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Research Article

FORMULATION AND EVALUATION OF TRANSDERMAL PATCHES OF KETOPROFIN BY USING DIFFERENT POLYMERS

Shuwana Zakir*, Syeda Kahkasha Banu,Syeda Nuzhath Fatima, Tabassum Jahan,Wajida Firdous.P.Sireesha.Roshan.S, N.L.Mahammed.

AZAD College Of Pharmacy,Moinabad, R.R.District,Telangana,India

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ABSTRACT

The purpose of this research work was to develop and evaluate matrix-type transdermal patches of Ketoprofen. Employing different ratios of hydrophilic and hydrophobic polymers by solvent evaporation technique. The physicochemical compatibility of the drug and the polymers was studied by infrared spectroscopy. The results suggested no physicochemical incompatibility between the drug and the polymers. Seven formulations (consisting of Hydroxypropyl methylcellulose E5 and Ethylcellulose in the ratios of10:0, 0:10, 1:9, 2:8, 3:7, 4:6, 5:5 (F1, F2, F3, F4, F5, F6, F7) were prepared. All formulations carried dimethyl sulfoxide as penetration enhancer and dibutyl phthalate as plasticizer in chloroform and methanol (1:1) as solvent system. The prepared TDDS were evaluated for in vitro release, moisture absorption, moisture loss and mechanical properties. The diffusion studies were performed by using modified Franz diffusion cells. Patch coded as F1 (HPMC alone) showed maximum release of 95.526 ± 0.982 % in 8 h, where as F2 (EC alone) showed maximum release of 67.078 ± 1.875 % in 24 h and in combination of polymers F7 (5:5) showed maximum release of 86.812 ± 0.262 % in 24 h, emerging to be ideal formulation for Fenoprofen. The results followed Higuchi kinetics (r2), and the mechanism of release was diffusion mediated.

Keywords:*Ketoprofen, solvent evaporation technique, transdermal patch,: drug release, skin permeation.*

INTRODUCTION

Transdermal drug delivery systems (TDDS) which can deliver medicines via the skin portal to systemic circulation at a predetermined rate and maintain clinically effective concentrations over a prolonged period of time. Optimization of drug delivery through human skin is important in modern therapy[1]. With the limitations of oral drug delivery and the pain and needle phobias associated with traditional injections, drug delivery research has focused on the transdermal delivery route[2]. Delivery of drugs into systemic circulation via skin has generated a lot of interest during the last decade as TDDS offer many advantages over the conventional dosage forms and oral controlled release delivery systems notably avoidance of hepatic first pass metabolism, decrease in frequency of administration3, reduction in gastrointestinal side effects and improves patient compliance. Ketoprofen, (RS)2-(3-benzoylphenyl)-propionic acid (chemical formula C16H14O3) is one of the propionic acid class of nonsteroidal anti-inflammatory drugs (NSAID) with analgesic and antipyretic effects. It acts by inhibiting the body's production of prostaglandin4. Ketoprofen's exact mode of action is unknown, but it is thought that prostaglandin synthetase inhibition is involved. Ketoprofen has been shown to inhibit prostaglandin synthetase isolated from bovine seminal vesicles. The

Address For Correspondence
[*]Shuwana Zakir
AZAD College Of Pharmacy
Moinabad,R.R.District,Telangana-501504.
Mobile=+91-9550994772
Email id= sireesha.panditha@gmail.com

purpose of this research work was to develop and evaluate matrix-type transdermal patches of Ketoprofen. Employing different ratios of hydrophilic and hydrophobic polymers by solvent evaporation technique.

MATERIALS AND METHODS:

Materials:

Ketoprofen, Hydroxypropyl methylcellulose E 5, Ethylcellulose, Octanol, Chloroform, Methanol Dimethyl sulphoxide, Dibutyl phthalate, Sodium hydroxide pellets, Potassium dihydrogen ortho phosphate, Potassium chloride, Fused Calcium chloride, Aluminium foils etc.

Methods:

Before going to formulation development we did analytical method development of ketoprofin then we went to preformulation study. We did preformulation study including Determination of pH, Determination of melting point, Determination of solubility, Determination of partition coefficient, Determination of drug-excipient compatibility by FTIR. After preformulation study we gone to the preparation of transdermal patches.

Preparation of transdermal patches: In the present study, drug loaded matrix type transdermal films of Ketoprofen were prepared by solvent evaporation method. A mould of 5cm length and 5cm width with a total area of 25cm2 was fabricated and used.The bottom of the mould was wrapped with aluminium foil, 300mg of the polymer(s) was accurately weighed and dissolved in 5ml of chloroform: methanol (1:1) and kept aside to form clear solution. Dibutyl phthalate was used as plasticizer and dimethyl sulfoxide was used as permeation enhancer as shown in table 5.3 and mixed thoroughly. 30mg of KF was dissolved in the above solution and mixed for 10min. The resulted uniform solution was cast on the aluminium foil and dried at 40oC in the hot air oven for 24h. An inverted funnel was placed over the mould to prevent fast evaporation of the solvent. After 24h the dried films were taken out and stored in a dessicator for further studies.

Evaluation: After preparation of transdermal patches we did evaluation of transdermal patches including Physical appearance, Thickness uniformity, Weight uniformity, Folding endurance, Percentage moisture absorption, Percentage moisture loss, Water vapour transmission rate, Tensile strength, Drug content uniformity of films, Invitro drug release studies.

RESULTS :

Analytical Methods

Determination of max of Ketoprofen in pH 7.4 phosphate buffer solution:

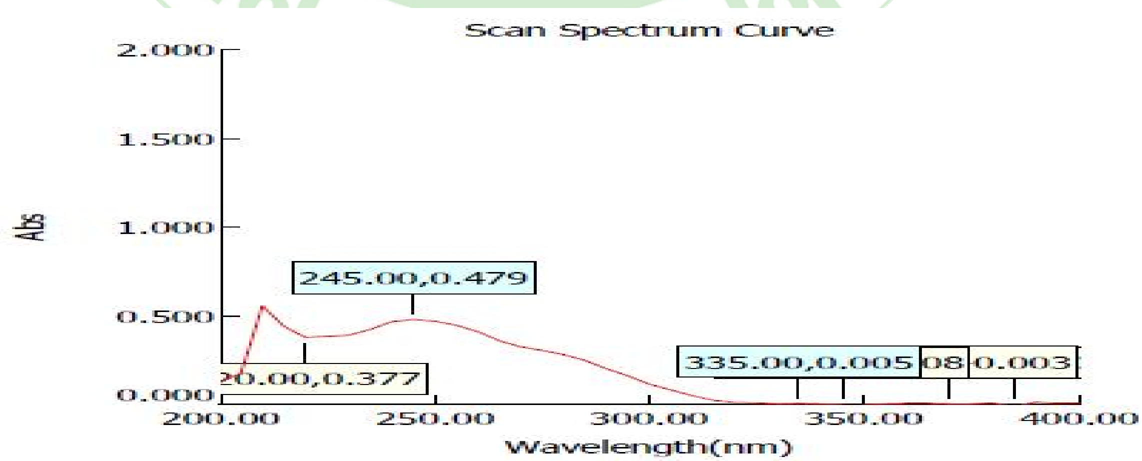

Figure1: UV spectrum of Ketoprofen in 245nm

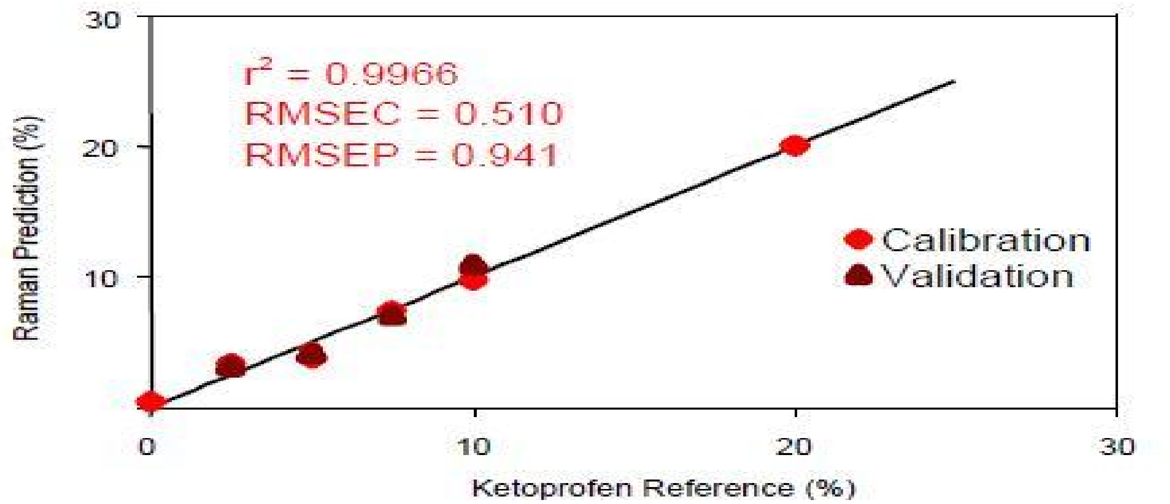

Figure 2: Calibration curve of Ketoprofen in pH 7.4 buffer

Table No:1 Data For Calibration Curve Of Ketoprofen In Ph 7.4 Buffer Solution

S. No.	Concentration µg/ ml	Absorbance at 245 nm Mean ± D*
1	0	0.000 ± 0.000
2	2.0	0.072 ± 0.008
3	4.0	0.138 ± 0.007
4	6.0	0.196 ± 0.012
5	8.0	0.261 ± 0.008
6	10.0	0.324 ± 0.008
7	12.0	0.399 ± 0.004
8	14.0	0.456 ± 0.011
9	16.0	0.519 ± 0.006
10	18.0	0.571 ± 0.004
11	20.0	0.640 ± 0.006

* Each value was an average of three determinations

PREFORMULATION STUDIES

Physicochemical properties of Ketoprofen:

Table No:2 Data Of Various Preformulation

Sl.No.	Drug	pH	Melting point	Solubility
1.	Ketoprofen	7.4	168–171 °C	8.11e-02 g/l

DRUG-EXCIPIENTS COMPATIBILITY STUDIES:

FT-IR spectrum and values

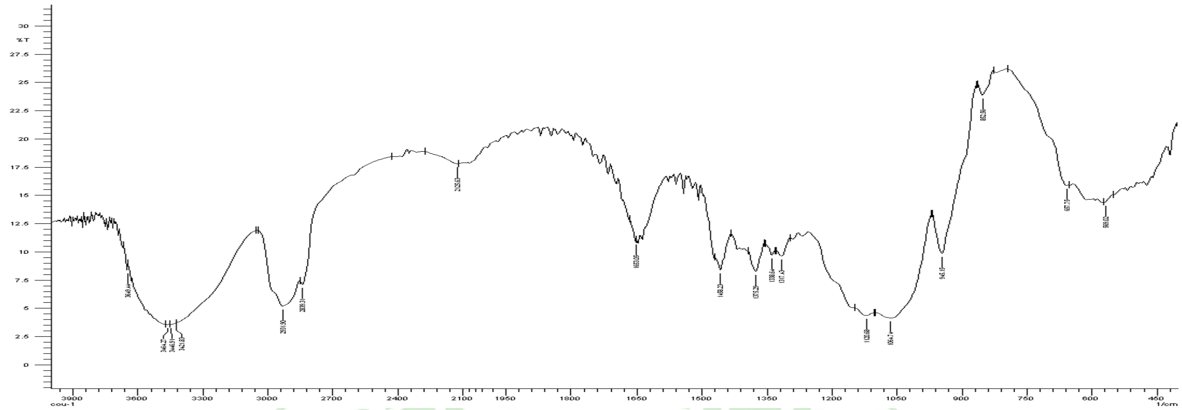

Figure 3: IR spectrum of pure ketoprofen

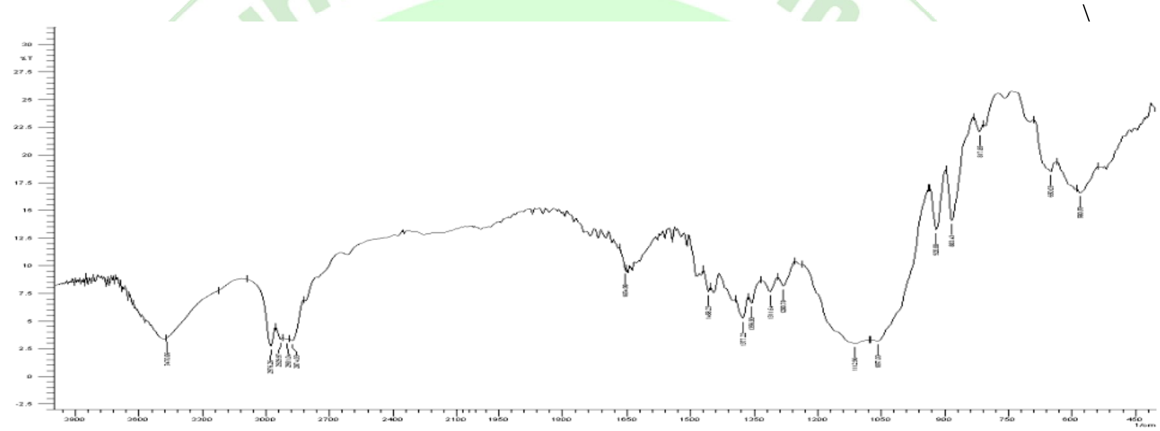

Figure 4 : IR spectrum of drug + excipients

Table No:3 FT-IR spectrum values

S. No.	IR spectrum	Groups	Peak (cm^{-1})	Stretching/ Deformation
1	Ketoprofen	N- tertiary	1552	Stretching
		CH_2	1562	Stretching
		CH_3	1242	Stretching
		C=O	1524	Stretching
		C=C	1345	Stretching
		C-N	1265	Stretching
		C-S	698	Stretching
2	HPMC E5	O-H	3463	Stretching
		C-O-C	1064	Stretching
3	EC	CH_2	2976	Stretching
		CH_3	2873	Stretching
		C-O-C	1056	Stretching

FORMULATION OF TRANSDERMAL PATCHES:

Table No:4 Composition Of Different Formulations Containing Ketoprofen

FORMULATIONS	F1	F2	F3	F4	F5	F6	F7
ketoprofen, mg	200	200	200	200	200	200	200
HPMC E(5cps), mg	300	*	30	60	90	120	150
Ethylcellulose, mg	*	300	270	240	210	180	150
Dibutyl phthalate (2 drop), ml	0.12	0.12	0.12	0.12	0.12	0.12	0.12
DMSO, ml	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Chloroform: Methanol (1:1), ml	5	5	5	5	5	5	5

* No ingredients was used; HPMC = Hydroxypropyl methylcellulose; DMSO = Dimethyl sulfoxide.

EVALUATION OF TRANSDERMAL PATCHES:

Thickness uniformity:

Table No:5 Thickness Uniformity Of F1 To F7 Patch Formulations

S. No.	Formulation code	Average thickness (mm)			
		Trial 1	Trial 2	Trial 3	Average
1	F1	0.17	0.19	0.19	0.18
2	F2	0.19	0.28	0.36	0.27
3	F3	0.38	0.45	0.53	0.45
4	F4	0.14	0.14	0.17	0.15
5	F5	0.27	0.29	0.30	0.28
6	F6	0.38	0.38	0.39	0.38
7	F7	0.17	0.18	0.20	0.19

Weight Uniformity:

Table No: 6 Weight Uniformity of F1 to F7 Patch Formulations

Sl. No.	Formulation code	Average weight (g)			
		Trial 1	Trial 2	Trial 3	Average
1	F1	0.40	0.43	0.42	0.416
2	F2	0.38	0.36	0.36	0.366
3	F3	0.40	0.38	0.37	0.383
4	F4	0.41	0.39	0.38	0.393
5	F5	0.35	0.41	0.38	0.380
6	F6	0.38	0.34	0.36	0.360
7	F7	0.43	0.40	0.41	0.413

*Standard deviation, n = 3

Folding Endurance:

Table No:7 Folding Endurance Of F_1 To F_7 Patch Formulations

Sl No.	Formulation code	Folding endurance			
		Trial 1	Trial 2	Trial 3	Average
1	F_1	300	300	300	300.0
2	F_2	300	300	300	200.0
3	F_3	300	300	300	250.0
4	F_4	270	270	270	260.0
5	F_5	189	185	180	283.0
6	F_6	205	205	210	270.0
7	F_7	169	184	200	284.0

Percentage Moisture Absorption:

Table No:8 Data Of Percentage Moisture Absorption

Sl. No.	Formulation code	Percentage moisture absorption			
		Trial 1	Trial 2	Trial 3	Average*
1	F_1	4.651	6.97	9.3	6.973
2	F_2	0	2.63	2.63	1.753
3	F_3	0	2.94	2.94	1.960
4	F_4	2.70	2.70	5.50	3.630
5	F_5	2.43	2.43	4.87	3.243
6	F_6	2.70	5.40	5.40	4.50
7	F_7	4.761	7.142	7.142	6.348

*Standard deviation, n = 3

Percentage Moisture Loss:

Table No:9 Data Of Percentage Moisture Loss

S. No.	Formulation code	Percentage moisture loss			
		Trial 1	Trial 2	Trial 3	Average
1	F_1	10.0	12.5	15.0	12.5
2	F_2	7.89	10.52	10.52	9.643
3	F_3	7.50	10.0	10.0	9.166
4	F_4	2.5	5.0	7.5	5.00
5	F_5	2.85	2.85	5.71	3.80
6	F_6	0	5.26	7.89	4.38
7	F_7	6.97	9.30	11.62	9.29

Water Vapor Transmission Rate:

Table No: 10 Water Vapor Transmission Rate Of F_1 To F_7 Formulations

Sl. No.	Formulation code	Water vapor transmission rate			
		Trial 1	Trial 2	Trial 3	Average*
1	F_1	0.0043	0.0046	0.0046	0.0045
2	F_2	0.0020	0.0031	0.0028	0.0026
3	F_3	0.0026	0.0032	0.0034	0.0030
4	F_4	0.0028	0.0023	0.0034	0.0028
5	F_5	0.0031	0.0031	0.0028	0.0030
6	F_6	0.0037	0.0034	0.0040	0.0037
7	F_7	0.0046	0.0043	0.0037	0.0042

Tensile Strength:

Table No:1 1 Tensile Strength Of F_1 To F_7 Formulations

Sl. No.	Formulation Code	Tensile strength Kg/mm^2			
		Trial 1	Trial 2	Trial 3	Average
1	F_1	3.85	3.96	3.71	3.86
2	F_2	2.85	2.96	3.07	2.98
3	F_3	3.05	3.14	3.13	3.13
4	F_4	3.18	3.29	3.21	3.22
5	F_5	3.22	3.31	3.28	3.27
6	F_6	3.27	3.39	3.36	3.34
7	F7	3.32	3.47	3.44	3.41

Drug Content:

Table No:1 2 Percentage Of Drug Content Of F_1 To F_7 Formulation

Sl. No.	Formulation code	Concentration Mean ± SD* (mg/cm^2)	% Drug content
1	F_1	1.178 ± 0.071	98
2	F_2	1.054 ± 0.071	87.62
3	F_3	1.083 ± 0.047	90.00
4	F_4	1.083 ± 0.053	90.25
5	F_5	1.114 ± 0.071	91.85
6	F_6	1.114 ± 0.031	92.83
7	F_7	1.145 ± 0.035	95.41

*Standard deviation, n = 3

In Vitro Drug Diffusion Study:

Table No:1 3 In-Vitro Diffusion Profile Of Ketoprofen Transdermal Patch (F_1)

Time (h)	T	Log T	% Cumulative drug release Mean ±	Log % Cumulative drug release Mean±SD*	% Cumulative drug retained Mean ±SD*	Log % Cumulative drug retained Mean ± SD*
0	0	0	0 ± 0	0 ± 0	100 ± 0	2 ± 0
0.5	0.707	-0.301	15.022±0.491	1.176±0.013	84.978±0.491	1.928±0.002
1	1	0	29.477±0.490	1.469±0.006	70.522±0.490	1.847±0.002
2	1.414	0.301	42.516±0.850	1.628±0.009	57.483±0.850	1.759±0.006
3	1.732	0.477	58.389±0.490	1.766±0.003	41.610±0.490	1.619±0.005
4	2	0.602	64.908±0.491	1.812±0.003	35.091±0.491	1.544±0.005
5	2.236	0.698	72.845±0.491	1.862±0.002	27.154±0.491	1.433±0.007
6	2.449	0.778	79.931±0.850	1.902±0.004	20.068±0.850	1.301±0.018
7	2.645	0.845	87.584±0.850	1.942±0.004	12.415±0.850	1.092±0.029
8	2.828	0.903	95.526±0.982	1.979±0.004	4.479±0.982	0.615±0.124

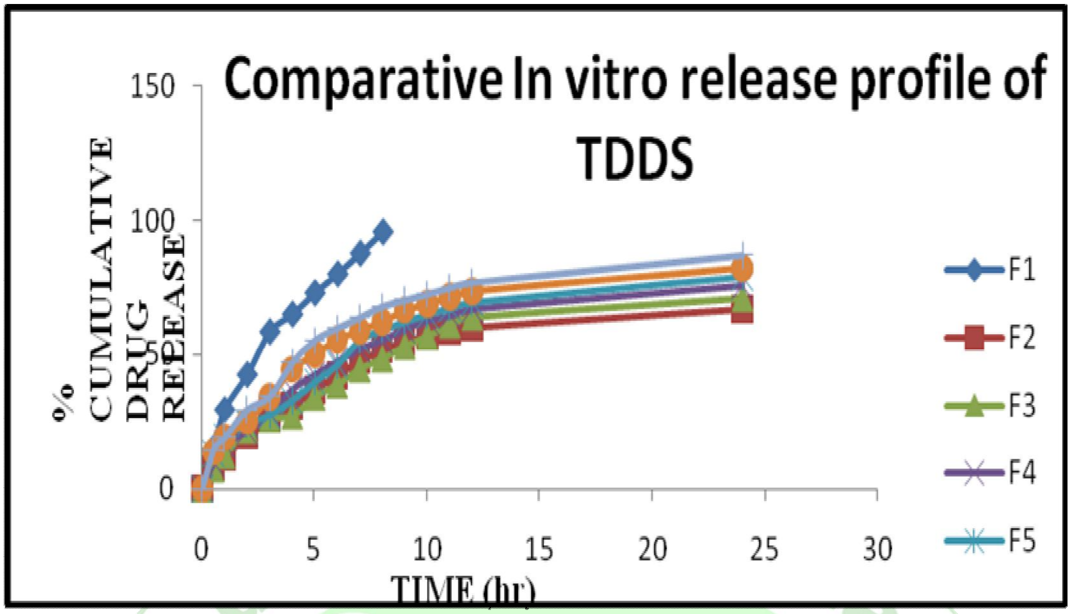

Figure 5: Comparative In vitro release profile of Ketoprofen TDDS

DISCUSSION :

Determination of λmax Ketoprofen in pH 7.4 phosphate buffer solution:

The solution containing 10 µg/ml was scanned between 200 - 400 nm. The λ_{max} was found to be 245 nm, which indicates purity of sample drug Ketoprofen.

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pH of Ketoprofen was found to be 7.4. Ketoprofen is a weak base, exists in a cationic form at skin pH, and therefore requires permeation enhancers to pass through the skin.Melting point of Ketoprofen was found to be 168–171 °C, as specified in monograph, which confirms purity of drug as per B.P.

Determination of solubility:

Ketoprofen is freely soluble in water, phosphate buffer pH 7.4, chloroform, methanol and acetone. The mean concentration of the drug dissolved in the water was 8.11e-02 g/l

Determination of partition coefficient:

The partition coefficient value was experimentally found to be 3.7. The results obtained indicate that the drug possesses sufficient lipophilicity, which fulfill the experiment of formulating the selected drug into a transdermal film.

Determination of drug-excipient compatibility

FT-IR: Chemical interaction between drug and the polymeric material was studied by using FT-IR. IR spectra of Ketoprofen, HPMC E5, EC.

The peaks can be considered as characteristic peaks of Ketoprofen, confirming the purity of the drug observed in IR spectra of Ketoprofen along with polymers.

EVALUATION OF TRANSDRMAL PATCHES:

Physical appearance

The prepared transdermal patches were transparent, smooth, uniform and flexible. The method adopted for preparation of system was found satisfactory.

Thickness uniformity

With the help of digital caliper, the thickness of film was measured at different points and the average thickness was noted. The result indicates that there was no much difference in the thickness within the formulations and it was found to vary from 0.15 ±0.015 to 0.45± 0.011 mm with low standard deviations. The results are given in Table 5.5 and order of the thickness of films is F4 < F1 < F7 < F2 < F5 < F6 < F3.

Weight uniformity

Three different films of the individual batch are weighed and the average weight was calculated. The dried films were weighed on digital balance. The films exhibited uniform weight ranging from 0.360 ± 0.020 to 0.416 ± 0.015 g with low standard deviation values. The data are shown in the Table 5.6 and order of the weight of films is F6 < F2 < F5 < F3 < F4 < F7 < F1.

Folding endurance

The recorded folding endurance of the films was > 150 times. It means all formulations had good film properties. The data are given in Table 5.7 and order of the folding endurance is F2 < F3 < F4 < F6 < F5 < F7 < F1. This test is important to check the ability of sample to withstand folding, which gives an indication of brittleness; less folding endurance indicates more brittleness.

Percentage moisture absorption

The moisture absorption studies carried out in desicator. All the patches showed least percentage moisture absorption. The order of the percentage moisture absorption is F2<F3<F5<F4<F6<F7<F1 and the data is presented in the Table 5.8. The moisture uptake of the formulations was low, which could protect the formulations from microbial contamination and reduce bulkiness.

Percentage moisture loss

The moisture loss studies were carried out at 80 – 90% relative humidity. All the patches showed least percentage moisture loss. The order of the percentage moisture loss is F5<F6<F4<F3<F7<F2<F1 and the data is presented in the Table 5.9. The small moisture content in the formulations helps them to remain stable and from being a completely dried and brittle film.

Water vapour transmission rate

The water vapour transmission rates of different formulations were evaluated and the results are shown in Table 5.10. Ketoprofen patches containing HPMC alone showed higher WVTR as compared to the formulations containing EC. This may be due to the HPMC, which is more hydrophilic in nature than EC, which is less permeable to water vapour. Formulation F7 showed highest WVTR where as F3 showed lowest WVTR.

Tensile strength

The tensile strength measures the ability of a patch to withstand rupture. Presence of dibutyl phthalate and dimethyl sulfoxide has shown good tensile strength. Both the combination show significant tensile strength. The mean value was found to vary between 2.98 ± 0.110 to 3.86 ± 0.125 kg/mm2. The tensile strength results indicate the strength of film and the risk of film cracking. But, no sign of cracking in prepared transdermal films was observed, which might be attributed to the addition of the plasticizer. The results of tensile strength are shown in Table 5.11.

Drug content

For the various formulations prepared drug content was found to vary between 1.054 ± 0.071 mg to 1.178 ± 0.071 mg. The cumulative percentage drug permeated and percentage drug retained by the individual patch in the in-vitro skin permeation studies were based on the mean amount of drug present in the respective patch. Drug distribution was found to be uniform in the polymeric films, and data is given in Table 5.12.

In vitro drug diffusion study.

The in vitro release profile is an important tool that predicts in advance how a drug will behave in vivo. Release studies are required for predicting the reproducibility of rate and duration of drug release. The transdermal therapeutic system of Ketoprofen using a polymeric matrix film, allows one to control the overall release of the drug via an appropriate choice of polymers and their blends. The results of percentage drug release from the prepared medicated transdermal film.The percentage of drug release at each time interval was calculated and plotted against time. The drug release profile is shown in Figure 5.9. The drug release from HPMC (F1) and EC films (F2) was found to 95.526 ± 0.982 % within 8 h and 67.078 ± 1.875 % within 24 h, respectively. Among the formulations F3 to F7 which has varying proportion of HPMC and EC showed release of 71.224 ± 0.925 % to 86.812 ± 0.262

%, F7 showed maximum release of 86.812 ± 0.262 % for 24 h due to presence of higher portions of HPMC which is more permeable than EC. Increase in the concentration of hydrophilic polymer (HPMC), increases the thermodynamic activity of the drug, which results in increased drug release during in vitro studies. Henceforth formulation F7 was found to be satisfactory as it fulfills the requirements of better and prolonged drug release.

It is well known that the addition of hydrophilic component to an insoluble film former leads to enhance its release rate constant. This is due to the fact that dissolution of aqueous soluble fraction of the polymer matrix leads to the formation of gelaneous pores. The formation of such pores leads to decrease the mean diffusion path length of drug molecules to release into the diffusion medium and hence, to cause higher release rate.

The release kinetics was evaluated by making by use of zero order, first order, Higuchi's diffusion and Korsemeyer - Peppas equation (Figure 5.10 to 5.13). The study of drug release kinetics showed that majority of the formulations were governed by Peppas model and to see whether the drug release is by diffusion, by swelling or by erosion mechanism, the data was plotted according to Higuchi's equation. The release kinetics data are represented in Table 5.20. The co-efficient of determination indicated that the release data for formulation F1 followed zero order release kinetics with diffusion mechanism, while formulation F2 to F7 followed first order release kinetics with diffusion mechanism. Higuchi equation explains the diffusion release mechanism. The diffusion exponent 'n' values were found to be in the range of 0.5 to 1 indicating Non-Fickian mechanism.

CONCLUSION:

The following conclusions were drawn from results obtained.A suitable UV Spectroscopy method for the analysis of Fenoprofen was developed. Ketoprofen showed maximum absorption at wavelength 245nm in isotonic phosphate buffer (pH 7.4) solutions. The R^2value for the standard curve was found to be 0.999, which showed linear relationship between drug concentrations and absorbance values. The preformulation studies involving description, solubility, melting point, partition coefficient of the drug were found to be comparable with the standard. Based on the all the above preformulation studies the drug was suitable for making the transdermal formulation. Drug-polymer compatibility studies by FT-IR gave confirmation about their purity and showed no interaction between the drug and selected polymers.Various formulations were developed by using hydrophilic and hydrophobic polymers like HPMC E5 and EC respectively in single and combinations by solvent evaporation technique with incorporation of penetration enhancer such as dimethyl sulfoxide and dibutyl phthalate as plasticizer.

Developed transdermal patches possessed the required physicochemical properties such as drug content uniformity, folding endurance, weight uniformity, thickness uniformity, tensile strength and water vapour transmission rate (WVTR). As HPMC concentration increases showed higher WVTR.Patches exhibited higher tensile strength as the concentration of HPMC was increased.

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REFERENCES

1. *Liu L, Fishman M, Kost J, Hicks KB. Pectin based systems for colon specific drug delivery via oral route. Biomaterials 2003;24:3333-43.*
2. *Abdul B, Bloor J. Perspectives on colonic drug delivery, business briefing.Pharmtech 2003:185-90.*
3. *Cheng G, Jou MJ, Sun J, Hao XU, He YX. Time- and ph dependent colon- specific drug delivery for orally administered diclofenac sodium and 5-amino salicylic acid. World J Gastroenterol 2004;10(12):1769-74*
4. *Krishnaiah YSR, Satyanarayana S, editors. Advances in controlled and novel drug delivery. 1st ed New Delhi: CBS Publishers and Distributors 2001; p.89-119.*
5. *Sarasija S, Hota A.Colon specific drug delivery systems. Ind J Pharm Sci 2000;62(1):1-8.*
6. *Toratora Gradowski. Principles of anatomy and physiology. 10th ed New York: John Wiley & Sons 2002; p. 866-73.*
7. *RamPrasad YV, Krishnaiah YSR, Satyanarayana S. Trends in colonic drug delivery: a review. Ind Drugs 1995;33(1):1-10.*

8. Kumar R, Patil MB, Patil RS, Paschapur SM. Polysaccharides based colon specific drug delivery: a review. Int J Pharm Tech Res 2009;1(2):334-46.
9. Maestrelli F, Cirri M, Corti G, Mennini N, Mura P. Development of enteric- coated calcium pectinate microspheres intended for colonic drug delivery. EurJ Pharm Biopharm 2008;69:508–18.
10. Asghar LFA,Chandran S.Multiparticulate formulation approach to colon specificdrugdelivery:currentperspectives. JPharmPharmSci2006;9(3):327-38
11. Rubenstein A. Colonic drug delivery. Drug Discov Today Technol 2005;2(1):33-7.
12. Rubinstein A. Natural polysaccharides as targeting tools of drugs to the human colon. Drug Dev Res 2000;50:435–9.