International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 3 May-June 2023, pp: 3407-3421 www.ijprajournal.com ISSN: 2249-7781

Development and Characterization of Mouth Dissolving Films of Bilastine and Montelukast Sodium

Shaikh Abid Shabbir[1], Arun M Mahale[2], Mohd. Amin Mahmood[3] Mohammad, Zishan Ibrahim[4], Abrar Asif Nagani[5]

Department of pharmaceutics, Sudhakarrao Naik Institute of Pharmacy,Pusad, Nagpur Road, Pusad

Submitted: 20-06-2023 Accepted: 29-06-2023

ABSTRACT:
The aim of this investigation was to develop rapid dissolving oral films containing Bilastine and Montelukast Sodium, with the goal of achieving a swift onset of action to enhance the management of allergic rhinitis. Using the solvent-casting method, nine formulations of mouth dissolving films were created, employing HPMC K4M, HPMC K100, and HPMC K15M as film-forming polymers. Various parameters such as thickness, weight variations, folding endurance, surface pH, disintegration, drug content, and in-vitro drug release were evaluated for all the films. Among the formulated variations, F4 exhibited exceptional characteristics, boasting a minimal disintegration time of only 17 seconds. Moreover, it demonstrated the highest drug release, with an impressive 96.32% of the drug being released within just 30 minutes, surpassing the performance of the other formulations. Thus, F4 was selected as the optimized formulation. Analysis through FTIR indicated that there were no significant interactions between the drug and the polymers used in the optimized formulation. In conclusion, the development of fast dissolving film formulations of Bilastine and Montelukast represents a promising approach for the treatment of allergic rhinitis. These films offer the advantage of rapid dissolution, leading to enhanced therapeutic efficacy.

Keywords: Mouth Dissolving Films, Bilastine, Montelukast Sodium, Allergic rhinitis

I. INTRODUCTION:

Oral film technology was initially created in the late 1970s to address the difficulties faced by elderly and young patients who have trouble swallowing tablets and capsules. However, it has gained popularity in the pharmaceutical industry due to its numerous advantages, including increased durability, rapid release, precise dosing, and ease of administration.[1-5] The oral route of drug delivery is preferred for its cost-effectiveness and convenience, leading to high patient adherence, especially among the elderly and pediatric populations. Nevertheless, the challenge of swallowing difficulties necessitates the development of innovative and safer drug delivery systems such as oral strips and buccal films.[6-10]

Fast-dissolving films have become increasingly popular as an alternative to fast-dissolving tablets because they quickly dissolve upon contact with wet surfaces like the tongue, eliminating the need for additional liquids. This convenience not only provides a marketing advantage but also enhances patient compliance. Furthermore, the drug is directly absorbed into the systemic circulation, bypassing degradation in the gastrointestinal tract and the first-pass effect. These advantages have contributed to the widespread acceptance and popularity of this formulation, particularly among pediatric and geriatric patients and individuals with a fear of choking. Oral thin films are now approved and utilized as a technique for achieving systemic distribution of active pharmaceutical ingredients (APIs) in over-the-counter (OTC) medications and some prescription treatments.[11-14]

Fast-dissolving oral films are formulated using hydrophilic polymers that dissolve rapidly on the tongue or buccal cavity, facilitating drug delivery to the systemic circulation upon contact with liquid. The user applies the film on or under the tongue (sublingual) or along the inside of the cheek (buccal) for oral administration. These films are typically postage stamp-sized, with a similar shape and thickness. By bypassing first-pass metabolism through this drug delivery method, the medication's bioavailability is enhanced. A major challenge in developing fast-dissolving oral films lies in taste masking, as medications administered in the oral cavity should have an acceptable taste. Taste plays a crucial role in the development of oral pharmaceuticals, particularly in pediatric medicine, as it influences patient acceptance, compliance, and the market success of oral

International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 3 May-June 2023, pp: 3407-3421 www.ijprajournal.com ISSN: 2249-7781

formulations regardless of the administration mode.[14-19]

Materials:

Bilastine and Montelukast are obtained from Concept Pharma Aurangabad. HPMC (K4M, K15 and K100) was obtained by Research-lab fine chemicals industries in Mumbai, along with Mannitol and Aspartame. Polyethylene glycol is sourced from Gateefoseeas, a company located in Mumbai. Citric Acid is supplied by Thomas Baker Pvt. Ltd, based in Mumbai. Finally, Vanillin is sourced from Ranbaxy Fine Chemicals Limited, located in New Delhi.

Pre-formulation Study

Characterization of Bilastine :

Description: Color and physical form of Bilastine were checked visually.

Solubility: Solubility of Bilastine was checked in water and different pH buffers (pH 1.2, 4.5, 6.8, and 7.4).

Melting Point: The melting point of Bilastine was determined by introducing a small amount of the substance in a capillary attached to a graduated thermometer, and constant heat was applied with the assembly suspended in a melting point apparatus. The temperature at which the substance melted was noted.

Spectroscopy

Determination of λ max of Bilastine:

Weigh accurately 10 mg of Bilastine, transfer it into a 100 mL volumetric flask, and make up the volume to 100 mL with phosphate buffer (pH 6.8). From this solution, 1 mL was withdrawn and added to a 10 mL volumetric flask and diluted up to 10 mL with phosphate buffer (pH 6.8). Finally, the sample was scanned in the range of 200-400 nm. The wavelength of the maximum absorption was noted, and the UV spectrum was recorded.

Determination of λ max of Montelukast:

Weigh accurately 10 mg of Montelukast, transfer it into a 100 mL volumetric flask, and make up the volume to 100 mL with phosphate buffer (pH 6.8). From this solution, 1 mL was withdrawn and added to a 10 mL volumetric flask and diluted up to 10 mL with phosphate buffer (pH 6.8). Finally, the sample was scanned in the range of 200-400 nm. The wavelength of the maximum absorption was noted, and the UV spectrum was recorded.

Standard Calibration Curve:

Standard Calibration Curve of Bilastine in Phosphate Buffer (pH 6.8):

Accurately weigh 100 mg of Bilastine and add it to a 100 mL volumetric flask. Make up the volume to 100 mL with phosphate buffer (pH 6.8) (1000 µg/mL). From this solution, 10 mL was withdrawn and added into a 100 mL volumetric flask, and the volume was made up to 100 mL with phosphate buffer (pH 6.8) (100 µg /mL). This solution was used as the stock solution. From the stock solution, 2,4,6,8,10,12 and 14 mL of solution was withdrawn and added into a 10 mL volumetric flask and finally diluted up to 10 mL with phosphate buffer (pH 6.8). The absorbance was measured for each solution at 280 nm using a UV-Visible spectrophotometer. The graph was plotted for absorbance vs. concentration.

Standard Calibration Curve of Montelukast in Phosphate Buffer (pH 6.8):

Accurately weigh 100 mg of Montelukast and add it to a 100 mL volumetric flask. Make up the volume to 100 mL with phosphate buffer (pH 6.8) (1000 µg/mL). From this solution, 1 mL was withdrawn and added into a 10 mL volumetric flask, and the volume was made up to 10 mL with phosphate buffer (pH 6.8) (100 µg/mL). This solution was used as the stock solution. From the stock solution, 2,4,6,8,10,12 and 14 mL of solution was withdrawn and added into a 10 mL volumetric flask and finally diluted up to 10 mL with phosphate buffer (pH 6.8). The absorbance was measured for each solution at 345 nm using a UV-Visible spectrophotometer. The graph was plotted for absorbance vs. concentration.

Formulation of Fast Dissolving Films:

Dose Calculation

The drug to be loaded in the film was determined by the dose of the drug and the drug loading in the glass plate was determined by the area of the glass plate.

Preparation of films by solvent casting method:

All the ingredients were weighed accordingly. The polymer was dissolved in ethanol. Kept aside for swelling. The drug mannitol, citric acid and vanillin were dissolved separately in ethanol. Then polymer solution added to drug solution and plasticizer (PEG-400) added then stirred for 15 minutes to produce a clear solution,

International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 3 May-June 2023, pp: 3407-3421 www.ijprajournal.com ISSN: 2249-7781

which kept aside for 15 minutes to get bubble free solution. Then solutions were casted slowly with continuous flow on glass plate to prevent formation of bubbles then it kept for drying. The dried films were gently separated from glass plate and evaluated.

Formulation design:

Fast dissolving oral films were prepared using various grades of HPMC as polymer.

Sr.No	Ingredients	F1	F2	F3	F4	F5	F6	F7	F8	F9
1	Bilastine	20	20	20	20	20	20	20	20	20
2	Montelukast	10	10	10	10	10	10	10	10	10
3	HPMC K4M	25	30	35	-	-	-	-	-	-
4	HPMC K15	-	-	-	25	30	35	-	-	-
5	HPMC K100	-	-	-	-	-	-	25	30	35
6	PEG 400 (ml)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
7	Aspartame	5	5	5	5	5	5	5	5	5
7	Mannitol	10	10	10	10	10	10	10	10	10
8	Citric Acid	5	5	5	5	5	5	5	5	5
9	Vanillin	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
10	Ethanol(ml)	q.s	q.s	q.s	q.s	q.s	q.s	q.s	q.s	q.s

II. RESULTS AND DISCUSSION:

Standard calibration curve of Bilastine and Montelukast:

Concentration	Absorbance	
	Blastine	Montilukast
0	0	0
2	0.1758	0.1343
4	0.2987	0.2346
6	0.4168	0.3401
8	0.5284	0.4599
10	0.6594	0.5587

International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 3 May-June 2023, pp: 3407-3421 www.ijprajournal.com ISSN: 2249-7781

12	0.7648	0.6822
14	0.8704	0.7654

Table 1: Calibration Curve of Bilastine and Montelukast

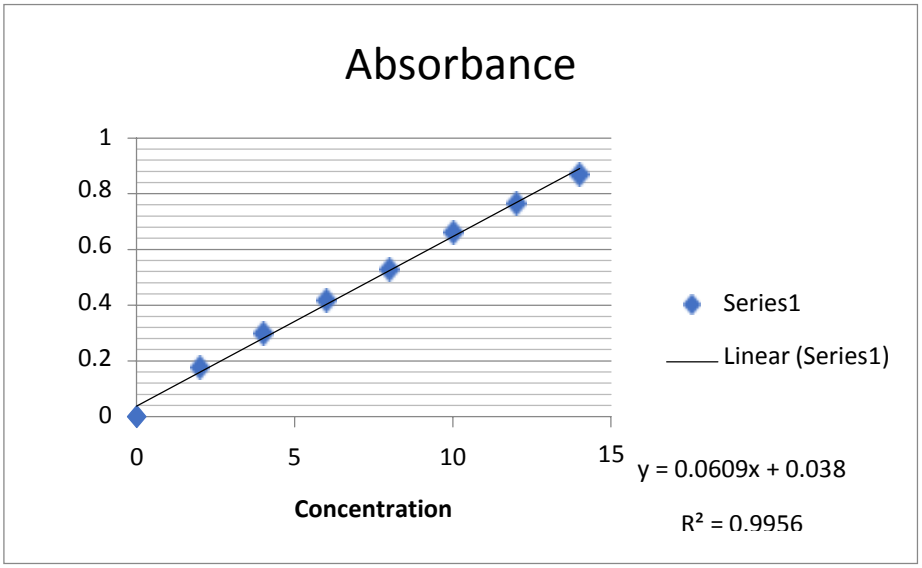

Fig 1: Calibration Curve of Bilastine

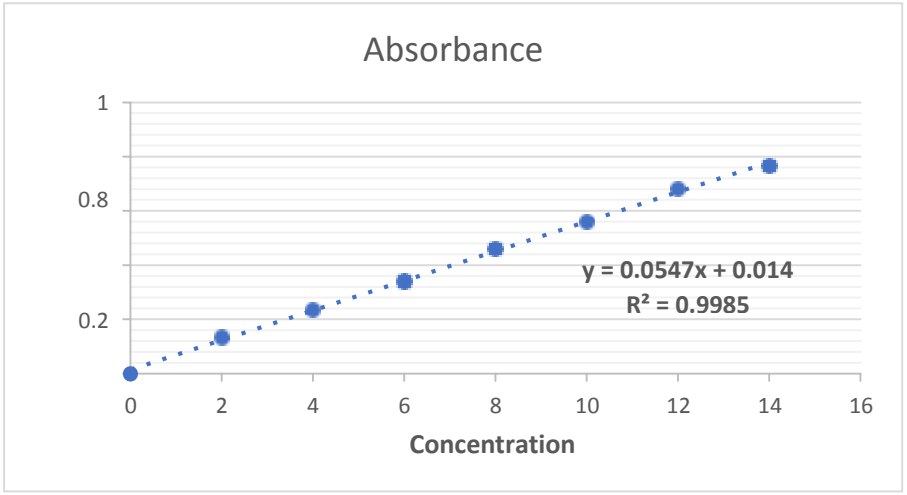

Fig 2 : Calibration Curve of Montelukast Sodium

Evaluation:

FormulationBatch	Appearance	Tack Test	Film Thickness(mm)	Tensile Strength (Kg/mm)

International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 3 May-June 2023, pp: 3407-3421 www.ijprajournal.com ISSN: 2249-7781

F1	Transparent	Non Tacky	0.7±0.04	0.216±0.004
F2	Transparent	Tacky	0.9±0.10	0.220±0.002
F3	Transparent	Non Tacky	1.3±0.21	0.221±0.006
F4	Transparent	Non Tacky	0.7±0.10	0.410±0.002
F5	Transparent	Tacky	1.0±0.06	0.416±0.002
F6	Transparent	Non Tacky	1.1±0.24	0.421±0.004
F7	Transparent	Non Tacky	0.8±0.25	0.506±0.004
F8	Transparent	Tacky	1.0±0.08	0.512±0.002
F9	Transparent	Non Tacky	1.2±0.05	0.516±0.002

Table 2: Evaluation of Films for, Appearance Tack test, Thickness and Tensile Strength

Physical Appearance and Surface Texture of Fast Dissolving films:

These parameters were checked simply with visual inspection of Fast dissolving film and by feel or touch. The observation suggests that Fast dissolving films are having smooth surface and they are elegant enough to see.

Tack Test

All Strips were evaluated for tack test out of that only F2 , F5 and F8 batches were found to be tacky and other batches were found to be non-tacky The tack test of all fast dissolving oral films is given in above table.

Tensile Strength:

Tensile strength was found to increase with increase in concentration of the polymers. Tensile strength range of the films varied from to 0.216 ± 0.004 to 0.516±0.002 for HPMC films.

Thickness of Fast Dissolving films:

The thickness of fast dissolving Films were measured using screw gauge and the average thickness of Fast dissolving film given in above Table The thickness of Fast dissolving film prepared with HPMC K4, K15, K100 respectively. Thickness of fast dissolving films was found between 0.7±0.04 to 1.3±0.25.

Batch	Disintegration Time (sec)	Folding Endurance	% Drug Content	Weight Variation (mg)	pH
F1	19.6±0.24	74±0.24	95.43±0.38	4.5±0.09	6.26
F2	20.3±0.26	76±0.38	98.47±0.27	6.7±0.08	6.81
F3	28.3±0.64	79±0.51	89.12±0.28	7.9±0.21	6.73

International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 3 May-June 2023, pp: 3407-3421 www.ijprajournal.com ISSN: 2249-7781

F4	17.23±0.12	78±0.24	96.54±0.98	5.5±0.11	6.81
F5	23.01±0.37	80±0.45	92.12±0.44	7.1±0.24	6.38
F6	34.77±0.39	82±0.54	90.25±0.16	6.5±0.42	6.70
F7	19.25±0.76	76±0.95	96.15±0.37	4.9±0.84	6.32
F8	24.54±0.24	77±0.27	92.21±0.75	6.1±0.36	6.47
F9	36.78±0.97	79±0.25	95.25±0.17	7.9±0.57	6.75

Table 3: Evaluation parameter of formulation batches.

Disintegration Time of Fast Dissolving film:

Strip of 2 x 2 cm^2 size taken and disintegration time checked visually. In each case three fast dissolving films were used and the average drug content was calculated, the results were shown in above table.

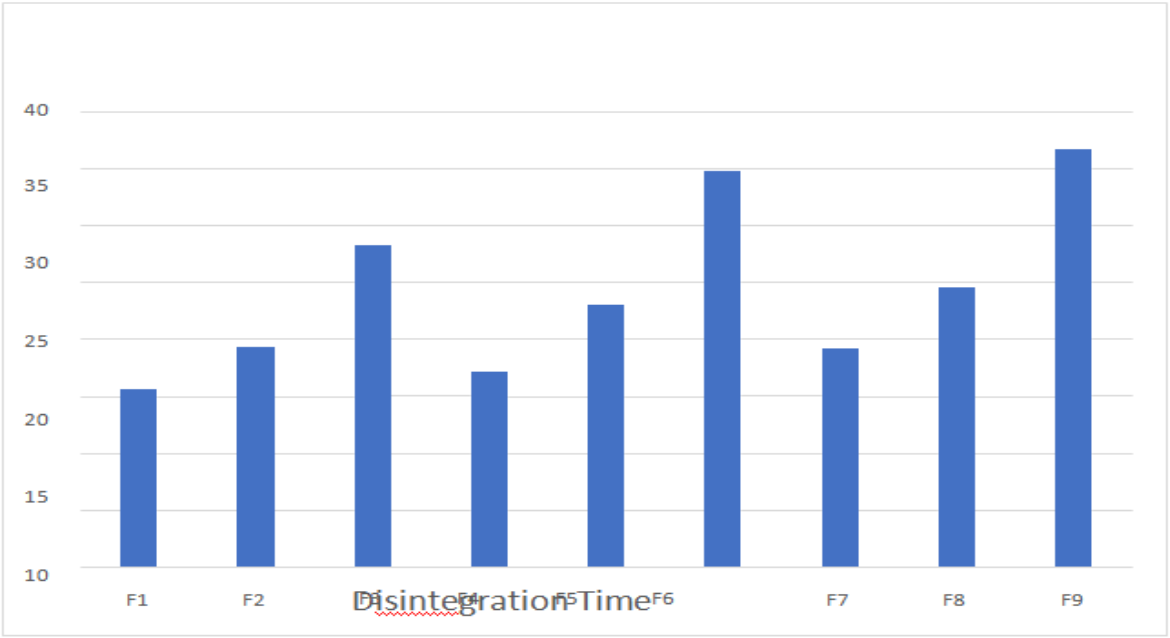

Fig 3: Disintegration Time Prepared Films

Disintegration time of fast dissolving films were found between 15.60±30to36.7±0.54.

Folding Endurance of Fast dissolving films:

The folding endurance of Fast dissolving film was determined by repeatedly folding a small film of Fast dissolving film at same place till it broke and the average folding endurance of all Films given in Table which ranges between in table sin between range 74±0.24 to 82±54.

International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 3 May-June 2023, pp: 3407-3421 www.ijprajournal.com ISSN: 2249-7781

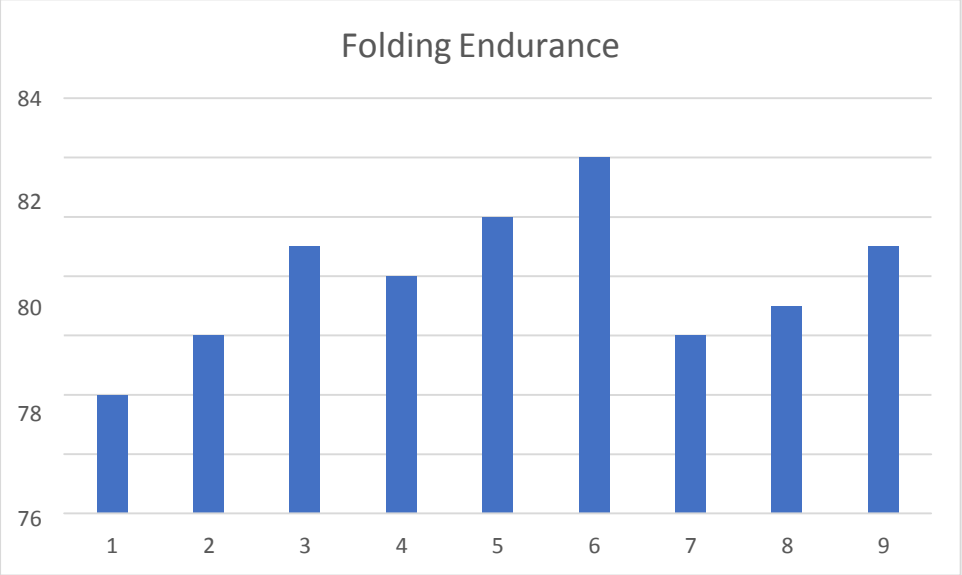

Fig 4 : Folding Endurance Of Prepared Films

Drug Content Uniformity of Fast Dissolving Films:

In each case three fast dissolving films were used and the average drug content was calculated, the results were shown in above table. The drug was dispersed in the range of 89.12±0.14 to 98.47±0.12. Suggesting that drug was uniformly dispersed in fast dissolving films. The S.D. value calculated for such formulation is very less which suggest that the results are reproducible and accuracy in the method used to prepare fast dissolving films.

Weight Variation of Fast Dissolving films:

Weight of Fast dissolving Films was determined using digital balance and the average weight of Fast dissolving films were given in above table. The weight variation of formulated films in between 4.5±0.09 to 7.9±0.57.

Surface pH of Fast Dissolving Films:

The surface pH was noted by pH meter near the surface of fast dissolving film and allowing to equilibrate for 1 min and the surface pH of fast dissolving films was given in above table the surface pH of fast dissolving film was found to be in- between 6.26 to 6.81 pH (n=3).

In-Vitro Dissolution Studies Of Bilastine:

Time	F1	F2	F3
0	0	0	0
1	22.64	21.98	20.35
2	39.71	35.24	34.58
3	55.47	50.87	48.37
4	77.24	73.68	70.87
5	85.98	82.26	80.29
6	92.46	90.58	89.24

Table 4 : In-Vitro Dissolution studies of Bilastine

International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 3 May-June 2023, pp: 3407-3421 www.ijprajournal.com ISSN: 2249-7781

All values expressed as mean ±SD (n=3), F=Formulation batch

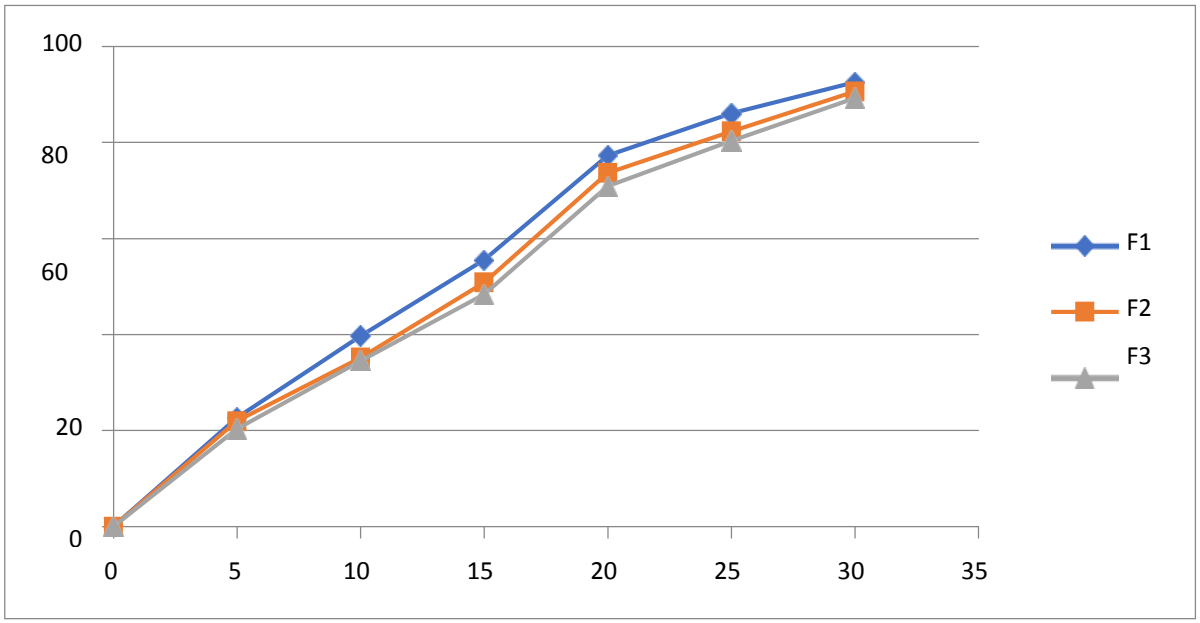

Fig 5: Cumulative % Drug Release From F1-F3

The better release of drug in batches containing HPMC K4M can be observed and the % drug release of corresponding batches can be ranked in following descending order.
F1>F2>F3.

Time	F4	F5	F6
0	0	0	0
5	23.98	21.55	20.25
10	39.32	34.25	32.32
15	55.74	53.35	51.25
20	70.93	67.25	65.35
25	87.16	85.32	82.35
30	96.32	91.25	89.35

Table 5 : In-Vitro Dissolution studies of Bilastine

International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 3 May-June 2023, pp: 3407-3421 www.ijprajournal.com ISSN: 2249-7781

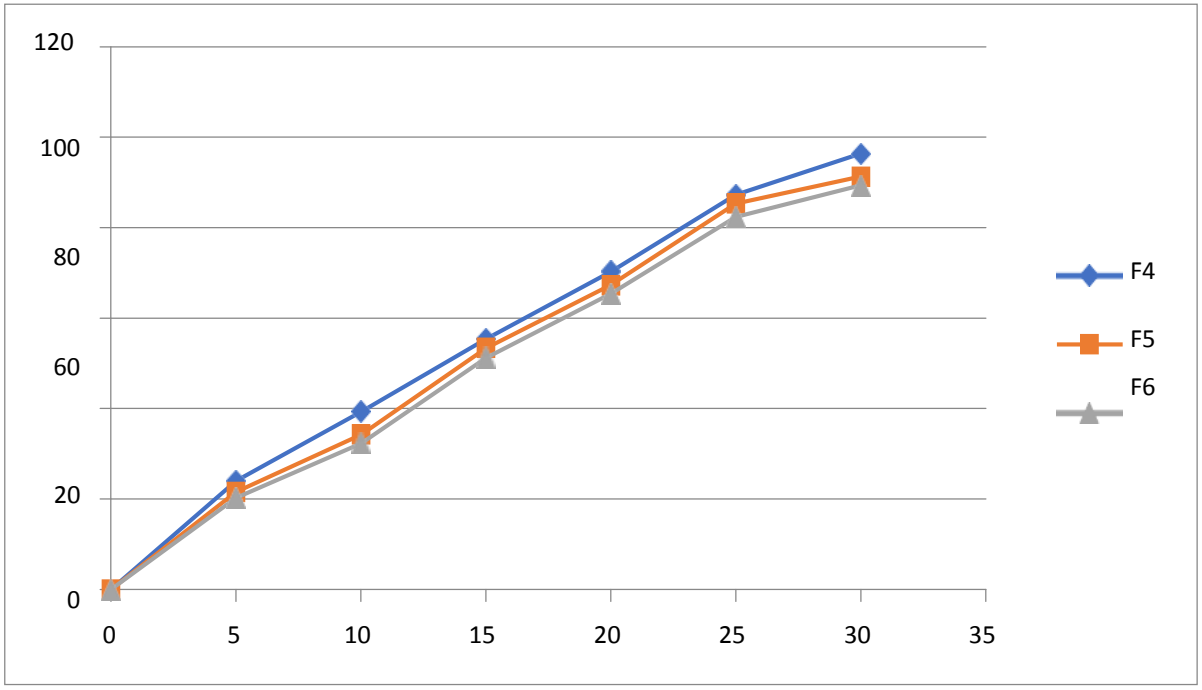

Fig 6: Cumulative % Drug Release From F4-F6

The better release of drug in batches containing HPMC K15M can be observed and the % drug release of corresponding batches can be ranked in following descending order.
F4>F5>F6

Time	F7	F8	F9
0	0	0	0
5	22.27	21.25	19.84
10	38.68	35.82	32.93
15	54.39	51.32	49.29
20	65.11	62.74	60.44
25	78.47	73.92	71.83
30	89.35	87.94	85.32

Table 6 : In-Vitro Dissolution studies of Bilastine

International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 3 May-June 2023, pp: 3407-3421 www.ijprajournal.com ISSN: 2249-7781

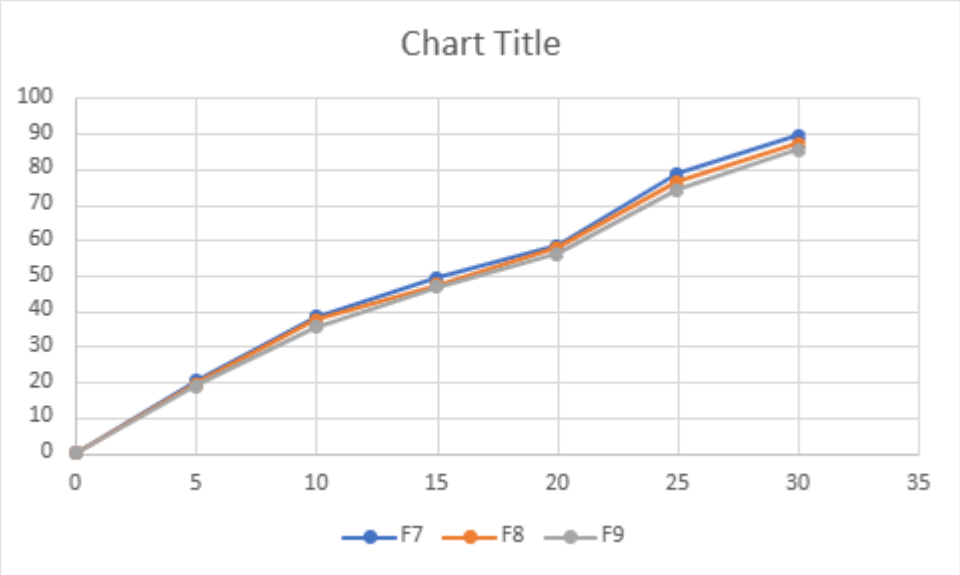

Fig 7: Cumulative % Drug Release from F7-F9

The better release of drug in batches containing HPMCK100 can be observed and the % drug release of corresponding batches can be ranked in following descending order.
F7>F8>F9.

In-Vitro Dissolution Studies of Montelukast:

Time	F1	F2	F3
0	0	0	0
5	22.58	21.35	20.01
10	37.25	35.95	34.32
15	51.85	50.47	49.55
20	65.25	63.25	61.34
25	81.34	79.78	78.25
30	92.74	91.35	90.04

Table 7: In-Vitro Dissolution studies of Montelukast

International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 3 May-June 2023, pp: 3407-3421 www.ijprajournal.com ISSN: 2249-7781

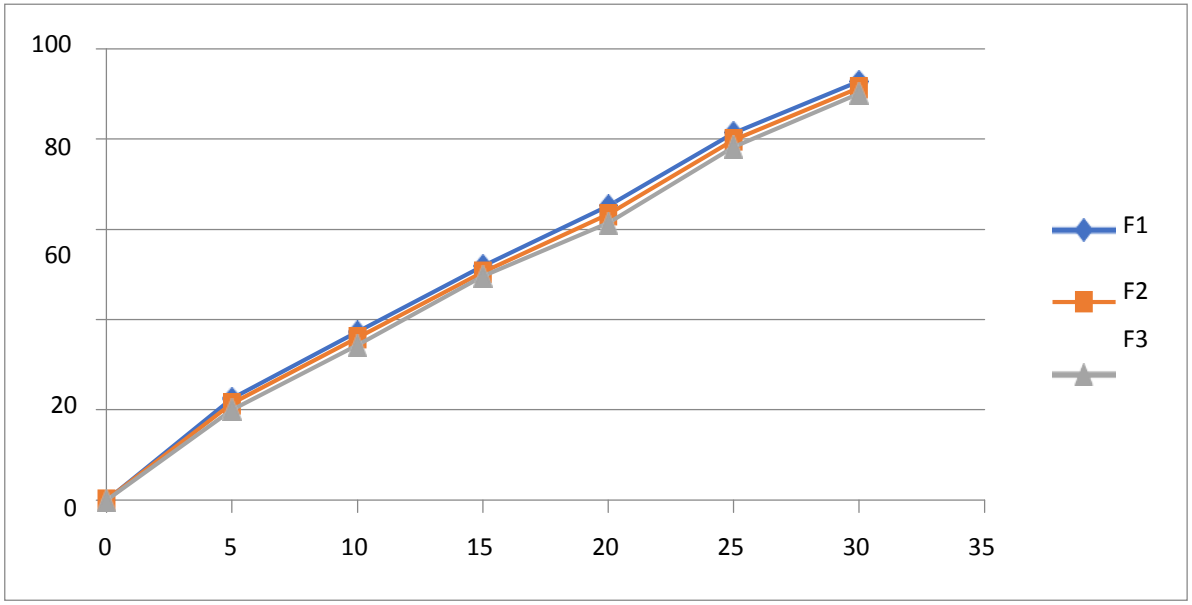

Fig 8: Cumulative % Drug Release from F1-F3

The better release of drug in batches containing HPMC K4M can be observed and the % drug release of corresponding batches can be ranked in following descending order.
F1>F2>F3

Time	F4	F5	F6
0	0	0	0
5	24.35	22.65	21.27
10	41.67	39.97	38.75
15	66.94	64.68	61.24
20	78.16	76.14	74.32
25	89.64	86.75	84.54
30	96.32	92.35	90.35

Table 8: In-Vitro Dissolution studies of Montelukast

International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 3 May-June 2023, pp: 3407-3421 www.ijprajournal.com ISSN: 2249-7781

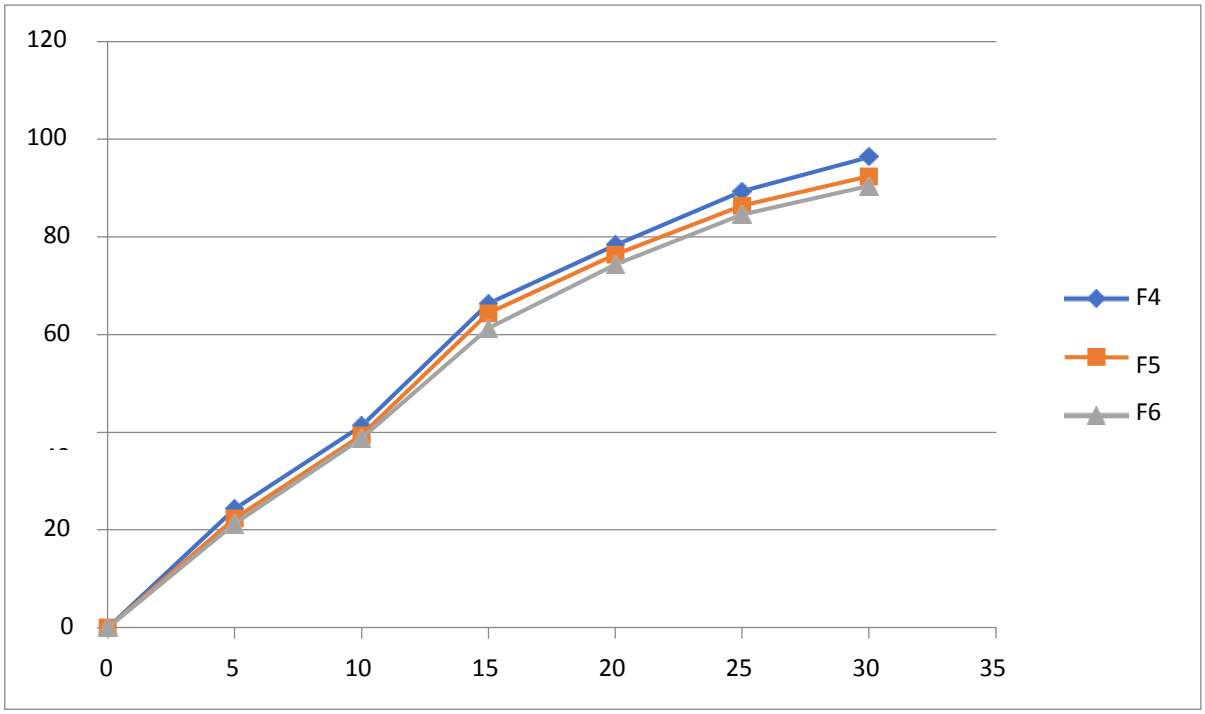

Fig 9: Cumulative % Drug Release from F4-F6

The better release of drug in batches containing HPMC K15M can be observed and the % drug release of corresponding batches can be ranked in following descending order.
F4>F5>F6.

Time	F7	F8	F9
0	0	0	0
5	20.25	19.35	18.75
10	38.17	37.4	35.54
15	49.25	47.24	46.78
20	58.24	57.87	55.94
25	78.61	76.34	74.23
30	89.25	87.21	85.38

Table 9: In-Vitro Dissolution studies of Montelukast

International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 3 May-June 2023, pp: 3407-3421 www.ijprajournal.com ISSN: 2249-7781

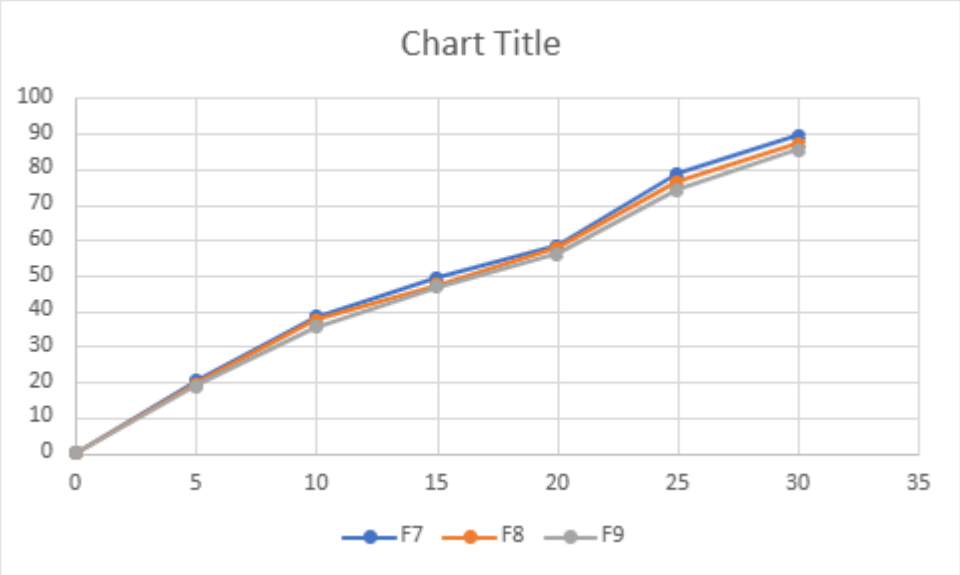

Fig 10: Cumulative % Drug Release from F7-F9

The better release of drug in batches containing HPMCK100 can be observed and the % drug release of corresponding batches can be ranked in following descending order.
F7>F8>F9.

In these all aspects the formulation F4 satisfied all the pharmaceutical parameters of mouth dissolving films, and appears to give better therapeutic effects, with disintegration time 17.23±0.12 seconds 96.32 % drug release.

Stability Studies

Stability studies for the optimized formulation (F4) was carried out in order to determine the physical stability of the formulation. The results were shown in there was no significant change in the parameters which are evaluated during the study period in the accelerated conditions

Evaluation Parameters	**0 Days**	**30 Days**	**60 Days**
Thickness	0.9	0.9	0.9
Weight Variation	0.79	0.79	0.76
Folding Endurance	14.24	14.24	13.51
Surface pH	6.8	6.7	6.7
Disintegration Time (Sec)	17.23	16.57	16.21
% Drug Content	96.54	96.45	96.31
Visual Inspection	Transparent	Transparent	Transparent
% Drug Release	96.32±0.21	96.11±0.47	95.84±0.24

Table 10: Parameters studies on F4 formulation before and after stability study

International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 3 May-June 2023, pp: 3407-3421 www.ijprajournal.com ISSN: 2249-7781

There were no considerable changes in physical parameter of film such as Thickness, Weight variation, Folding endurance, Disintegration time, % Drug content of formulation F4 before andafter accelerated stability study.

III. SUMMARY

Bilastine and Montelukast are the drugs used in allergic rhinitis which is very common. The absolute bioavailability of Bilastine is approximately 61% and for Montelukast it is 64%. To overcome the above-mentioned problems an attempt was made to develop and to improve the solubility of drug and reduce side effects, it was attempted to develop fast dissolving films using different film forming polymers. FTIR spectroscopic studies were carried out in order to establish compatibility between drug and excipients. The results were concluded that there were no chemical interactions between drug and the excipients used, so they could be used for the formulation of fastdissolving films.

Total 9 formulations of mouth dissolving films were developed using various excipients which were found to be compatible using FTIR of films. Formulations were prepared using three different polymers such as HPMC K4M, HPMC K15and HPMC K100.

Films were evaluated for quality control tests such as Appearance, Tack test, Thickness, Tensile strength, disintegration time, folding endurance, % Drug content, Weight variation, in-vitro dissolution, Comparison with marketed product and stability study.

The appearance of the formulations was found to be transparent. Results of tack test shown F2, F5 and F8 were tacky and all the other formulations were non tacky.

The thickness of formulations was between 0.7±0.04 to 1.3±0.21. Tensile Strength of all 9 formulations was found to be in between 0.0216±0.004 to 0.516±0.002. The Disintegration time of the formulations was found to be between17.23± 0.12 to 36.78±0.97.

The surface pH of all formulations was found to be in between 6.26 to 6.81. The Folding endurance of the formulations was found to be in between 74± 0.24 to 82± 0.54 The % drug content of all the formulations was found be in between 89.12±0.28 to 98.47±27. The Weight variation of the formulations was found to be in between 4.5± 0.09 to 7.9 ± 0.57.

The % drug release of Bilastine in F1, F2 and F3 containing HPMC K4M as a polymer was found to be 92.46 %, 90.58 % and 89.24 % respectively. Whereas in batch F1, F2 and F3 the % release of Montelukast was found to be 92.74 %,91.35 % and 90.04 % respectively. In this study we observed that as we increase the concentration of polymerthe % drug release decreases.

The drug release percentages for Bilastine in batches F4, F5, and F6, where HPMC K15 was used as the polymer, were determined to be 96.32%, 91.25%, and 89.35% respectively. Similarly, for Montelukast in batches F4, F5, and F6, the drug release percentages were found to be 96.32%, 92.35%, and 90.35% respectively. It was observed in this study that an increase in the concentration of the polymer resulted in a decrease in the percentage of drug release.

The drug release percentages for Bilastine in batches F7, F8, and F9, where HPMC K100 was used as the polymer, were determined to be 89.35 %, 87.94 %, and 85.32% respectively. Similarly, for Montelukast in batches F4, F5, and F6, the drug release percentages were found to be 89.25 %, 87.21 %, and 85.38% respectively. It was observed in this study that an increase in the concentration of the polymer resulted in a decrease in the percentage of drug release.

In these all aspects the formulation Batch F4 satisfied all the pharmaceutical parameters of mouth dissolving films. So, the F4 batch was selected as optimized batch.

CONCLUSION

Overall, this study successfully developed fast dissolving films for Bilastine and Montelukast, which showed desirable physical characteristics and drug content. The findings suggest that the formulation approach using these film-forming polymers can be a promising strategy to enhance the solubility and minimize side effects of the drugs in the treatment of allergic rhinitis. Further investigations, including in vivo studies and clinical trials, may be warranted to assess the efficacy and safety of these formulations for potential therapeutic applications.

REFERENCES:

[1]. Mandeep K, Rana AC, Nimrata S. Fast dissolving films: an innovative drug delivery system. Int J Pharm Res Allid Sci., 2013; 2: 14-24.

[2]. Rathborne N, Hadgraft J, Roberts M. Oral thin films, in orally disintegrating tablet and film technologies. Technol Catalyst

Int Corporation, 2006; 4: 18-31.
[3]. Khatoon N, Rao NR, Reddy BM. Overview on fast dissolving oral films. Int J Chem Pharm Sci., 2013; 1: 63-75.
[4]. Patil P, Shrivastava S. Fast dissolving oral films: an innovative drug delivery system. Int J Sci Res., 2014; 3: 2088-93.
[5]. Hariharan, Madhu, Bogue, B Arlie. Orally dissolving film strips (ODFS): the final evolution of orally dissolving dosage forms. Drug delivery technology, Montville. New Jersey, 2009; 9: 24–9.
[6]. Aggarwal J, Singh G, Saini S, Rana AC. Fast dissolving films: a novel approach to oral drug delivery. Int Res J Pharm, 2011; 2: 69-71.
[7]. Mahajan A, Chabra N, Aggarwal G. Formulation and characterization of fast dissolving buccal films: a review. Pharm Lett., 2011; 3: 152–65.
[8]. PrakrutiM, Gangurde AB, Pranali V. Oral film technology: challenges and future scope for the pharmaceutical industry. Int J Pharmacogn Phytochem Res., 2015; 3: 183-203.
[9]. Panda BP, Dey NS, Rao ME. Development of innovative orally fast disintegrating film dosage forms: a review. Int J Pharm Sci Nanotech, 2012; 5: 1666-74.
[10]. Rathi V, Senthil V, Kammili L, Hans R. A Briefreview onoral film technology. Int J Res Ayurveda Pharm, 2011; 2: 1138-47.
[11]. RP Dixit, SPPuthil. Oral strip technology: overview and future potential. J Controlled Release, 2009; 139: 94-107.
[12]. Nagar P, Chauhan I, Yasir M. Insights into polymers: film formers in mouth dissolving films. Drug Invention Today, 2011; 3: 280-9.
[13]. Dey P, Gosh A. Wafers: an innovative advancement of oro-dispersible films. Int J Appl Pharm, 2016; 8: 1-7.
[14]. Reza KH, Chakraborthy P. Recent industrial development in oral thin film technology: an overview. Pharma Tutor, 2016; 4: 17-22.
[15]. Mary Elizabeth RN, Martelli BS. Sublingual and buccal medication administration. Encyclopedia of Nursing and Allied Health, 20050229.
[16]. Galey, W.R., H.K. Lonsdale and S. Nacht, The in vitro permeability of skin and buccal mucosa to selected drugs and tritiated water. J. Investigative Dermatol., 1976; 67(6): 713-717.
[17]. Malke, M., S. Shidhaye and V.J. Kadam, Formulation and evaluation of Oxacarbazine fast dissolve tablets. Indian J. Pharmaceutical Sci., 2007; 69(2): 211-214.
[18]. Frey P. Films strips and pharmaceuticals, pharm mf. & package. Sourcer, winter; 2006; 92-93.
[19]. Siegel, I.A. and H.P. Gordon, Surfactant-induced increase of permeability of rat oral mucosa to non-electolytes in vivo. Archives of Oral Biol., 1985; 30: