Contents lists available at UGC-CARE

International Journal of Pharmaceutical Sciences and Drug Research

[ISSN: 0975-248X; CODEN (USA): IJPSPP]

Available online at www.ijpsdronline.com

Research Article

Formulation and Evaluation of Flurbiprofen Solid Dispersions Incorporated Buccal Patches

Mohammed Jaffer Sadik, Abdulla Khan*

Department of Pharmacy, Mewar University, Chittorgarh-312901, Rajasthan, India

ARTICLE INFO

Article history:

Received: 31 August, 2020

Revised: 26 October, 2020

Accepted: 30 October, 2020

Published: 30 November, 2020

Keywords:

Buccal patch,
Flurbiprofen,
HPMC E15,
Release order kinetics Solid dispersions.

DOI:

10.25004/IJPSDR.2020.120611

ABSTRACT

Flurbiprofen is an anti-inflammatory drug, used in treating rheumatoid arthritis and ankylosing spondylitis. The present work is aimed to overcome the deprived solubility of flurbiprofen by solid dispersion (SD) technique. The current paper is the continuance of the published solid dispersion by considering the best final optimized formulation containing flurbiprofen drug: AQOAT AS: SLS as drug: polymer: surfactant in 1:5:2 ratios, and incorporating it into buccal patches to overcome the gastric side effect and attaining sustained drug release. In this study, 15 buccal patches were formulated by adopting solvent casting technique using polymers like polyvinyl hydroxyethylcellulose (HEC), hydroxypropryl methyl cellulose E15 (HPMC E15), polyvinyl pyrrolidone (PVP), carbopol and analyzed for drug content, drug diffusion, *in-vivo* dissolution and stability studies. All SD loaded patches displayed superior drug release (95 to 99.96%) over 12 hour. The formulation BP14 showed excellent drug release extended over 12 hours with drug release of 99.96% whereas marketed formulation, which is sustained release Tablet showed 96.86% drug release within 6 hour. The drug release kinetics show that the buccal patches follow zero order release kinetics with correlation coefficient (R^2) ranging between 0.905–0.971 and BP14 formulation shown best R^2 value. All the formulations exhibited best fit to Higuchi model with R^2 ranging between 0.9911–0.9962 indicating drug release by diffusion process. The results conclude that buccal patches are superior alternatives for flurbiprofen that facilitates enhanced drug release for prolonged period in the effective management of rheumatoid arthritis.

Introduction

Enhancement of drug bioavailability is the challenge before today's pharmaceutical research. The targeted drug delivery systems reduce drug solubility, which was not addressed by conventional formulation methods. In recent past, pharmaceutical research revolved around enhancing the physicochemical properties of drug for enhanced efficacy and patient compliance. The conventional oral drug delivery systems suffer from possible first pass effect, GI toxicity, enzymatic degradation, etc. These drawbacks could be bypassed by transdermal drug delivery methods that include delivery of drugs through mucosal linings. The buccal mucosa is the most preferred region for drug delivery compared to the sublingual mucosa as it is easily accessible.[1]

Flurbiprofen in effectively used for treating rheumatoid arthritis, osteoarthritis and ankylosing spondylitis with thermographic index of inflamed rheumatoid joints being improved. It is sparingly soluble in water thus reducing the bioavailability of drug. Flurbiprofen is low molecular weight compound with low melting point (114-117^{0}C), with an elimination half life of 3 to 4 hours. The lower bioavailability, higher amount of penetration into buccal mucosa, GI irritation and ulcerogenic effect make the drug a suitable candidate for sustained-release formulation. [2,3]

In the current paper, an effort was made to formulate solid dispersion incorporated buccal patch of flurbiprofen using HEC, hydroxypropryl methyl cellulose E15 (HPMC E15), PVP, carbopol polymers by solvent casting method

***Corresponding Author:** Abdulla Khan

Address: Department of Pharmacy, Mewar University, Chittorgarh-312901, Rajasthan, India

Email ✉**:** abdullahkhan@kpjuc.edu.my

Tel.: +91-8885285289

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

to eliminate unwanted side effects like gastric irritation and first pass metabolism caused by flurbiprofen.

Materials and Methods

Materials

Flurbiprofen gifted by Hetero Labs Limited, Hyderabad, Froben ® SR (Marketed product) marketed by Abbott Laboratories, India. HEC, hydroxypropryl methyl cellulose E15 (HPMC E15), PVP and carbopol were obtained from MSN Labs Ltd, Hyderabad.

Methodology

Formulation of Flurbiprofen Solid Dispersion (SD)

Flurbiprofen SDs were formulated by adopting solvent evaporation technique, a simple and easily reproducible method. Figteen formulations were prepared using five hydrophilic carrier polymers and all SD formulations exhibited better drug release than release of pure drug and SD6 containing flurbiprofen drug: AQOAT AS: SLS as drug: polymer: surfactant in 1:5:2 ratios showed highest release and is employed in preparation of buccal patches.[4]

Preparation of Buccal Patches

Weighed accurately SD of flurbiprofen containing equivalent weight of 50 mg of flurbiprofen. Using this, the patches containing drug and carbopol, HPMC E15, HEC, PVP, different proportions was formulated by adopting solvent casting technique. The SDs was dissolved in 5 mL of carbinol and the polymers were dissolved in separate container with 10 mL of distilled water under continuous stirring for 4 hours. After stirring, mix the drug and polymer solution. Propylene glycol that acts as a plasticizer was mixed with the solution followed by continuous stirring. The viscous solution thus formed was left for 8 hours to obtain bubble free clear solution. The contents transferred to a glass petridish, dried at 40^0C till the formation of flexible patch. The dried patch was removed cautiously, checked for presence of any flaws or air bubbles and cut into pieces of 2x2 cm^2. These patches are then packed in aluminum foil and preserved in desiccators to retain the integrity and elasticity (Table 1).[5]

Evaluation Parameters

Thickness Uniformity (TU)

The TU of formulated patches was measured using micrometer screw gage (Mitutoyo, Japan) by randomly choosing 3 formulations of 1 cm^2 area.[6]

Folding Endurance (FE)

The FE value is analyzed by folding a single film repetitively at the one single point until it breaks. The number of times the given film folded without breaking is assumed as the FE value. [7]

Tensile strength (TS) and % Elongation (Mechanical Strength)

The TS of all formulation was estimated with the locally fabricated instrument. A tiny film strip of 30 x 10 mm dimensions taken whose upper end is fixed between adhesive tapes to provide support while in film holder. The other side of the film was set amid the adhesive tape containing small pins packed amongst them to ensure that the strip remains erect during stretching.

Table 1: Formulation of Flurbiprofen SD Incorporated Buccal Patches

Code	*Carbopol (mg)*	*PVP (mg)*	*HPMC E15 (mg)*	*HEC (mg)*	*Ethanol (mL)*	*Propylene glycol(mL)*	*Distilled water (mL)*
BP1	25	25	-	-	5	0.4	10
BP2	25	-	25	-	5	0.4	10
BP3	25	-	-	25	5	0.4	10
BP4	30	20	-	-	5	0.4	10
BP5	-	25	25	-	5	0.4	10
BP6	-	25	-	25	5	0.4	10
BP7	-	30	20	-	5	0.4	10
BP8	-	-	25	25	5	0.4	10
BP9	-	-	30	20	5	0.4	10
BP10	20	-	-	30	5	0.4	10
BP11	10		40	-	5	0.4	10
BP12	40	10	-	-	5	0.4	10
BP13	-	10	-	40	5	0.4	10
BP14	-	10	40	-	5	0.4	10
BP15	-	-	40	10	5	0.4	10

*Each formulation contains solid dispersions equivalent weight of 50mg flurbiprofen

The TS was determined by pilling the film using the pulley system. Weights were steadily placed on pan to augment the pulling force till the film breaks.[8] The weight requisite to break the film is considered as break force.

The TS was calculated as

TS =weight required to break film [a x b x (1+l)] / l

Where, a = film thickness
B = film width
L = film length

The % elongation was calculated using formula

% Elongation = [Final length - Initial length] * 100/Initial length

Moisture Absorption (MA)

The formulation was precisely weighed and positioned on the desiccators filled with 100 mL of aluminium chloride solution that maintains 75 ± 5% relative humidity (RH). The films reweighed after 3 days, and the % MA was calculated as,[9]

Percentage moisture absorption (%) = Final weight – Initial weight x100 /Initial weight

In-vitro Mucoadhesion

The mucoadhesive strength of formulations was analyzed using a customized physical balance. A portion of sheep buccal mucosa was joined to the opening of a glass vial packed entirely with phosphate-buffered saline (PBS) of pH 6. The vial was firmly fixed at the midpoint of a beaker containing PBS maintained at 37 ± 1 °C. The patches were glued to the other end of rubber stopper and the weight(g) essential to cut off the patches away from mucosal surface was considered as its mucoadhesive strength which is calculates as.[10,11]

Force of adhesion (N) = (Bioadhesive strength (g) ×9.8)/1000

Bond strength (N m^{-2}) = Force of adhesion / surface area

Drug Content Determination

A 1 cm^2 of the formulations were incised, dissolved in adequate amount of carbinol and made up to 10 mL. About 1 mL of resultant solution withdrawn, diluted to 10 mL with suitable anount of phosphate buffer. The sample was analyzed spectrophotometrically at 247nm.[12]

Surface pH

The buccal patches were permitted to swell while in contact with 0.5 mL of water (pH 6.5 ± 0.5) for an hour, maintained at room temperature. The pH of resultant solution measured using pH meter.[11]

Measurement of In-vitro Residence Time (RT)

The in vitro RT was estimated by using customized USP disintegration apparatus. The disintegration medium chosen was 800 ml of isotonic phosphate buffer (pH 6.8) maintained at 37 ± 2°C. About 3 cm each of porcine buccal mucosa, were glued to glass slab, followed by attaching vertically to the apparatus. Three mucoadhesive films of each formulation were hydrated on one side using isotonic phosphate buffer solution (pH 6.8) and brought in touch with the mucosal membrane. The glass slab was perpendicularly set to the apparatus and permitted to move up and down. The film was completely immersed in the buffer.[13]

Swelling Index (SI)

The swelling index procedure was used to determine the general swelling characteristics of patch. A flurbiprofen-loaded patch of 2×2 cm^2 dimension was accurately weighed on a pre-weighed cover slip and placed on petridish. About 50 mL of buffer added to the dish. The cover slip removed after every 5 minutes and weighed for about 30 minutes. The variation in weight represents the weight increased because of swelling of patch.[14]

$$Swelling\ index = \frac{Wt\text{-}W0}{W0}$$

Where, Wt - weight of the patches at time t
W_0 - weight of the patches at time 0

In vitro Release Study

The dissolution of flurbiprofen from the formulated patches was calculated at 37^0C with the help of Franz diffusion cell and phosphate buffer of pH 6.8 as diffusion medium. The parchment paper drenched in the medium for about an hour followed by air drying. It was fixed amid the donor compartment and receptor compartment followed by placing wet film on it. Both the compartments fastened together. The dissolution medium was packed in the receptor compartment (11 mL capacity) and continuously stirred with the help of magnetic stirrer.

The samples were withdrawn at predetermined time replaced with equivalent volumes of fresh dissolution medium. The drug content estimated spectrophotometrically at 247nm.[15-17]

Release Kinetic Study

Different kinetic models such as zero order, first order, Higuchi, and Korsmeyer-Peppa's were used to infer the drug release rate from the buccal patches comprising of flurbiprofen solid dispersions. The drug release data was substituted in various kinetic models to envisage the kinetics and mechanism. The release constant was premeditated from the slopes of plots, and the regression coefficient (R^2) calculated.[18]

Stability Studies

Stability studies for flurbiprofen SD loaded buccal patches were studied by preserving the formulations in a container lined with aluminium foil at various temperature ranges and RH values for 3 months. The patches were then

physically checked for variations and the drug content analysed at the end of 3rd month.[19]

Results

Preparation of Flurbiprofen Buccal Patch

Solid dispersions incorporated buccal patches of flurbiprofen were formulated as per the composition mentioned in Table 1 and the dried patches were found to be clear without imperfections and air bubbles and were incised into pieces of 1 mm^2 area as shown in Fig. 1. The formulations were packed in aluminum foils and preserved in desiccators.

Evaluation Parameters

The thickness of all formulations was determined within 0.23 ± 0.005-0.27 ± 0.075 mm. The FE of all formulation range between 305–318. The mechanical strength of all the formulations ranged between 5.38–12.96 kg/mm^2. The values show that the patches posses superior mechanical strength (Table 2).

Water uptake of all buccal patches containing flurbiprofen is given in Table 2. The values were within the range of 1.91 to 2.94. The % moisture absorption of each patch was determined at third hour.

In-vitro Mucoadhesion

An efficient buccal mucosal delivery system must sustain a close contact with mucus layer overlying the epithelial tissue. This value is vital for complete exploitation of these drug delivery systems. Hence, *in-vitro* mucoadhesion evaluation of all formulations was carried out using porcine gastric mucosa and the mucoadhesive strength was found to be within the range of 1.12 ± 2.86 to 1.67 ± 2.14. The formulation BP14 found to have highest mucoadhesive strength (Table 3).

Drug Content Determination

The drug content determination was analyzed for control of drug quality and effectiveness of process for preparation of formulation. The drug content of various formulations was range between 92.59 ± 0.48 to 99.92 ± 0.03% w/w. The results confirmed the homogeneous distribution of drug within complexes (Table 4).

Measurement of Surface pH

The surface pH values in Table 4 are the mean of three replicate determinations. The values are within the range of 6.3–6.8 for all formulations and were within salivary

Fig. 1: Flurbiprofen Buccal Patch

Table 2: Evaluation of physical parameters of different SD incorporated Buccal Patches of Flurbiprofen

S. No	*Formulation code*	*Thickness (mm)*	*Folding endurance*	*Mechanical strength kg/mm²*	*Moisture absorbance*
1	BP1	0.23 ± 0.005	305 ± 4.04	5.38 ± 0.076	2.15 ± 0.64
2	BP2	0.26 ± 0.0027	318 ± 3.47	10.94 ± 0.018	2.64 ± 0.24
3	BP3	0.24 ± 0.024	309 ± 3.75	7.73 ± 0.062	1.91 ± 0.75
4	BP4	0.25 ± 0.067	313 ± 2.57	6.73 ± 0.031	2.01 ± 0.36
5	BP5	0.27 ± 0.034	308 ± 3.52	8.23 ± 0.075	1.98 ± 0.84
6	BP6	0.23 ± 0.095	317 ± 4.65	10.96 ± 0.098	2.33 ± 0.24
7	BP7	0.24 ± 0.032	308 ± 2.75	11.84 ± 0.023	2.75 ± 0.82
8	BP8	0.27 ± 0.075	315 ± 1.58	5.99 ± 0.072	2.43 ± 0.31
9	BP9	0.23 ± 0.047	312 ± 3.89	8.24 ± 0.082	2.67 ± 0.57
10	BP10	0.24 ± 0.027	314 ± 4.17	11.02 ± 0.012	2.41 ± 0.38
11	BP11	0.26 ± 0.083	316 ± 1.74	6.03 ± 0.089	2.60 ± 0.58
12	BP12	0.24 ± 0.063	309 ± 4.01	9.73 ± 0.048	2.31 ± 0.89
13	BP13	0.25 ± 0.005	310 ± 3.99	8.99 ± 0.072	2.57 ± 0.14
14	BP14	0.24 ± 0.003	307 ± 1.42	11.92 ± 0.063	2.79 ± 0.81
15	BP15	0.25 ± 0.043	311 ± 4.15	6.29 ± 0.041	2.35 ± 0.42

*n=SD ± 3

Table 3: Evaluation parameters of different SD incorporated buccal patches of flurbiprofen

S. No	*Code*	*Mucoadhesive strength(g)*	*Force of adhesion (N)*	*Bond strength (N m^{-2})*
1	BP1	1.43 ± 2.64	1.40 ± 0.03	453.02 ± 5.34
2	BP2	1.47 ± 3.72	1.42 ± 0.05	506.7 ± 4.82
3	BP3	1.50 ± 2.51	1.45 ± 0.01	460.32 ± 5.12
4	BP4	1.47 ± 2.01	1.53 ± 0.032	502.5 ± 3.82
5	BP5	1.35 ± 2.52	1.57 ± 0.07	501.63 ± 1.82
6	BP6	1.14 ± 2.87	1.46 ± 0.09	460.32 ± 2.74
7	BP7	1.47 ± 3.01	1.50 ± 0.04	465.67 ± 3.82
8	BP8	1.57 ± 2.97	1.53 ± 0.06	480.78 ± 3.61
9	BP9	1.42 ± 2.99	1.59 ± 0.04	503.87 ± 4.72
10	BP10	1.18 ± 2.13	1.42 ± 0.03	505.82 ± 4.27
11	BP11	1.59 ± 3.73	1.49 ± 0.08	478.82 ± 3.58
12	BP12	1.12 ± 2.86	1.53 ± 0.02	493.28 ± 5.10
13	BP13	1.37 ± 3.05	1.58 ± 0.04	501.81 ± 4.38
14	BP14	1.67 ± 2.14	1.63 ± 0.018	506.73 ± 3.21
15	BP15	1.57 ± 3.61	1.73 ± 0.07	501.82 ± 4.86

*n=SD ± 3

Table 4: Evaluation of performance parameters of different SD incorporated buccal patches of flurbiprofen

S. No	*Formulation code*	*% Drug content*	*pH*	*In vitro residence time (min)*
1	BP1	96.27 ± 0.41	6.3 ± 0.54	12 ± 1.74
2	BP2	98.92 ± 0.16	6.4 ± 0.42	12 ± 3.48
3	BP3	97.57 ± 0.31	6.5 ± 0.82	12 ± 4.72
4	BP4	96.82 ± 0.43	6.4 ± 0.58	12 ± 3.72
5	BP5	95.26 ± 0.5	6.6 ± 0.35	13 ± 2.84
6	BP6	96.42 ± 0.41	6.8 ± 0.78	13 ± 1.83
7	BP7	95.42 ± 0.40	6.2 ± 0.23	14 ± 4.83
8	BP8	93.53 ± 0.25	6.7 ± 0.89	15 ± 4.31
9	BP9	95.51 ± 0.33	6.5 ± 0.26	13 ± 3.01
10	BP10	94.42 ± 0.46	6.4 ± 0.57	16 ± 2.03
11	BP11	98.41 ± 0.21	6.7 ± 0.21	17 ± 4.07
12	BP12	92.59 ± 0.48	6.5 ± 0.98	18 ± 3.87
13	BP13	96.62 ± 0.19	6.6 ± 0.87	13 ± 3.2
14	BP14	99.92 ± 0.03	6.3 ± 0.4	11 ± 1.92
15	BP15	95.62 ± 0.49	6.5 ± 0.74	13 ± 2.71

*n = SD ± 3

pH limit of i.e. 6.2–7.4. It represents the better patient tolerability (Table 4).

In-vitro Residence Time

Upon swelling the matrix experience intra-matrix swelling force that promotes disintegration and leaching of the drug generating a highly porous matrix. Hence formulations with more HPMC E15 polymer showed less residence time as they showed rapid swelling and easily got leached, the in-vitro residence time was recorded for all the formulations and the values were changing with different ratios of polymers. The maximum time was found for BP12 about 18 min and least for BP14 about 11 minutes (Table 4).

Swelling Index

The persuade of drug on swelling nature of polymer matrices mainly depends on substitutions present on polymer. The -OH substituent play vital role in the matrix integrity. The quantity and property of the incorporated drug determines the matrix integrity. HPMC E15

containing patches displayed superior swelling index owing to presence of -OH group in the molecules. The swelling index ranges from 15.63–54.62 minutes, where BP14 formulation has highest swelling index when compare with other formulations (Table 5).

In-vitro Drug Dissolution

The in-vitro diffusion characteristics of 15 buccal patches were studied for 12 hours period of time and were compared to the marketed sustained release formulation. The dissolution profile of solid dispersion incorporated buccal patches BP14 showed maximum drug release of 99.96% in 12 hours. Formulations containing high HPMC content showed more drug release as the water-soluble hydrophilic carrier HPMC containing more hydroxyl groups compared to other polymers; it dissolves swiftly ensuing in high porosity. The voids are likely to be occupied with the external solvent diffusing through the patch and thus hastening the dissolution. The presence of carbopol in the ionized state results in loosening of polymeric network, thereby attributing to higher drug release. The formulation BP14 containing high ratio of HPMC in combination with carbopol which contributed to high drug release in comparison to other formulations. (Figs. 2 to 4)

Table 5: Swelling index of solid dispersions incorporated flurbiprofen buccal patches

	Swelling index in time (min)		
Formulation code	*5*	*10*	*30*
BP1	6.63	10.73	18.62
BP2	8.42	15.53	24.61
BP3	9.52	17.72	27.72
BP4	15.63	28.36	45.62
BP5	10.73	19.26	31.27
BP6	12.37	22.72	36.62
BP7	7.62	14.62	22.01
BP8	5.34	10.36	15.63
BP9	13.62	25.73	39.72
BP10	12.73	24.75	36.62
BP11	16.73	30.62	48.62
BP12	11.89	22.63	33.72
BP13	12.01	24.9	36.73
BP14	18.74	33.52	54.62
BP15	14.73	27.35	42.74

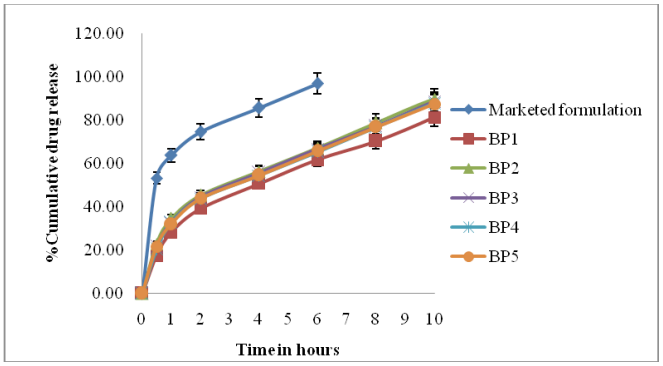

Fig. 2: Dissolution Profile of Marketed Product of Flurbiprofen and Different SD Incorporated Buccal Patches of Flurbiprofen (BP1to BP5)

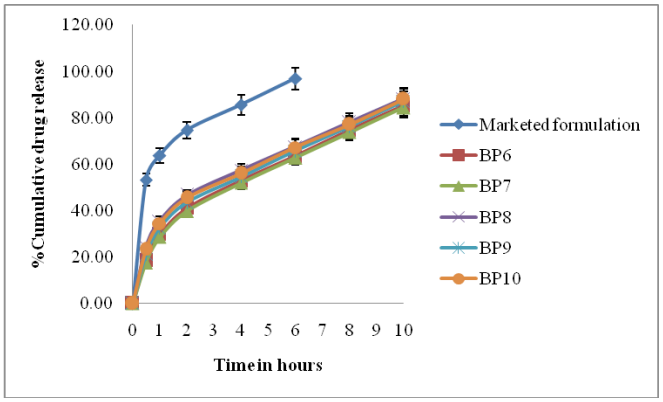

Fig. 3: Dissolution Profile Of Marketed Product of Flurbiprofen and Different SD Incorporated Buccal Patches of Flurbiprofen (BP6to BP10)

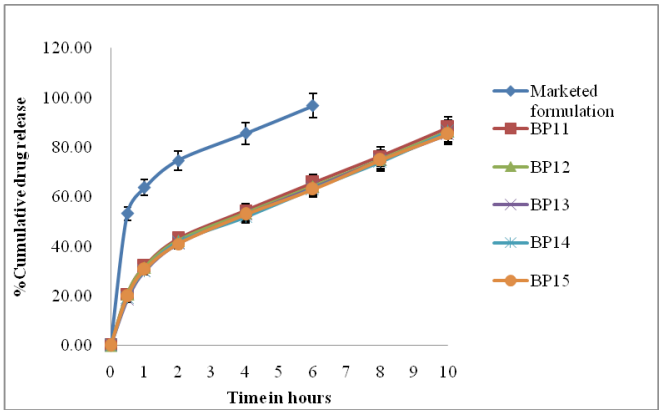

Fig. 4: Dissolution Profile of Marketed Product of Flurbiprofen and Different SD Incorporated Buccal Patches of Flurbiprofen (BP11to BP15)

Table 6: Release kinetics oof marketed product and SD included buccal patches of flurbiprofen (BP1-BP7)

	R^2 values							
Release kinetics	*Marketed formulation*	*BP1*	*BP2*	*BP3*	*BP4*	*BP5*	*BP6*	*BP7*
Zero order	0.6063	0.9373	0.9127	0.9222	0.926	0.9241	0.9359	0.939
First order	0.9406	0.9113	0.9111	0.8319	0.8549	0.8849	0.8901	0.9178
Higuchi model	0.8554	0.9939	0.9936	0.9948	0.994	0.9951	0.9954	0.9962
Korsmeyer-peppa's	0.4156	0.887	0.8672	0.8753	0.8774	0.8739	0.8869	0.8927

Table 7: Release kinetics of marketed product and SD included buccal patches of flurbiprofen (BP8-BP15)

	R^2 values								
Release kinetics	*Marketed formulation*	*BP8*	*BP9*	*BP10*	*BP11*	*BP12*	*BP13*	*BP14*	*BP15*
Zero order	0.6063	0.905	0.9225	0.9112	0.9279	0.9286	0.9338	0.971	0.934
First order	0.9406	0.844	0.8902	0.8735	0.844	0.8908	0.8972	0.6203	0.8879
Higuchi model	0.8554	0.9911	0.9946	0.9925	0.9948	0.9944	0.9956	0.9912	0.9947
Korsmeyer-Peppa's	0.4156	0.8574	0.8743	0.8626	0.8768	0.8743	0.8869	0.8755	0.8773

Table 8: Evaluation data of formulations subjected to stability studies

Retest time	*% Drug content*	*In-vitro drug release (%)*
0	99.92 ± 0.03	99.96 ± 4.83
30	98.26 ± 0.25	99.09 ± 0.39
60	97.82 ± 0.37	98.29 ± 0.40
90	97.57 ± 0.48	97.67 ± 0.39

Release Order Kinetics

The release kinetics show that the drug dissolution from buccal patches was best fitted in zero order kinetic plot with highest linearity. The R^2 value ranged between 0.905–0.971 for all the formulations and best was found for the formulation BP14. All the formulations exhibited best fit to Higuchi model with R^2 values ranging from 0.9911– 0.9962.

Hence it is clear from the results that the release rate from the formulation is not reliant on the concentration as it follows zero order release kinetics whereas the marketed formulation was following first order kinetics and the best fit model for buccal patches drug release was Higuchi model representing diffusion process of drug release based on Ficks law which is square root time dependant. (Tables 6 and 7)

Stability Study Results

The formulation BP14 was loaded for stability study at 40°C ± 2°C/ RH 75% ± 5%. The formulation was found to be stable (Table 8) with no significant variations in physical parameters measured.

Conclusion

From the present study carried out, 15 formulations of SD included buccal patches were prepared and all the formulation showed good evaluation characteristics with good drug dissolution. The BP14 containing HPMC E15 polymer in combination with carbopol has highest drug release of 99.96% over extended period of 12 hours and the drug release was fitted into various release kinetic models and found that the drug followed zero order release and the plots was linear with correlation coefficient (R^2) values ranging between 0.905–0.941 for various formulations while marketed formulation followed first order. All the formulations displayed fit to Higuchi model with R^2 values between 0.9911–0.9962 indicating drug dissolution was through diffusion process. Thus, one may conclude that solid dispersions included buccal patches formulation, have potential for contemplation for drug delivery as buccal dosage formulation to avoid first pass metabolism and prolonged drug release in controlled manner in the effective management of rheumatoid arthritis.

References

1. Patil JS, Rao KP. Design and evaluation of mucoadhesive buccal patches of Diclofenac sodium. Ind J Pharm Sci. 2003;7:420-423.
2. Mishra SK, Garud N, Singh R. Development and evaluation of mucoadhesive buccal patches of flurbiprofen. Acta Pol Pharm. 68; 955-964:2011.
3. Aligeti SK, Jampala RK, Vinaya J. Formulation and evaluation of flurbiprofen ocular *in-situ* gel. Int J Pharm Sci Res. 2018;9(5): 1851-1856.
4. Alaayedi, Maryam. Formulation and Evaluation of flurbiprofen Solid Dispersion. Ijppr Human.2016;7(3): 8-90.
5. Darwish MK, Elmeshad AN. Buccal mucoadhesive Tablets of flurbiprofen: Characterization and optimization. Drug Discov Ther. 2009;3(4):181-189.
6. Sandeep kumar D, Shashidharreddy K, Amitkumartiwari, Suddhasattyadey. Design and evaluation of buccal patches of lornoxicam.Int J Pharma Bio Sci. 2010;1(4):587-596.
7. Surya NR, Bhabani SN, Amit KN, and BiswaranjanMohanty Formulation and Evaluation of Buccal Patches for Delivery of Atenolol. AAPS PharmSciTech. 2010;11(3):1038-44.
8. Satishbabu BK, Srinivasan BP. Preparation and evaluation of buccoadhesive films of atenolol. Indian J Pharm Sci. 2008;70(2): 175–179.
9. Singhal, Peeush&Jadoun, Gajendrasingh&Saraf, Shubhini. Formulation and Evaluation of Buccal Patches of Terbutaline Sulphate. Int J Res Pharm Sci. 2010;1(4),440-449.
10. Erma N, Wahi AK, Verma A, Chattopadhayay P. Evaluation of a mucoadhesive buccal patch for delivery of atenolol: *in vitro* screening of bioadhesion. J Pure Appl Microbiol. 2007;1:115–118.
11. Mohamed SP, Pramod KT. Formulation and evaluation of a bioadhesive patch for buccal delivery of tizanidine. Acta Pharm Sin B. 2012;318-324.
12. Vishnu M, Patel G, Prajapati, Madhabhai M. Design and characterization of chitosan-containing Mucoadhesive buccal patches of propranolol hydrochloride. Acta pharm.2007;57:61–72.
13. Rajesh SP, Poddar SS. Development and Characterization of Mucoadhesive Buccal Patches of Salbutamol Sulphate.Current Drug Deliv. 2009;6,140-144.
14. Vijendra S, Chanchal DK, Amit A, Moh. AkhatarRasool, Shekhar S. Development and Invitro Evaluation of buccoadhesive formulation of Dimenhydrinate Tablet. International journal of pharma professional's Reasearch. 2010;1(2):109-113.
15. Amit Khairnar, Parridhi Jain, DheerajBaviskar, Dinesh Jain. Development of mucoadhesive buccal patch Containing aceclofenac: in vitro evaluations. International Int J Pharmtech Res. 2009;1(4):978-981.
16. Daravath, Bhaskar, Naveen, Chella, Vemula, Sateesh Kumar, Tadikonda, Rama Rao. Solubility and dissolution enhancement

of flurbiprofen by solid dispersion using hydrophilic carriers. Brazilian Journal of Pharmaceutical Sciences. 2017;53(4): e00010.
17. Khan, Kamran Ahmad & Khan, Gul Majid &Rehman, Asim. ur&Kifayat, & Shah, KifayatUllah. Studies on Drug Release Kinetics of Controlled Release Matrices of flurbiprofen and Comparison with Market Product. Latin American Journal of Pharmacy. 2013;32: 1321-1328.
18. Lalatendupanigrahi, Snigdha pattnaik, Saroj K. Ghosal, Design and characterization of mucoadhesive buccal patches of Salbutamol sulphate. ActapoloniaePharmaceutica- Drug Res. 2004;61(5):351-360.
19. Gupta A, Garg S, Khar RK. Measurement of bioadhesive strength of mucoadhesive buccal Tablets: design of an in vitro assembly. Ind Drugs. 1993;30:152–155.
20. Gupta A, Garg S, Khar RK. Measurement of bio adhesion strength of muco-adhesive buccal Tablet: design of an in vitro assembly. Indian Drugs. 1992;30:15
21. Gupta A, Garg S, Khar RK. Measurement of bioadhesion strength of muco-adhesive buccal Tablet: design of an in vitro assembly. Indian Drugs. 1992;30:152–155

HOW TO CITE THIS ARTICLE: Sadik MJ, Khan A. Formulation and Evaluation of Flurbiprofen Solid Dispersions Incorporated Buccal Patches. Int. J. Pharm. Sci. Drug Res. 2020;12(6):674-681. **DOI:** 10.25004/IJPSDR.2020.120611