INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES
[ISSN: 0975-4725; CODEN(USA):IJPS00]
Journal Homepage: https://www.ijpsjournal.com

Research Article

Comparative Study Of Different Polymer Based Emulgel

Sharma Kriti, Yadav Rishu, Bhateja Pankaj , Devi Anjana, Piplani Mona*

Maharaja Agrasen School of Pharmacy, Maharaja Agrasen University, Baddi, India

ARTICLE INFO

Received: 27 Feb 2024
Accepted: 01 March 2024
Published: 05 March 2024
Keywords:
Emulgel, Dual release control, Drug delivery system, Carbopol, Topical
DOI:
10.5281/zenodo.10781299

ABSTRACT

Emulgel, which contain a dual release control mechanism that includes both a gel and an emulsion, have become one of the most intriguing topical delivery systems. The main goal of this formulation is to transfer hydrophobic medications to systemic circulation through the skin. The direct accessibility of the skin as a target organ for diagnosis of disease and therapy is a distinctive aspect of topical medication administration. Instead of just mixing medications into the gel formulation, emulgel may demonstrate higher drug stability and release in addition to having a higher loading capacity due to their extensive network. Drugs are integrated into globules and disseminated in an emulgel drug delivery system before using different polymeric gel base. Due to their benefits, such as their gracelessness, smooth and homogenous texture, glossy look, transparency, pH comparable to skin's pH, high drug content, and sustained release, emulgel have been found to be superior topical drug delivery systems to others. This research article discusses the preparation of emulgel using different polymers (carbopol 940, HPMC, xanthine) and evaluation of formulation i.e. drug content, pH, spreadibility, viscosity and in vitro drug release, demonstrating why they are among the most efficient and practical drug delivery systems. In vitro test was performed to ensure the uniform and accurate release of the drug a good drug permeability was observed among all emulgel formulations. Result revealed that the release of all the emulgel formulations was found to be in the ranges of 85.12±0.36% to 89.56±0.66%. Formulation F1 shows comparable drug release when it was compared with marketed formulation (91.55±0.35 %). So, it is concluded that from present research work that topical emulgel of diclofenac potassium using carbopol 940 as gelling agent possess an effective drug release compared to all other formulations and marketed formulations. Surely it would be better for use and can be possessed for in vivo studies in future

INTRODUCTION

The skin is the primary mechanical defense system and act as barrier for penetration of many pharmacological compounds, and it also serves as an ideal site for local and systemic drug delivery. Over the last few decades, the topical route of

***Corresponding Author:** Piplani Mona
Address: *Maharaja Agrasen School of Pharmacy, Maharaja Agrasen University, Baddi, India*
Email : mona@mau.edu.in
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.

medication delivery has been increasing popularly despite the limitations of traditional topical medication delivery techniques, such as poor retention and bioavailability. This disadvantage is resolved through intensive research aimed at developing novel topical drug delivery technologies that increase safety, effectiveness, and side effects [1-3]. Skin is the largest organ of the body and contributes about 15% of the total adult body weight and covers an average area of 1.7 m2. The major function of skin is to protect the internal body from the external environment such as temperature, humidity and radiation. The skin also regulates the water content and heat loss from the body. The skin is made up of three sheets of different components an outermost sheet termed as epidermis, a middle sheet is termed as dermis and innermost sheet is termed as hypodermis [4-5]. There are various skin diseases in which the administration of a hydrophobic medication is required, the topical delivery method fails. Other cutting-edge methods include niosomes and liposomes, which are nanosized and may leak due to their vesicular architecture, resulting in less effective trapping [6]. Many excipients are included in each formulation containing active substances. Sometimes more than one formulation can be blended to improve medication delivery emulgel is one of such examples. It is a combination of emulsion and gel. Emulgel is a more recent innovation in novel drug delivery system that is used topically and has the properties of both an emulsion and a gel for dual control release. Emulgel are either w/o or o/w emulsions that have been mixed with a gelling agent to create a gelled state. Emulgel are the most stable and ideal delivery system for hydrophobic drugs. Emulgel have a high rate of patient acceptance. Emulgel, which have two phases—aqueous and non-aqueous can deliver both hydrophilic and lipophilic medicines, when compared to other topical medicines that require excessive rubbing, they are applied to skin appropriately because they are non-greasy [7-8]. The aim of this work was to develop an emulgel formulation of diclofenac potassium, a hydrophobic drug, using Carbopol 940, hydroxypropyl methyl cellulose (HPMC), xanthine as gelling agent and penetration enhancer, i.e. Clove oil. In this research article the influence of different polymeric gelling agent and release along with the rheological studies, spreading coefficient and in vitro release has been studied.

MATERIALS AND METHODS

Materials

Diclofenac potassium, Carbopol 940, HPMC, xanthine was obtained from departmental lab. All other chemicals used were of analytical grade and were used without any further chemical modification.

Methods

The emulgel was prepared using following steps:

a. Emulsion formation
b. Formation of gel base
c. Mixing of emulsion into gel base

Step 1: Emulsion formation

Preparation of aqueous phase: The aqueous phase was prepared by dispersing the calculated amount of tween 20 in purified water and heat separately at 70ºC. Propyl paraben and methyl paraben were used as preservatives and were dissolved in propylene glycol. On the other hand, diclofenac potassium was dissolved in ethanol. Both the mixture was added to the aqueous phase.

Preparation of oil phase:

The oil phase was prepared by dispersing the calculated amount of span 20 in light liquid paraffin and heat separately at 70℃.

Mixing of oil phase and aqueous phase:

Afte heating, the oil phase was added to the aqueous phase by continuous stirring until it cool. [9-10]

Step 2: Formation of gel base

I. Preparation of carbopol 940 gel:

The carbopol 940gel was prepared by adding the calculated amount of carbopol 940in the warm water with continuous stirring on a magnetic stirrer at moderate speed. The pH of carbopol 940gel was adjusted by using triethanolamine.

II. **Preparation of HPMC gel:**

The HPMC gel was prepared by adding a calculated amount of HPMC in warm water with continuous stirring on a magnetic stirrer at moderate speed.

III. **Preparation of Xanthine gel:**

The xanthine gel was prepared by adding a calculated amount of xanthine in warm water with continuous stirring on a magnetic stirrer at moderate speed.

Step 3: Formation of emulgel

The prepared emulsion was mixed with all the gel base separately with an appropriate ratio with continuous stirring to obtain the emulgel. The prepared emulgel was stored in glass jar with a tight lid [11].

Table 1: Composition of emulgel of diclofenac potassium.

Ingredients	Formulations		
	F1	F2	F3
Diclofenac potassium(gm)	1	1	1
Liquid paraffin(ml)	7.5	7.5	7.5
Tween20(ml)	0.5	0.5	0.5
Span 20(ml)	1	1	1
Propylene glycol(ml)	5	5	5
Methylparaben (mg)	0.03	0.03	0.03
Propylparaben(mg)	0.01	0.01	0.01
Clove oil(ml)	4	4	4
Carbopol 940(gm)	1	-	-
HPMC (gm)	-	1	-
Xanthine(gm)	-	-	1
Purified water(ml) Up to 100ml	100	100	100

Figure 1: Formulations of emulgel containing various polymer

EVALUATION OF EMULGEL

Visual examination:

In the visual examination, formulations were investigated for the color, phase separation, and homogeneity of emulgel.

Spreadability test:

Spredability is one of the important parameters for topical delivery of formulation. It was performed using a wooden block and glass slide apparatus to determine spreadability. A modified apparatus consisting of two glass slides with sample in between, with the lower side fixed to a wooden block and the upper side attached to a balance by a hook. All of the samples (about 1g) were placed between these two glass slides and pressed together for 5 minutes to expel the air and provide a uniform thickness of gel by placing a suitable weight. The top glass slide of the same size was fixed with ground slide. As a result, a weight (50g) was added to the pan, and the glass slide was pulled with the help of a stirring stick attached to the hook. The time taken by upper glass slide to move over the lower plate by 10 cm was recorded. The spreadability was calculated using the formula below:

$$S = M \times L / T$$

Where, S=Spreadability in g .cm/s

M=Mass of gel placed between the two slides

L=Length of slide (cm)

T=Time taken by the upper slide to detatch (seconds/minutes)

pH determination:

By using a digital pH meter, the pH of each formulation was calculated. The readings of pH will be taken an average of 3 times. [12-13]

Drug content:

Separately, a specific amount (1gm) of each developed formulation was taken and dissolved in 100 ml of phosphate buffer (pH 5.5). The volumetric flasks containing the gel solution were shaken for 2 hours to ensure complete drug solubility. After an appropriate dilution, the solution was filtered and analyzed with UV-spectrophotometer at 282.2 nm.

Stability studies:

The accelerated stability studies were carried out in accordance with the ICH guidelines Q1R2 in order to gain access to the drug and formulation stability for three months. The optimized formulation was stored in screw-capped amber colored glass bottles at 45 ± 5°C and 75±5 % relative humidity. At different time interval till 3 months, samples were analyzed for physical appearance, pH and drug content.

Viscosity:

Viscosity of emulgel was determined by using a Brookfield viscometer with spindle no.04 at 100 RPM. [14-15]

In vitro release study:

By using an eggshell membrane with a receptor compartment (80ml capacity) in vitro release studies were performed. With the help of a thread, the eggshell membrane was fixed at the end of the hollow tube as a donor compartment and beaker present as a receptor compartment. a specified quantity of prepared emulgel was applied on to the surface of the eggshell membrane and eggshell membrane clamped between the donor and receptor chamber. Receptor compartment filled with phosphate buffer solution pH 7.4 to solubilize the drug. On the magnetic stirrer, the whole assembly was placed and the solution was continuously stirred with the help of a magnetic bead. The temperature was maintained at 37±0.5ºC. At suitable interval, 1ml sample was withdrawn and analyzed for drug content spectrophotometrically at 282.2 nm.[16]

RESULTS AND DISCUSSION

Physicochemical properties:

Formulations were investigated for colour, phase separation, pH, spreadibility and compared with marketed formulation, the results shown in Table 2.

Table 2: Physicochemical properties of diclofenac potassium emulgel

Formulation	Color	Phase separation	pH	Spreadability (g.cm/s)
F1 (Carbopol 940)	White	No	5.9±0.2	4.8±0.5
F2 (HPMC)	White	No	4.3±0.5	4.2±0.5
F3 (Xanthine)	White	No	5.0±0.3	4.5±0.5
Marketed formulation	White	No	6.5±0.5	5.0±0.5

Drug content:

For all the diclofenac potassium, drug content analysis was done using the phosphate buffer (pH 7.4) as the medium and the results are given in Table3.

Table 3: Percent drug content of emulgel formulation

Formulation	Percent of drug content (%)
F1(Carbopol 940)	80 ± 0.32%
F2(HPMC)	72± 0.68%
F3(Xanthine)	79 ± 0.63%
Marketed formulation	89 ± 0.56%

Stability study:

All the formulations of emulgel were found to be stable after different intervals till 3 months at 45±5℃ and 75±5 % RH. No changes were recorded in parameters like visual appearance, pH, spreadability, and drug content. Syneresis is the main drawback of gel; also, there was no presence of syneresis effect.

Viscosity:

The viscosity of the formulations in which carbopol 940, HPMC, xanthine was used as gelling agent is given below in Table 4

Formulations	Viscosity(cps)
F1(Carbopol 940)	21599±0.65
F2(HPMC)	19819±0.65
F3(Xanthine)	19009±0.14
Marketed formulation	26711±0.11

In vitro release study: In vitro release study of all the formulations of emulgel was performed using phosphate buffer solution medium at 7.4 pH for 6 hours. After the time interval at 30 min 2ml sample were withdrawn and diluted with PBS 7.4 pH and the absorbance were measured at λmax 282.2 nm by UV spectrophotometer. The in vitro test was performed to ensure the uniform and accurate release of the drug. Good drug permeability was observed among all emulgel formulations. Result revealed that the release of all the emulgel formulations was found to be in the range of 84.45±0.16% to 89.56±0.66% Formulation F1has shown highest cumulative amount of drug release (89.56±0.66%) for up to 6 hours among all the other emulgel formulations and compared with marketed formulation of emulgel indicated that the rate of drug release depended upon the percentage of drug entrapment efficiency. The maximum release was also due to optimum surfactant concentration because at this concentration the surfactant molecule gets associated with the bi-layer resulting in better partitioning of the drug and result in higher drug release from the vesicles. The in vitro drug release profile of all emulgel formulation was shown in Table 5 and Figure 2.

Table 5: % Drug release of emulgel formulations

Time(hrs.)	Cumulative% drug release			
	F1	F2	F3	Marketed formulation
0.5	9.18 ± 0.45	8.59 ± 0.34	8.36 ± 0.42	10.23 ± 0.58
1	17.56 ±0.55	15.56 ± 0.78	16.62 ±0.48	19.45 ± 0.67
1.5	24.34 ± 0.38	22.45 ± 0.72	23.96 ± 0.42	25.19 ± 0.24
2	32.45 ± 0.57	29.56 ± 0.63	31.52 ± 0.93	34.34 ± 0.34
2.5	42.55 ± 0.87	39.78 ± 0.87	41.54 ± 0.49	44.98 ± 0.92
3	50.23 ± 0.23	47.67 ± 0.56	49.22 ± 0.32	51.25 ± 0.54
3.5	58.14 ± 0.96	54.89 ± 0.91	57.34 ± 0.72	60.23 ± 0.76
4	66.89 ± 0.4	62.58 ± 0.82	64.55 ± 0.23	68.59 ± 0.45
4.5	72.48 ± 0.71	69.59 ± 0.35	71.28 ± 0.66	74.22 ± 0.79
5	78.44 ± 0.34	74.34 ± 0.23	75.69 ± 0.19	80.34 ± 0.87
5.5	83.55±0.69	78.46±0.65	81.22±0.66	85.65±0.65
6	89.56±0.66	84.45±0.16	85.12±0.36	91.55±0.35

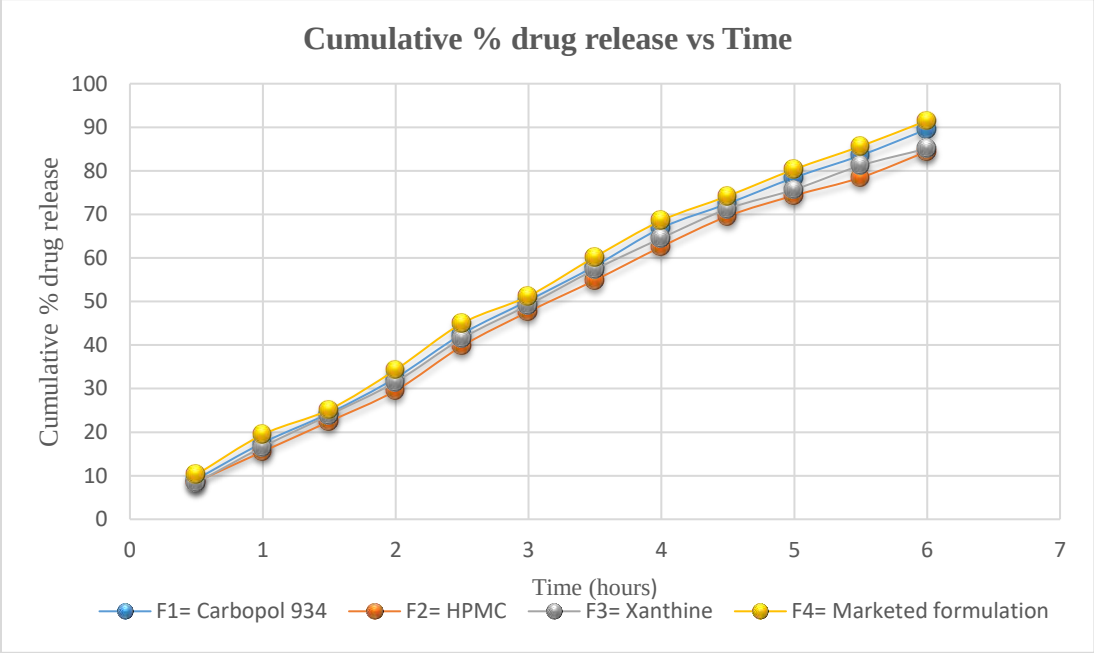

Figure 2: Cumulative% drug release of emulgel formulations

DISCUSSION

The future of pharmaceutical products will be rushing up with topical delivery products because of drawbacks in oral, parenteral and other routes and more patient compliance. Loading of hydrophobic drug in hydrophilic gel matrix was found easy by dual drug delivery system of emulgel. Emulgel possess an excellent bio adhesion, viscosity and long-term stability which will increase compliance. In this study emulgel were prepared by using different gel forming polymers i.e. Carbopol 940, HPMC, xanthine. The in vitro drug release studies reinforced that carbopol 940 was the best polymer to formulate emulgel with 89.56% of drug release than HPMC as 84.45% and xanthine as 85.12% when compared with marketed formulation (Voveran emulgel) as 91.55±0.35%. Diclofenac potassium emulgel formulated with carbopol 940 can be used as anti-inflammatory and analgesic for topical delivery.

CONCLUSION

Diclofenac potassium emulgel was successfully prepared and evaluated. The formulation containing carbopol 940 were found to exhibit better drug release profile than formulations contains HPMC and xanthine when compared with the release of marketed formulation. Emulgel enhances the topical delivery of the poorly soluble drugs like diclofenac potassium.

ACKNOWLEDGEMENT

This work is part of second year M. Pharmacy (Pharmaceutics) project of first author. The authors gratefully acknowledge the Supervisor Prof. (Dr.) Mona Piplani, Ms. Rishu Yadav, Mr. Pankaj Bhateja, Hon'ble Vice Chancellor Prof (Dr.) R.K. Gupta and special gratitude to project incharge Mr. Suresh Gupta. Author also wants to thanks School of Pharmacy and Maharaja Agrasen University, Baddi for providing an ambient environment for the successful completion of the project.

REFERENCE

1. Khullar R, Saini S, Seth N, Rana AC. Emulgels: a surrogate approach for topically used hydrophobic drugs. Int J Pharm Bio Sci. 2011 Jul;1(3):117-28.
2. Singla V, Saini S, Joshi B, Rana AC. Emulgel: A new platform for topical drug delivery.

International Journal of Pharma and Bio Sciences. 2012;3(1):485-98.
3. Jain A, Gautam SP, Gupta Y, Khambete H, Jain S. Development and characterization of ketoconazole emulgel for topical drug delivery. Der Chemica Sinica. 2010.
4. Yadav SK, Mishra MK, Tiwari A, Shukla A. Emulgel: a new approach for enhanced topical drug delivery. Int J Curr Pharm Res. 2016;9(1):15-9.
5. Mahaparale SP, Ahire SM, Akotkhane M, Pansare A, Shingare S, Tagad R. Emulgel: A Novel Approach for Topical Drug Delivery System. Lampyrid: The Journal of Bioluminescent Beetle Research. 2023 May 11;13:625-37.
6. Yadav R, Pandey NK, Kukkar R, Dutta D, Avasthi P, Rana M, Modgil S. Emulgel A Reliable System for Topical Delivery of Lipophilic Drugs in Present Scenario. Research Journal of Pharmacy and Technology. 2022;15(6):2845-8.
7. Yadav R, Pandey NK, Kukkar R, Dutta D, Avasthi P, Rana M, Modgil S. Emulgel A Reliable System for Topical Delivery of Lipophilic Drugs in Present Scenario. Research Journal of Pharmacy and Technology. 2022;15(6):2845-8.
8. Panwar A, Upadhyay N, Bairagi M, Gujar S, Darwhekar G, Jain D. Emulgel: A review. Asian J Pharm Life Sci. 2011;2231:4423.
9. Suman D, Beena K. Emugel for topical drug delivery: A novel approach. GSC Biological and Pharmaceutical Sciences. 2020;11(3):104-14.
10. Yadav SK, Mishra MK, Tiwari A, Shukla A. Emulgel: a new approach for enhanced topical drug delivery. Int J Curr Pharm Res. 2016;9(1):15-9.
11. Alexander A, Khichariya A, Gupta S, Patel RJ, Giri TK, Tripathi DK. Recent expansions in an emergent novel drug delivery technology: Emulgel. Journal of Controlled Release. 2013 Oct 28;171(2):122-32.
12. Panwar A, Upadhyay N, Bairagi M, Gujar S, Darwhekar G, Jain D. Emulgel: A review. Asian J Pharm Life Sci. 2011;2231:4423.
13. Stam-Posthuma JJ, Vink J, Le Cessie S, Bruijn JA, Bergman W, Pavel S. Effect of topical tretinoin under occlusion on atypical naevi. Melanoma Research. 1998 Dec 1;8(6):539-48.
14. Khullar R, Kumar D, Seth N, Saini S. Formulation and evaluation of mefenamic acid emulgel for topical delivery. Saudi pharmaceutical journal. 2012 Jan 1;20(1):63-7.
15. Pragya V, Shikha A. LULICONAZOLE EMULGEL: CHARACTERIZATION, PREPARATION, AND EVALUATION.
16. Verma S, Singh AK, Mukerjee A. Formulation and evaluation of ketoconazole nanoemulgel. World journal of pharmacy and pharmaceutical sciences. 2016;5(2):89

HOW TO CITE: Sharma Kriti, Yadav Rishu, Bhateja Pankaj, Devi Anjana, Piplani Mona , Comparative Study Of Different Polymer Based Emulgel , Int. J. of Pharm. Sci., 2024, Vol 2, Issue 3, 129-136. https://doi.org/10.5281/zenodo.10781299