose PH102 was considered to be the best formulation, which releases up to 98.34% of the drug in 30 min.

FORMULATION OF FAST DISSOLVING TABLETS OF LISINOPRIL

Table 1: Composition of Fast Dissolving Tablets of Lisinopril

Ingredients (mg)	Batch code							
	F1	F2	F3	F4	F5	F6	F7	F8
Lisinopril	10	10	10	10	10	10	10	10
Betacyclodextrin	50	50	50	50	50	50	50	50
Microcrystalline cellulose PH102	26.8	24.8	22.8	26.8	24.8	22.8	15	10
Partially pregelatinized starch	5	5	5	5	5	5	12.8	17.8
Sodium starch glycolate	-	-	-	6	8	10	10	10
Crosscarmellose sodium	6	8	10	-	-	-	-	-
Aerosil	1	1	1	1	1	1	1	1
Magnesium stearate	1	1	1	1	1	1	1	1
Iron oxide red	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table 2: Calibration Curve Data for Lisinopril in 0.1N HCl at 205.5 nm.

Concentration (µg/ml)	Absorbance* ± S.D at 205.5 nm
0.5	0.05± 0.0182
3	0.159±0.0079
7	0.375± 0.0137
9	0.49± 0.0146
13	0.663± 0.0073
15	0.765± 0.0146

Figure 1: Standard graph of Lisinopril in 0.1NHCl at 205.5 nm

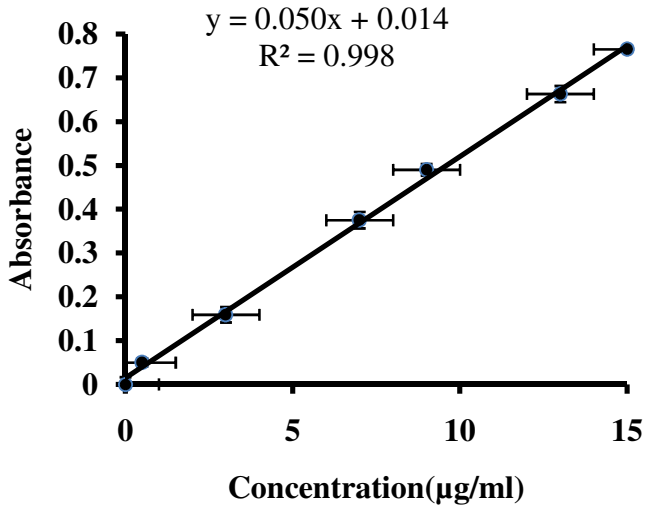


Figure 2: FTIR Spectrum of Pure Lisinopril

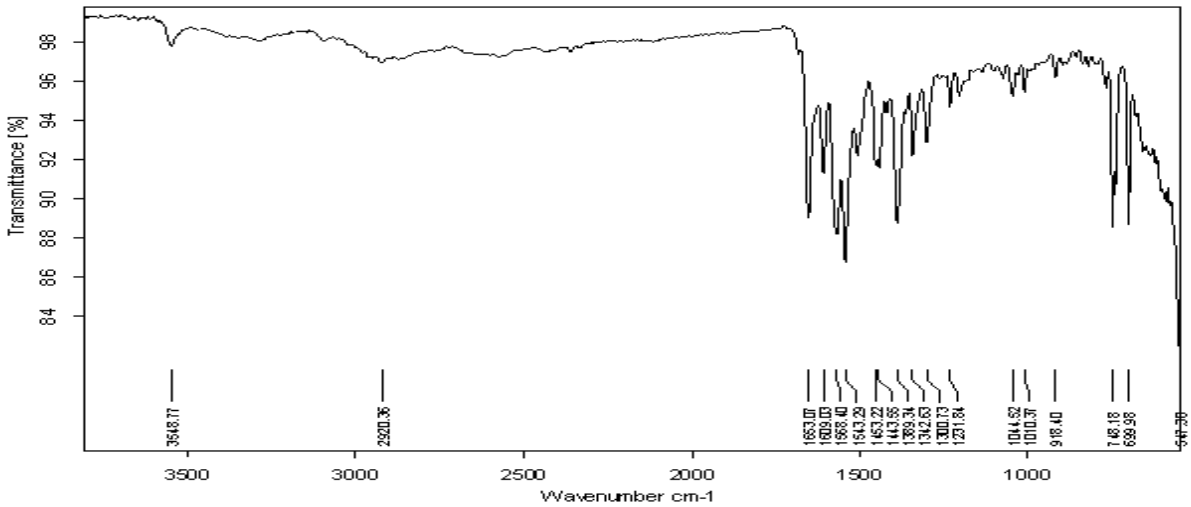


Figure 3: FTIR Spectrum of Physical Mixture of Lisinopril, SSG and Avicel PH 102

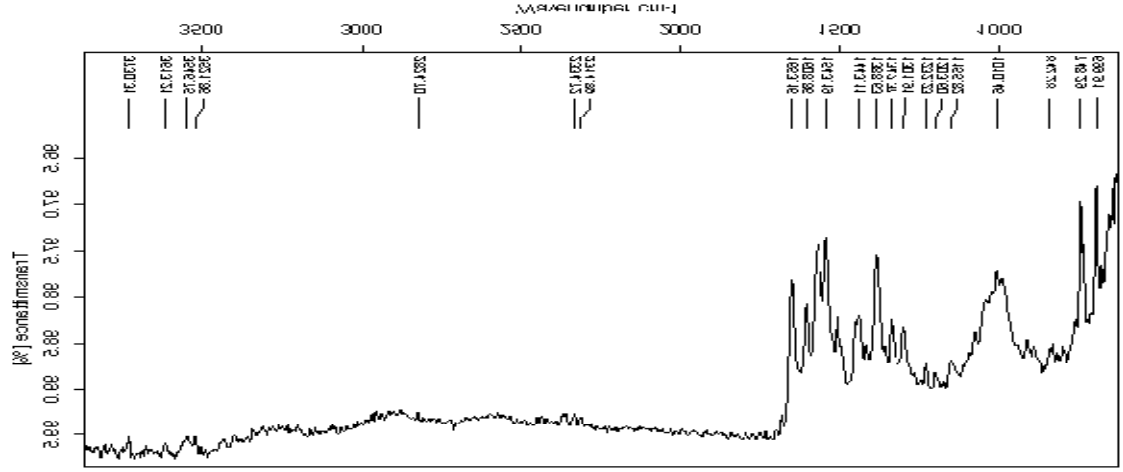


Table 3: Precompression parameters of Lisinopril batch

Formulation	Parameters				
	Angle of Repose (θ)*	Bulk Density (g/ml)*	Tapped Density (g/ml)*	Carr's index (%)*	Hausner Ratio*
F1	25.8± 0.28	0.701± 0.02	0.828± 0.04	15.338± 0.04	1.181± 0.01
F2	26.7± 0.19	0.698± 0.00	0.822± 0.01	15.085± 0.11	1.178±0.02
F3	26.0± 0.16	0.695± 0.01	0.818± 0.01	15.037± 0.15	1.177± 0.01
F4	26.0± 0.21	0.696± 0.01	0.820± 0.00	15.122± 0.05	1.178±0.02
F5	26.5± 0.23	0.696± 0.01	0.820± 0.01	15.122±0.13	1.178±0.02
F6	25.4± 0.17	0.694± 0.02	0.824± 0.02	15.777± 0.14	1.187± 0.01
F7	27.3± 0.08	0.698± 0.01	0.812± 0.01	14.039± 0.14	1.163± 0.01
F8	28.0± 0.22	0.702± 0.00	0.800± 0.01	12.250± 0.08	1.140± 0.01

Table 4: Evaluation of Fast Dissolving Tablets of Lisinopril

TESTS	F1	F2	F3	F4	F5	F6	F7	F8
Weight Variation (mg)*	99.75±2.0	96.20±1.85	98.50±3.85	99.70±1.50	96.25±1.75	97.50±1.50	98.45±2.50	97.90±2.50
Hardness (Kg\cm^2)*	3.82±1.7	3.50± 1.4	3.35±1.4	3.96±1.8	3.98±1.3	3.70±2.1	3.65±1.5	3.50±1.6
Friability (%w/w)*	0.48	0.54	0.56	0.52	0.50	0.52	0.48	0.50
Invitro disintegrating time(sec)*	63± 3.00	55± 2.5	50± 3.15	48± 2.73	45± 2.5	43± 2.33	41± 2.35	38± 2.18
Wetting time(sec)*	52± 3.15	48± 3.15	45± 2.73	38± 2.18	35± 3.00	30± 2.33	28± 2.5	23± 3.00
Drug content(%)*	97.9±1.1	98.9± 2.2	98.7±1.4	99.2±2.1	98.5±1.3	99.4±2.1	96.8±1.4	97.6±1.6

Figure 4: Bar diagram showing *invitro* disintegrating time for the formulation of taste masked FDT of Lisinipril

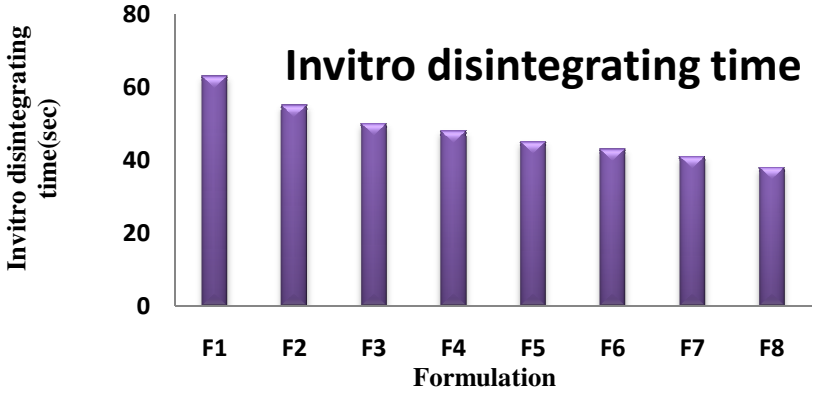


Figure 5: Bar diagram showing wetting time for the formulation of taste masked FDT of Lisinipril

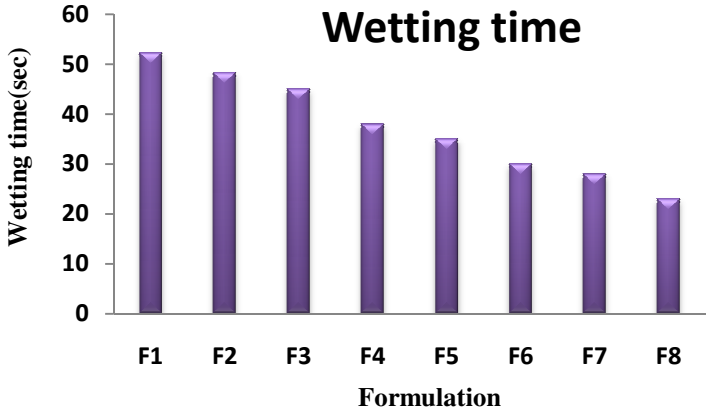


Table 5: *Invitro* Drug Release Study of Fast Dissolving Tablets of Lisinopril

Time (min)	F1*	F2*	F3*	F4*	F5*	F6*	F7*	F8*
0	0	0	0	0	0	0	0	0
5	45.20±1.18	46.38±1.20	47.81±0.65	48.31±0.65	52.30±0.90	53.49±1.50	56.45±0.85	58.32±0.95
10	54.56±1.28	56.93±2.10	7.21±1.15	57.46±1.65	62.97±1.40	66.75±1.25	69.62±1.75	71.39±0.56
15	61.69±0.90	62.23±1.18	64.75±0.45	66.36±1.45	73.15±1.10	76.23±1.80	79.28±0.80	81.63±0.95
20	71.23±0.50	72.34±1.65	73.62±1.40	74.69±1.10	79.68±1.35	82.36±1.55	84.86±1.30	86.29±1.20
25	74.62±1.15	77.82±1.52	8.96±1.56	79.35±0.65	81.38±0.75	85.62±1.20	90.23±1.36	94.65±0.65
30	75.56±0.85	79.98±0.56	5.15±0.45	81.2±0.85	4.46±0.90	89.96±1.20	92.63±1.84	8.34±0.50
45	73.26±0.15	78.62±0.75	82.23±0.70	80.86±0.50	83.96±0.85	88.68±1.00	91.8±0.65	97.84±0.75

Figure 6: *Invitro* Drug Release Profile of Fast Dissolving Tablets of Lisinopril

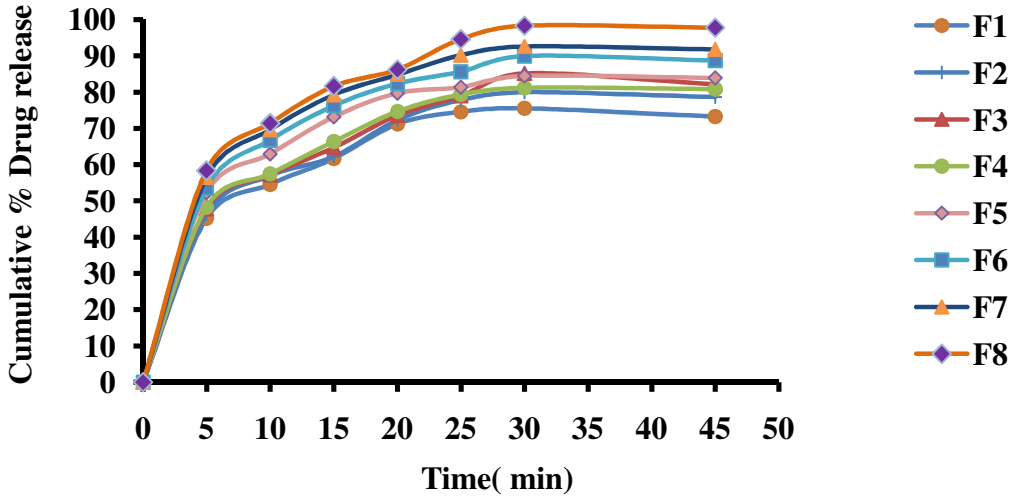


Table 6: Drug Release Kinetics of optimized batch F8

Kinetic model	Equation	R^2
Zero order	Y= -1.775x+59.73	0.623
First order	Y= -0.040x+1.851	0.886
Higuchi model	Y= 14.83x+16.20	0.890
Hixon crowel cube root model	Y= 0.074x+0.649	0.910

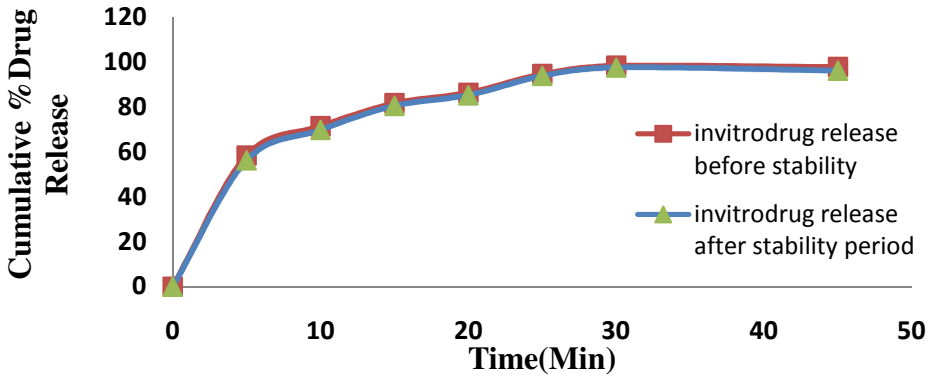
Table 7: Stability study (40 °C/75%RH) of Optimized Batch F8

Parameters	Before stability studies	After stability studies
Weight variation(mg))	99.10±2.50	98.85±1.24
Hardness (kg/cm^2)	3.15±1.6	3.15±0.15
Friability(% w/w)	0.50	0.50
Invitro disintegrating time(sec)	38± 2.18	38±1.35
Wetting time(sec)	23± 3.00	24± 1.5
Drug content (%)	97.6±1.65	97.50±1.10
In vitro release (%) at 30sec	98.34±0.50	98.59±0.50

Table 8: Comparison of release profile of Reference and Test formulation

Time (min)	CPR*	
	Optimized batch F8 before stability (Reference)	Optimized batch F8 after stability (Tested)
0	0	0
5	58.32±0.95	56.25±0.85
10	71.39±0.56	69.85±1.2
15	81.63±0.95	80.57.±1.5
20	86.29±1.20	85.28±0.55
25	94.65±0.65	93.87±0.8
30	98.34±0.50	97.59±0.50
45	97.84±0.75	96.24±0.96

Figure 7: Comparison of release profile of Reference and Test formulation



A perusal of Table 6 indicated that the optimized batch F8 release kinetics followed first order as the R^2 values are 0.886 for first order kinetics and also obeys Hixson-Crowell Cube Root Law as showing R^2 values near to unity. Hence the release mechanism was due to the diffusion of drug through the formulation.

From the results of stability study, it was observed that the optimized formulation F8 was stable for the one month at 40^0C, 75% RH as specified by the ICH guidelines. From the data, the formulation F8 is found to be stable under the conditions mentioned before since there was no significant change in the physical characterization, Hardness, Friability, disintegrations, dissolution, drug content and percentage amount of drug content. Thus, it was found that the Fast Dissolving tablet of lisinopril (F8) was stable under these storage conditions for at least one month.

The calculated value for f_2 was more than 50 which shows that there is similarity of release profile between reference and tested formulations. The *in vitro* drug release profiles of the formulation obtained before and after stability studies were compared (Figure 8). The profiles appeared to be almost super imposable.

CONCLUSION

Fast Dissolving tablets of Lisinopril were prepared by direct compression method using croscarmellose sodium (6%, 8%& 10%) sodium starch glycolate (6%,8% &10%) and Avicel 102 (10%). From the observed parameters it was concluded that the formulation F8 considered as the best formulation than other formulations due to fast and complete release within 30 minutes. From the observed parameters it was concluded that the formulation F8 satisfied all the official requirements. The tablets had acceptable hardness of average 3.15 kg/ cm^2, 0.50 % friability, In-vitro disintegration time 38 secs, wetting time 23 secs and in-vitro drug release of 98.34%. Hence it can be concluded that using a combination of synthetic superdisintegrants would be quite effective in providing faster onset of action without the need of water for swallowing.

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