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Research Article

# Formulation and Evaluation of Bisoprolol Hydrochloride Fast Dissolving Tablet

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**ABSTRACT**

The oral route of administration is the most promising route of administration among all the dosage forms due to ease of administration, accurate dose and higher patient compliance. Conventional dosage forms like tablets and capsules have the drawback of difficulty in swallowing for some patients, in case of motion sickness, when water is not available, and cough, allergic conditions like bronchitis and in paediatrics and geriatric population. Fast dissolving tablets offer a solution to overcome the drawbacks of conventional tablets and capsules.

In the present study, an attempt was made to formulate fast dissolving tablets of Bisoprolol Hydrochloride, a cardioselective β-adrenergic blocking agent. The fast-dissolving tablets were prepared by direct compression method using sodium starch glycolate and Croscarmellose sodium as super disintegrants in different concentrations. Compatibility studies of excipients and drug were carried out using FT-IR spectroscopy. Formulations were evaluated for pre-compressional parameters such as density, angle of repose, Carr's index and Hausner's ratio. The tablets were evaluated for weight variation, thickness, hardness, friability, drug content, wetting time, disintegration time and in-vitro dissolution study. No chemical interaction between drug and excipients was confirmed by FTIR studies. All the formulations showed satisfactory tablet properties. The formulation F3 contain (15%) Croscarmellose sodium showed maximum drug release.

## INTRODUCTION

Oral routes of drug administration have wide acceptance up to 50-60% of total dosage forms. Solid dosage forms are popular because of ease of administration, accurate dosage, self-medication, pain avoidance and most importantly patient compliance. The most popular solid dosage forms are tablets and capsules; one important drawback of these dosage forms for some patients is the difficulty to swallow. Drinking water plays an important role in the swallowing of oral dosage forms. Often people experience inconvenience in swallowing conventional dosage forms such as tablets when water is not available, in the case of motion sickness (kinetosis) and sudden episodes of coughing during the common cold, allergic condition and bronchitis. For this reason, tablets that can rapidly dissolve or disintegrate in the oral cavity have attracted a great deal of attention. Fast dissolving tablets (FDT) are not only indicated for people who have swallowing difficulties but also are ideal for active people.

FDT is also called mouth-dissolving tablets, melt-in-mouth tablets, Orodispersible tablets, rapimelts, porous tablets, quick dissolving etc. FDT are those when put on the tongue disintegrate instantaneously releasing the drug which dissolves or disperses in the saliva. The faster the drug is in the solution, the quicker the absorption and onset of clinical effect. Some drugs are absorbed from the mouth, pharynx and oesophagus as the saliva passes down into the stomach. In such cases, the bioavailability of a drug is significantly greater than those observed in conventional tablets dosage form. The advantage of fast dissolving dosage forms is increasingly being recognized in both, industry and academics.

According to European Pharmacopoeia, the FDT should

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disperse/disintegrate in less than three minutes. The basic approach in the development of FDT is the use of super disintegrants like cross-linked carboxymethyl cellulose (croscarmellose), sodium starch glycolate (primogel, explotab), polyvinylpyrrolidone (polyplasdone) etc, which provide instantaneous disintegration of tablet after putting on the tongue, their by release the drug in saliva.

The bioavailability of some drugs may be increased due to absorption of the drug in the oral cavity and also due to pregastric absorption of saliva containing dispersed drugs that pass down into the stomach. More ever, the amount of drug that is subjected to first pass metabolism is reduced as compared to a standard tablet. The technologies used for manufacturing FDTs are freeze-drying, spray-drying, tablet moulding, sublimation, sugar-based excipients, tablet compression, and disintegration addition. As a result of increased life expectancy, the elderly constitute a large portion of the worldwide population today. These people eventually will experience deterioration of their physiological and physical abilities.

Recent developments in technology have presented viable alternatives for patients who may have difficulty swallowing tablets or liquids. To overcome these drawbacks, FDT or orally disintegrating tablets (ODT) have emerged as alternative oral dosage forms. These are novel types, of tablets that disintegrate/dissolve/disperse in saliva within a few seconds.

## MATERIALS & METHODS

Bisoprolol Hydrochloride was obtained from Pharmatrain, Hyderabad, India. The superdisintegrants such as croscarmellose sodium, sodium starch glycolate and other materials like microcrystalline cellulose, mannitol, aspartame, magnesium stearate and talc are purchased from Narmada Chemicals, Hyderabad, India.

### Formulation of Bisoprolol Hydrochloride Fast Dissolving Tablets

Fast dissolving tablets of Bisoprolol Hydrochloride were prepared by direct compression method. The drug and excipients were passed through a sieve (#60) to ensure better mixing. Microcrystalline cellulose (MCC) was used as a direct compressible material. Superdisintegrants like Sodium starch glycolate (SSG), Croscarmellose sodium (CCS) were used in different concentrations. All the ingredients were mixed in mortar and pestle then magnesium stearate and talc were added. The formulations were compressed with a ten-station rotary tablet punching machine (Chamunda, Mini Press-1, India) using an 8mm flat punches set.

### Pre- Compressional Evaluation Studies

The powder blend was evaluated for pre-compressional parameters as per I.P guidelines and the results were given in Table 2.

### Bulk density

The bulk density of powder was determined by passing 10-15g of powder through a glass funnel into a 50 ml graduated cylinder. The volumes occupied by the samples were recorded.

Bulk density = weight of sample in gram /volume occupied by the sample

### Tapped density

Tapped density was determined by using an Electro lab density tester, which consists of a graduated cylinder mounted on a mechanical tapping device. An accurately weighed sample of powder was carefully added to the cylinder with the aid of a funnel. Typically, the initial volume was noted, and the sample is then tapped (500, 750 or 1250 tapping) until no further reduction in volume is noted or the percentage of difference is not more than 2%.

Tapped density = Wt. of sample in gm / Tapped volume

### Angle of repose

The angle of repose has been used to characterize the flow properties of solids. The angle of repose is a characteristic related to inter-particulate friction or resistance to movement between particles. This is the maximum angle possible between the surface of the pile of powder or granules and the horizontal plane.

$$\text{Tan } \theta = h / r$$

$$\theta = \text{Tan } -1\ h / r$$

Where, θ = angle of repose, h = height, r = radius.

A funnel was fixed at a height of approximately 2-4 cm over the platform. The loose powder was slowly passed along the wall of the funnel, till the cone of the powder formed. Determine the angle of repose by measuring the height of the cone of powder and the radius of the heap of powder.

### Compressibility index

The simplest way to the measurement of free flow of powder is compressibility, an indication of the ease with which a material can be induced to flow is given by Compressibility Index. The value below 15% indicates a powder with gives rise to good flow properties, whereas above 25% indicates poor flowability. Which is calculated as follows.

$$\text{Carr's index} = \frac{\text{Tapped desnity} - \text{Bulk density}}{\text{Tapped density}} \times 100$$

### Hausner ratio

Hausner's ratio is an indirect index of ease of powder flow. Hausner's ratio is the ratio of tapped density to bulk density. Lower the value of Hausner's ratio better is than the flow property.

Hauser's Ratio = Tapped Density / Bulk Density

### Drug- Excipient compatibility studies

IR spectra of Bisoprolol Hydrochloride and all super disintegrants along with drug in KBr pellets at a moderate scanning speed between 4000-400cm-1 were carried out using FTIR. The peak values and the possibility of functional groups shown in spectra were compared with standard values. The FT-IR spectra of the pure drug and the optimized formulation were given in figure 1 and figure 2 respectively.

### Post-Compressional Evaluation studies

All the prepared tablets were evaluated for the following parameters as per the I.P guidelines and the results are given in Table 3 and the dissolution profile was given in Table 4 and Figure 3.

### Weight variation

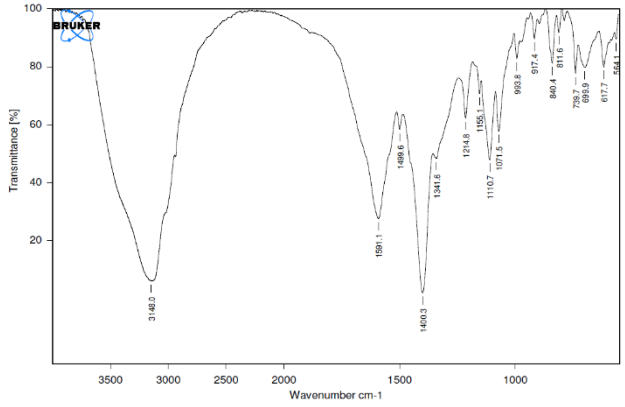
Twenty tablets from each formulation were selected randomly and the average weight was determined. Individual tablets were then weighed and compared with average weight. The variation in the weight was expressed in terms of % deviation.

### Hardness test

The force required to break a tablet in a diametric compression was determined by using a Pfizer tablet hardness tester.

**Friability**

The friability of tablets was determined by Roche Fraibilator. The weight of twenty tablets was noted and placed in the friabilator and then subjected to 100 revolutions at 25 rpm for 4 minutes. Tablets were de-dusted using a soft muslin cloth and reweighed.




Percent friability = [initial weight – final weight / initial weight] × 100

**In-vitro dispersion time**

Tablet was added to 10ml of distilled water at 37± 0.5˚C, and the time required for complete dispersion of the tablet was measured.

**Drug content uniformity**

Five tablets were weighed initially and powdered. The drug content uniformity was determined by taking the powder equivalent to 10mg, then it was (n=3) dissolved in PH 6.8 phosphate. Required dilution (10µg/ml) was prepared and absorbance was taken against the blank at measured at 232nm.

**In-vitro disintegration time**

The disintegration was performed using an I.P 85 disintegration apparatus with distilled water at 37±0.5 ˚C as a disintegration media and the time in seconds taken for complete disintegration of the tablet with no palatable mass remaining in the apparatus was measured.

**In-vitro Drug release**

The dissolution rate of Bisoprolol HCl from all formulations was performed using LAB INDIA DISSO 2000 an eight-stage dissolution rate testing apparatus with paddle. The dissolution fluid was 900 ml of PH6.8 phosphate buffer with a speed of 50 rpm and temperature of 37±0.5˚C were used in each test. 5 ml of sample was withdrawn at different time intervals (2.5, 5, 10, 15 & 20 mins) and fresh medium was replaced to maintain sink conditions. The samples are analyzed by using UV- Visible spectrophotometer at λmax232nm.

## RESULTS AND DISCUSSION

The fast-dissolving tablets of Bisoprolol Hydrochloride were prepared by direct compression method and the composition of the formulation were shown in Table 1. The super disintegrants such as croscarmellose sodium and sodium starch glycolate were used in different concentrations in the formulations. The compatibility of drug and excipients was characterized by FT-IR spectroscopy. The FT-IR spectra of Bisoprolol Hydrochloride and formulation containing different super disintegrants have the same characteristic peak indicating no chemical interaction between drug and excipients.

Six formulations were prepared by using 5%, 10% and 15% concentrations of super disintegrants like croscarmellose sodium and sodium starch glycolate. For each designed formulation, a powder mixed blend of drugs and excipients was prepared and evaluated for various parameters as shown in table 1.

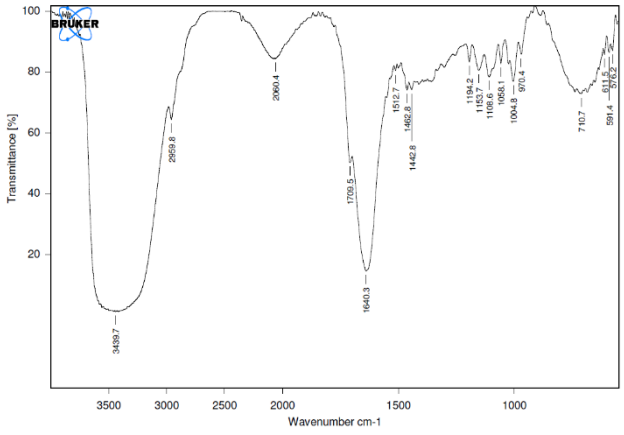



**Figure 2**: FT-IR spectra of Bisoprolol HCL pure drug

The angle of repose of all formulated batches prepared with different super disintegrants and various powder mixed blends was measured. The angle of repose was found in the range from 25º18 to 28º64 this implies an excellent free-flowing nature of blends. The bulk density of all formulated batches prepared with different super disintegrants and various powder mixed blends. The bulk density was found in the range from 0.30 to 0.53 g/cm3. The tapped density of all formulated batches prepared with different super disintegrants and various powder mixed blends was measured by the cylinder method. The tapped density was found in the range from 0.35 to 0.39 g/cm3.

**Table 1:** Composition of different formulations of Bisoprolol Hydrochloride fast dissolving t

**Figure 1**: FT-IR spectra of optimized formulation

| Ingredients | F1 | F2 | F3 | F4 | F5 | F6 |
|---|---|---|---|---|---|---|
| Bisoprolol Hcl | 20 | 20 | 20 | 20 | 20 | 20 |
| MCC PH101 | 82 | 77 | 72 | 82 | 77 | 72 |
| CCS | 5 | 10 | 15 | - | - | - |
| SSG | - | - | - | 5 | 10 | 15 |
| Mannitol | 75 | 75 | 75 | 75 | 75 | 75 |
| Aspartame | 4 | 4 | 4 | 4 | 4 | 4 |
| Magnesium Stearate | 4 | 4 | 4 | 4 | 4 | 4 |
| Talc | 4 | 4 | 4 | 4 | 4 | 4 |
| Total Weight | 200 | 200 | 200 | 200 | 200 | 200 |

The compressibility index of all formulated batches prepared with different super disintegrants and various powder mixed blends by using bulk density and tapped density data, compressibility index was calculated. It was found in the range of 8.82 % to 13.62 %. The Hausner ratio of all formulated

batches prepared with different super disintegrants and various powder mixed blends was calculated by using bulk density and tapped density data. It was found in the range of 1.16 to 1.22.

The research work was carried out to analyse and study the impact of various super disintegrants on enhancing the dissolution rate of Bisoprolol HCl. The experiment was designed with six formulations which were categorised into two groups based on the concentration of super disintegrants.

Tablets were prepared using the direct compression technique. Since the material was free flowing, tablets were obtained of uniforms weight due to uniform die fill. The tablets were obtained in the range with acceptable weight variations as per pharmacopoeia specifications of less than 7.5%. Tablets were evaluated by using Vernier callipers. The thickness of tablets was found to be uniform thickness was obtained due to uniform die fill. Tablets were evaluated by using a hardness tester. The hardness of the tablets was found in the range of 3.2 to 3.6 Kg/cm2. Tablets were evaluated by using Roche Friabilator and the Friability of tablets was observed in the acceptable range of 0.42 to 0.54 (Less than 1%).

**Table 2**: Pre-compression properties of formulations

| Ingredients | The angle of Repose (o) | Bulk Density (Kg/Cm2) | Tapped Density (Kg/Cm2) | Carr's Index (%) | Hausner's ratio |
|---|---|---|---|---|---|
| F1 | 25.89 | 0.32 | 0.37 | 13.68 | 1.16 |
| F2 | 25.69 | 0.33 | 0.36 | 13.42 | 1.09 |
| F3 | 28.54 | 0.30 | 0.35 | 11.82 | 1.17 |
| F4 | 27.88 | 0.31 | 0.36 | 8.82 | 1.16 |
| F5 | 26.22 | 0.33 | 0.37 | 8.94 | 1.12 |
| F6 | 25.18 | 0.32 | 0.39 | 13.157 | 1.22 |

**Table 3**: Different evaluation tests of Bisoprolol Hydrochloride fast dissolving tablets

| Formulation code | Weight Variation | Thickness | Hardness (Kg/cm2) | Friability | Content Uniformity (%) | Disintegration Time (Sec) | Wetting time (sec) |
|---|---|---|---|---|---|---|---|
| F1 | 201 | 2.6 | 3.2 | 0.42 | 98.66 | 36 | 58 |
| F2 | 203.25 | 2.6 | 3.6 | 0.52 | 99.92 | 33 | 55 |
| F3 | 199.58 | 2.5 | 3.5 | 0.48 | 98.87 | 32 | 53 |
| F4 | 200.79 | 2.6 | 3.5 | 0.51 | 99.24 | 38 | 59 |
| F5 | 201.26 | 2.4 | 3.6 | 0.49 | 99.84 | 36 | 57 |
| F6 | 200. | 2.6 | 3.5 | 0.54 | 99.72 | 33 | 56 |
| | | | | | | | 68 |

The results for content uniformity are presented in Table No 3. The results showed drug content was lying within the limits. The assay limit of Bisoprolol HCL tablets as per USP is 90-110%. The assays of the tablets were carried out as a process given in USP. Tablets were evaluated for disintegration time in the disintegration test apparatus (I.P). The disintegration time was found in between 32 to 38 sec for all the batches. The batch F3 showed the fastest disintegration (32 sec). A piece of tissue paper folded twice was placed in a small petri-dish (6.5cm) containing 6ml of water, a tablet was placed on the paper and the time for complete wetting was measured the wetted tablet was then weighed and the water absorption ratio was calculated for each batch. The ratio was calculated for each batch.

**Table 4:** Dissolution profiles of different formulations

| Formulations | Cumulative % drug released | | | | | |
|---|---|---|---|---|---|---|
| | 0 | 2.5 | 5 | 10 | 15 | 20 |
| F1 | 0 | 39.8 | 55.2 | 73.82 | 84.25 | 93.85 |
| F2 | 0 | 41.61 | 60.5 | 75.9 | 86.65 | 95.17 |
| F3 | 0 | 43.7 | 68.35 | 75.44 | 88.69 | 97.25 |
| F4 | 0 | 44.2 | 59.21 | 78.4 | 83.9 | 91.24 |
| F5 | 0 | 43.21 | 63.21 | 75.26 | 85.7 | 94.25 |
| F6 | 0 | 43.8 | 66.35 | 78.98 | 89.36 | 96.27 |

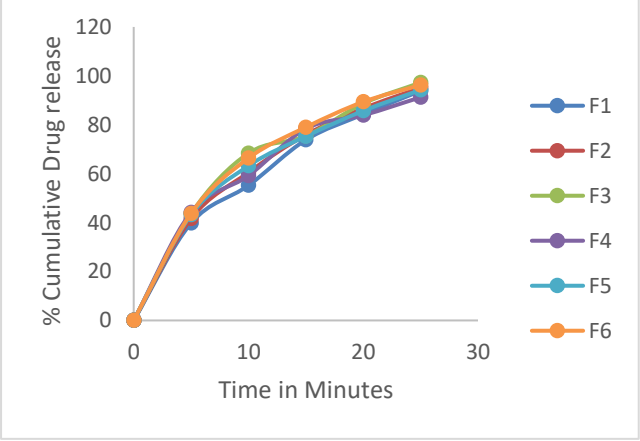



**Figure 3**: Dissolution profile of optimized formulation

The in-vitro dissolution studies of the Bisoprolol Hydrochloride fast dissolving tablets were performed in the water using USP dissolution apparatus type 2. The dissolution rate was found to increase linearly with the increasing concentration of super disintegrants. Formulations F1, F2, and F3 containing increasing concentration of Croscarmellose sodium showed 93.85%, 95.17% and 97.25% drug release, whereas formulations F4, F5, and F6 containing sodium starch glycolate showed 91.24%, 94.25% and 96.27% drug release. Among the all formulations (F3) contained 15% croscarmellose sodium showed maximum drug release.

## CONCLUSION

The Bisoprolol HCL Fast dissolving tablets were prepared by direct compression method. Based on disintegration and in-vitro drug release formulation (F3) containing croscarmellose sodium (15%) was the optimized batch. Thus it is concluded that by adopting a systematic formulation approach, an optimum point can be reached in the shortest time with minimum effort.

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## Conflict of Interest

The author(s) confirm that this article content has no conflict of interest.

## References

1. Shailesh Sharma, New Generation of Tablets: Fast Dissolving Tablets, Pharmaceutical reviews, 2008, Vol 6, Issue 1.
2. Debjit Bhowmik, Chiranjib. B, Krishnakanth, Pankaj and R. Margret Chandira Fast Dissolving Tablet: An Overview Journal of Chemical and Pharmaceutical Research, 2009, Vol 1, Issue 1, P 163-177.
3. Leon Lachman, Herberman, Joseph L.Kanig, The theory and practice of industrial pharmacy third edition, 1991, P 293-336.
4. Yourong Fu, Shicheng Yang, Seong Hoon Jeong, Susumu Kimura, and Kinam Park Orally Fast Disintegrating Tablets: Developments, Technologies, TasteMasking and Clinical Studies Critical Review in Therapeutic Drug Carrier Systems, 2004, Vol 21, Issue 6, P 433–475
5. Mary Kathryn Kottke and Edward M. Rudnic,Tablet dosage forms, Modern Pharmaceutics, Fourth Edition, Edited by Gilbert S. Banker, P 291-303
6. Patrick Kearney.,The Zydis Oral fast-dissolving Dosage Form., Modified-Release Drug Delivery Technology,edited by Michael J. Rathbone, Marcel Dekker, Inc. 2002, P 191
7. S. Indiran Pather, Rajendra K. Khankari, and Derek V. Moe. OraSolv and DuraSolv: Efficient Technologies for the Production of Orally Disintegrating Tablets, Modified-Release Drug Delivery Technology, edited by Michael J. Rathbone, Marcel Dekker, Inc. 2002, P 203
8. Lokesha Puttalingaiah, Kunchu Kavitha, Tamizh Mani T., Fast disintegrating tablets: An overview of formulation, technology and evaluation, Research Journal of Pharmaceutical, Biological and Chemical Sciences, 2011, Vol 2, Issue 2, P 589- 601
9. Rakesh Pahwa, Mona Piplani, Prabodh C. Sharma, Dhirender Kaushik and Sanju Nanda, Orally Disintegrating Tablets - Friendly to Pediatrics and Geriatrics, Archives of Applied Science Research, 2010, Vol 2, Issue 2, P 35-48
10. Tejvir Kaur, Bhawandeep Gill, Sandeep Kumar and G. D. Gupta, Mouth dissolving tablets: a novel approach to drug delivery, Int. J. Curr. Pharm. Res., 2010, Vol -3, Issue-1, P 17
11. Sharma Shailesh, Hardenia Shiv Shankar and Gupta G. D., Novel in-vitro disintegration evaluation for fast dissolving tablets, Journal of Global Pharma Technology, 2009, Vol 1, Issue 1, P 113-120
12. Debjit Bhowmik, Chiranjib B., Krishnakanth, Pankaj and R. Margret Chandira, Fast Dissolving Tablet: An Overview Journal of Chemical and Pharmaceutical Research, 2009, Vol 1, Issue 1, P 163-177
13. Bhupendra G Prajapati and Nayan Ratnakar, A Review on Recent patents on Fast Dissolving Drug Delivery System, International Journal of Pharm Tech Research, 2009, Vol 1, No.3, P 790-798.
14. Simone Schiermeier and Peter Christian Schmidt, Fast dispersible ibuprofen tablets, European Journal of Pharmaceutical Sciences, April 2002, Vol 15, Issue 3, P 295–305
15. Panati Dinakar, C. Varalakshmi, P. K. Prakash Reddy, S. Mohanlakshmi, Formulation and evaluation of Bisoprolol fumarate transdermal patches, Journal of Pharmacy Research, 2010, Vol 3, Issue 8, P 1955-1957
16. Sudhir Bhardwaj, Vinay Jain, R.C. Jat, Ashish Mangal, Suman Jain, Formulation and evaluation of fast dissolving tablet of aceclofenac, International Journal of Drug Delivery, 2010, Vol 2, P 93-97.
17. R. Margret Chandira, BS Venkataeswarlu, MV Kumudhavalli, Debjit Bhowmik and B. Jayakar, Formulation and evaluation of mouth dissolving tablets of the etoricoxib, Pak. J. Pharm. Sci., April 2010, Vol 23, No 2, P 178-181
18. H.A.Patel, J.K.Patel, K.N.Patel,R.R.Patel, Studies on formulation and in vitro evaluation of fast dissolving tablets of domperidone, International Journal of Pharmaceutical Sciences, 2010, Vol 2, Issue 1, P 470-476.
19. Indhumathi D, Grace Rathnam, Design and optimization of orodissolving tablet of antidepressant drug by superdisintegrants addition method, International Journal of Pharmaceutical Sciences Review and Research, May – June 2010, Volume 2, Issue 2, Article 001
20. A. Prameela Rani1, N. Archana, P. Siva Teja, P. Mohan Vikas, M. Sudheer Kumar and C. Bala Sekaran, Formulation and evaluation of orodispersible metformin tablets: a comparative study on isphagula husk and crosspovidone assuperdisintegrants, International Journal of Applied Pharmaceutics, 2010, Vol 2, Issue 3
21. Mahaveer P. Khinchi, M. K. Gupta, Anil Bhandari, Dilip Agrawal, Natasha Sharma, Sandeep Kr.Gupta, Effect of various super disintegrants on drug release of orally disintegrating tablet, IJPRD, July 2010, Vol 2, Issue 5
22. Suhas M. Kakade, Vinodh S. Mannur, Ketan B. Ramani, Ayaz A. Dhada, Chirag V. Naval, Avinash Bhagwat, Formulation and evaluation of mouth dissolving tablets of losartan potassium by direct compression techniques, Int. J. Res. Pharm. Sci, 2010, Vol 1, Issue 3, P 290-295.
23. Reddy S, Panakanti P, Kandagatla R, Yamsani MR. Formulation and Release Characteristic of a Bilayer Matrix Tablet Containing

Glimepride Immediate Release Component and Metformin Hydrochloride as Sustain Release Component. Int J of Pharma Sci and Nanotec, 2010, Vol 3, Issue 1, P 851-859.

24. N. G. Raghavendra Rao, T. Patel and S. Gandhi, Development and evaluation of carbamazepine fast dissolving tablets prepared with a complex by direct compression technique, Asian journal of pharmaceutics, 2009, Vol 3, Issue 2 , P 97-103
25. Venkatesh, Sajal Kumar Jha and Roopa Karki, Formulation Development and Evaluation of Taste MaskedORO-dispersible tablets of anti-emetic drug, Journal of Pharmacy Research, 2009, Vol 2, Issue 4, P 606-609
26. B. Jayakar, K. Sampath Kumar and Debjit Bhowmik, Design And Characterisation of Fast Dissolving Tablet of Telmisartan, International Journal of Pharma Recent Research, 2009, Vol 1, Issue 1, P 31-40
27. Raguia Ali Shoukri, Iman Saad Ahmed, Rehab N. Shamma, In vitro and in vivo evaluation of nimesulide lyophilized orally disintegrating tablets, European Journal of Pharmaceutics and Biopharmaceutics, 2009, Volu 73, Issue 1, P 162- 171.
28. C.P. Jain and P.S. Naruka, Formulation and evaluation of fast dissolving tablets of valsartan, International Journal of Pharmacy and Pharmaceutical Sciences, 2009, Vol 1, Issue 1.
29. Narmada G. Y., Mohini K., Prakash Rao B., Gowrinath and Kumar K. S., Formulation, evaluation and optimization of fast dissolving tablets containing amlodipine besylate by sublimation method, Ars Pharm, 2009, Vol 50, Issue 3, P 129-144
30. P.S. Zade, P.S. Kawtikwar, D.M. Sakarkar, Formulation, Evaluation and Optimization of Fast dissolving tablet containing Tizanidine Hydrochloride, International Journal of PharmTech Research, 2009 Vol 1,No 1, P 34-42
31. United State Pharmacopoeia 29-NF 24, Vol 30, Issue 5, P 1588
32. Raymond C R, Paul J S, Martan Equinn. Handbook of Pharmaceutical Excipients, 6 th Edition, 2009, P 206-208
33. Raymond C R, Paul J S, Martan Equinn. Handbook of Pharmaceutical Excipients, 6 th Edition, 2009, P 663-666
34. Raymond C R, Paul J S, Martan Equinn. Handbook of Pharmaceutical Excipients, 6 th Edition, 2009, P 208-210
35. Raymond C R, Paul J S, Martan Equinn. Handbook of Pharmaceutical Excipients, 6 th Edition, 2009, P 581-585
36. Raymond C R, Paul J S, Martan Equinn. Handbook of Pharmaceutical Excipients, 6 th Edition, 2009, P 133-134
37. Raymond C R, Paul J S, Martan Equinn. Handbook of Pharmaceutical Excipients, 6 th Edition, 2009, P 424-428
38. Robert M. Silverstein, Francis X. Webster. Infrared Spectrometry. In: Robert M. Silverstein. Editors. Spectrometric Identification of Organic Compounds. 6th Ed. John Wiley and Sons. Inc. New York, P. 71–143.
39. Y. R. Sharma. Elementary Organic Spectroscopy, Principles and chemical applications, P 69-339.
40. Akmar Sandip, Paramane Sonali, Kothapalli Lata, Thomas Asha, Jangam Sumitra, Mohite Mukesh and Deshpande Avinash, Spectrophotometric Estimation of Bisoprolol Fumarate in Bulk Drug and Tablets, Oct– Dec 2007, Vol 41, Issue 4, P 353-357
41. C. V. S. Subrahmanayam. Micromeritics. In: C. V. S. Subrahmanayam. Editors. Textbook of physical pharmaceutics. 2nd Ed. Vallabh Prakashan. Delhi, 2000, P 180-234.
42. Martin, P. Bustamante and A. Chun, Micromeritics, in Physical PharmacyPhysical Chemical Principles in the Pharmaceutical Sciences, 4th ed., Lippincott Williams and Wilkins, Baltimore, 2002, P 446–448.
43. H. C. Ansel, L. V. Allen and N. G. Popovich, Capsules and Tablets, in Pharmaceutical Dosage Forms and Drug Delivery Systems, 7th ed., Lippincott Williams &Wilkins, Philadelphia, 2002, P 204–209.
44. Alfred Martin. Diffusion and Dissolution. In: Alfred Martin, Pilar Bustamante and A. H. C. Chun. Editors. Physical Pharmaceutics. 4th edition, Lippincott Wi Jens T. Carstensen. Preformulation. In: Jens T. Carstensen. Editors. Drug Stability; Principles and practice. 3rd Ed. Revised and Expanded. Marcel Dekker Inc; New York. USA, 2008, P 237.