ejpmr, 2022,9(6), 153-159

SJIF Impact Factor 6.222

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Review Article

ISSN 2394-3211

EJPMR

EMULGEL-TOPICAL DRUG DELIVERY SYSTEM- REVIEW

P. Geethika, P. Madhuri, P. Revathi, Nafiroona and *Jyothi V.

Department of Pharmacognosy, Sarojini Naidu Vanita Pharmacy Maha Vidyalaya, Vijayapuri Colony, Tarnaka, Secunderabad. Telangana State-500017.

***Corresponding Author: Jyothi V.**
Department of Pharmacognosy, Sarojini Naidu Vanita Pharmacy Maha Vidyalaya, Vijayapuri Colony, Tarnaka, Secunderabad. Telangana State-500017.

Article Received on 05/04/2022 **Article Revised on 26/04/2022** **Article Accepted on 16/05/2022**

ABSTRACT

Topical drug delivery system can be defined as the application of the formulation onto the skin directly to elicit its pharmacological actions to treat skin diseases. The Major disadvantage of gel is the delivery of hydrophobic drugs, this can be overcome by the novel technique Emulgel. It is a combination of gel and emulsion that forms a dosage form referred to as Emulgel. Emulgel is one of the recent technologies in Novel Drug Delivery System and it also have characteristics of both drug delivery systems i.e., both emulsion as well as gel. The Emulgel is utilized in treating skin infections like fungal infections, acne, psoriasis. The union of hydrophilic cornified cells in lipophilic intercellular material provides a barrier to both hydrophilic and lipophilic layers. Polymers have been used in the manufacturing of emulgel which functions as emulsifiers and thickeners. These Emulgels are having major advantage on Novel Vesicular systems as well as Conventional systems. The use of Emulgels can be extended in Analgesics and Antifungal drugs.

KEYWORDS: Emulgel, Topical, Emulsion, Gel.

INTRODUCTION

Topical drug delivery refers to delivery of drug containing formulation anywhere in the body through skin. Topical drug delivery system can define as system in which API containing formulation is directly applied to skin to treat local cutaneous manifestations.[1] When other routes of administration like parenteral, sublingual and rectal fails or mainly to treat local skin infections like Tinea capitis, Tinea pedis (fungal infections).

Topical drug delivery system can be used for both local and also systemic infection treatment. One of the major advantages of topical drug delivery system is to avoid pre-systemic metabolism, and also other advantage of topical drug delivery is avoidance of patient inconvenience and risk by intravenous therapy and different conditions of absorption like presence of enzymes, change in PH.[3-5] Topical medicinal products are diverse in their formulation which are directly applied to the skin and available in liquid to powder consistency, but semisolid preparation is most popular among those formulations. When compare to creams and ointments gels provide faster drug release but major limitation is unable to deliver hydrophobic drugs. So, to overcome this limitation emulgel is formulated.[6]

PHISIOLOGY OF SKIN[7-8]

Most of the topical formulations are meant to be applied to the skin. The skin covers a surface area approximately $2m^{[2]}$ and with one-third of blood circulating through the body. Skin contains on average of 40-70 follicles and 200-300 sweat ducts on centimetre square. The skin pH can be from 4 to 5.6. The Skin consists of 4 layers of tissue.

i. Non-viable Epidermis: it is named as Stratum Corneum and is the outermost layer of skin. It is 10-20 cell layer thick over most of the body. Each cell is a flat, plate-like structure-34-44 µm long, 25-36 µm wide, 0.5 to 0.20 µm thick with a surface area of 750 to 1200µm stocked up to each other in brick-like fashion. It consists of lipids and protein.
ii. Viable Epidermis: This layer is located in between the stratum corneum and the dermis, with thickness ranging from 50-100µm.the structure of cells in this layer is similar to other living tissues.
iii. Dermis: It is a structural fibrin and very few cells like this can be found histological in normal tissue. Thickness ranges from 2000 to 3000µm. It consists of a matrix of a loose connective tissue composed of fibrous protein embedded in an amphorphose ground substance.
iv. Subcutaneous Connective Tissue: It is not actually considered as a true part of the connective tissue. It is composed of loose textured, white, fibrous connective tissue containing blood and lymph vessels, secretary pores of the sweat gland and cutaneous nerves. It is the layer where the drug permeates through skin and enters circulatory system before reaching hypodermis.

DRUG DELIVERY ACROSS THE SKIN[9-11]

There are two vital layers named the epidermis and the dermis in the skin. Blood vessels are distributed below the sub-cutaneous layer of the skin profusely. There are three primary mechanisms for drug absorption through the skin which includes intercellular, trans cellular and follicular. The keratinized corneocytes and the largely non-polar lipids are the major factors involved in the maintenance of efficient barrier for drugs. The most common route of delivery is through pilosebaceous route, in this penetration occurs through intercellular matrix, but through the transcellular pathway, this is proven to provide fastest route for highly polar molecules. The drug penetration for skin can be enhanced by using organic solvents such as propylene glycol, surfactants and DMSO. The permeation enhancers in the formulation alters the barrier characteristics of the stratum corneum. It is observed by the mechanisms which includes enhancing solubility, splitting the stratum corneum, fluidising the crystalline structure of the stratum corneum. Creams and gels that are applied on the skin have been used for years for effective treatment against infections and pain by medication. New technologies have been developed which allows other drugs to be absorbed through the skin. These can be used to treat not just the affected areas of the skin but the whole body by systemic route.

CLASSIFICATION OF TOPICAL DRUG DOSAGE FORMS[12]

LIQUID FORMS	SOLID FORMS	SEMISOLID FORMS
Syrup	Tablets	Emulgel
Solution	Capsules	Creams
Emulsion	Powder	Gels
Suspension	Dusting Powder	Suppositories

EMULSION

Emulsion is defined as thermodynamically unstable system consisting of at least two immiscible liquid phases, one of which is dispersed as globules in the other liquid phase. The emulsion is stabilized with the help of emulsifying agent.

Two or more normally incompatible liquids are combined to formulate emulsion. In this system oil phase is made to miscible with the aqueous phase by using an emulsifying agent. Both water-in-oil and oil-in-water type of emulsion are used as vehicle to deliver different types of drugs.

Number of factors that could affect emulsification process are temperature, nature of the oil, type of emulsifier and also concentration of emulsifier.

TYPES OF EMULGEL

•Macroemulsion: It is a formulation with emulsion droplet particle sizes greater than 400nm. They are not visible to the naked eye, but can be observed under a microscope. It is thermodynamically not stable.

•Microemulsion: It is a formulation with emulsion droplet particle size differs from 10 to 100nm and don't coalesce.

•Nano emulsion: These are transparent(translucent) oil-water dispersions which are thermodynamically stable because of the usage of surfactant and co-surfactant with the size varies from 1nm to 100nm. Nano emulsion have increased dermal and transdermal characteristics in vivo as well as in vitro.

GEL

Gels are semisolid, homogeneous preparations usually consisting of solutions or dispersions of one or more medicaments in a suitable hydrophilic or hydrophobic bases.

The gel word refers to increase the viscosity of liquid formulation without interfering with the other properties of the formulation. Gels are used to enhance the consistency and homogeneity of the formulation. These can also be used as thickening agent.

Gels are made up of organic or inorganic polymers of natural or synthetic origin by entrapment of liquids such as aqueous or hydroalcoholic into colloidal solid particles of the polymers. Due to high aqueous content, it allows greater drug dissolution and also it permits easy drug migration compare to other conventional dosage forms such as creams and ointments.

EMULGEL

Emulgel is o/w or w/o emulsion carrying drug to be incorporated into gel base to obtain jellified emulsion.

Emulgel is known as an emulsion that has been gelled by gelling agent. Emulgel is a combination of emulsion and gel. To overcome the limitation of gel i.e., unable to delivery hydrophobic drugs, an emulsion-based solution is used.

Emulgel has an ability to deliver both hydrophilic and lipophilic drugs due to the presence of both aqueous and non-aqueous phases. These are biphasic systems that have better loading capacity and better stability. In emulgel formulation, the emulsion acts as controlled release drug delivery system in which the drug dispersed in internal phase (act as reservoir of drug) pass through continuous phase to the skin and get absorbed slowly and gel act as controlled drug release system as the cross-linked network entrapped the small particles of the drug. Emulgel has several good properties, such as good spread ability, thixotropic, pleasant appearance, odourless, greaseless and long shelf-life over the conventional topical formulation.

IDEAL PROPERTIES

- Very pleasing appearance.
- It can be easily spreadable and removable formulation.
- Act as emollient.

- It has long shelf-life.
- Non-staining and biofriendly.
- Being greaseless.

ADVANTAGES

- Pre-systemic metabolism is avoided.
- Controlled or prolong release of drugs having short half-life.
- Improved stability and local loading capacity.
- Easy for production and a low-cost mechanism.
- Avoid gastrointestinal incompatibility.
- Site specific target drug delivery on the body.
- Self- medication is possible.
- Improve patient convenience.

DIS-ADVANTAGES

- There may be possibility of bubble occurrence during emulgel formulation.
- Possibility of skin irritation in patients with contact dermatitis.
- Absorption of large size drug particles through skin is not easy.
- some drugs have low permeability through the skin.

RATIONALE

The formulations which are applied to the topical cutaneous layer of the skin or mucous membrane for therapeutic action or to restore the function of the skin is called as topical medication.

Conventional topical drug delivery systems like creams and ointments have disadvantages such as greasy and sticky when applied to the skin which causes discomfort and uneasiness to the patients and also, they need to apply by rubbing due to less spreading coefficient. Due to these disadvantages in pharmaceutical and cosmetic preparation the use of gels has increased widely. However, in spite of numerous advantages, the major limitation is poor vehicle for hydrophobic drug delivery, these can be overcome by emulgel formulation. The emulgel formulation as ability to incorporate hydrophobic drug particles into oil phase which are dispersed into continuous aqueous phase leads to formulation of o/w emulsion. Then this emulsion is jellified with gel base results in emulgel formation with enhanced drug stability and also a controlled release of the drug.

CONSTITUENTS OF EMULGEL

• Vehicles

In the emulgel preparation, both lipophilic and hydrophilic drugs can be delivered by using aqueous and oil phase.

• Properties of vehicle:

Even distribution of drug on the skin with efficient deposition of drug on the skin.

Controlled release of the drug and deliver of the drug to specific target site.

At target tissue, sustain the therapeutic drug level for specific period to show pharmacological action.

Depending on the vehicle characteristics the rate and extend of drug absorption varies and it also depends on characteristics of active agent.

• **Aqueous material:** These are used to formulate the aqueous phase of the emulsion. Commonly used agents are water and alcohol as aqueous phase in emulgel.

• **Oils:** These agents form the oily phase in the emulsion. For externally applied emulsions, example: mineral oils, either alone or combined with soft or hard paraffin, are widely used as the vehicle for the drug and for their sensory and occlusive characteristics. The commonly used oils in oral preparations are non-biodegradable mineral and castor oils that provide a local laxative action, and fish liver oils or various fixed oils of vegetable origin (example; cottonseed, maize and Arachis oils) as nutritional supplements.[12-13]

CHEMICAL	QUANTITY	DOSAGE FORM
Light Liquid Paraffin	7.5%	Emulgel and Emulsion
Isopropylmyristate	7 – 7.5%	Emulgel
Isopropyl Stearate	7 – 7.5%	Emulgel
Isopropyl Palmitate	7 – 7.5%	Emulgel
Propylene Glycol	3 – 5%	Emulgel

• Emulsifiers

To improve stability during the shelf-life and to increase the emulsification of the preparation, emulsifying agents are used. Emulsifiers are selected based in the HLB value and according to formulation characteristics. In w/o type of emulsion formulation mineral oil having HLB value less than 8 are used whereas in o/w emulsion formulation non-ionic surfactant with HLB value greater than 8 are used (Examples of emulsifying agents are Tween 80, Span80, Tween 20).

• Gelling agent

Gelling agents are used for preparing gels for any dosage form. It enhances the consistency of any formulation and also can be used as thickening agent. They are two types natural and synthetic gelling agents. Some examples of gelling agents are Carbopol 940, Carbopol 934, HPMC k 100 etc.[15-16]

GELLING AGENT	QUALITY	DOSAGE FORM
Cabapol-934	0.5 – 2%	Emulgel
Carbapol-940	0.5 – 2%	Emulgel
HPMC-2910	2.5%	Emulgel
HPMC	3.5%	Gel
Sodium CMC	1%	Gel

• Permeation enhancers

These are agents that partition into and interact with skin constituents to induce a temporary and reversible

increase in skin permeability and increase drug delivery into the skin.
Ex: methanol, oleic acid, clove oil, cinnamon.

• Properties of penetration enhancers

i. They should be non-allergic, non-irritating and non-toxic.
ii. They should work rapidly; the activity and duration of the effect should be reproducible and predictable.
iii. They should have no pharmacological activity within the body i.e., should not bind to receptor sites.
iv. The penetration enhancers should work unidirectional i.e., should allow therapeutic agents into the body whilst preventing the loss of endogenous material from the body.
v. The penetration enhancers should be appropriate for formulation into diverse topical preparations, thus should be compatible with both excipients and drugs.

MECHANISM OF PENETRATIONS ENHANCERS[44]

They can act by one or more main mechanisms:

- Disruption of the highly ordered structure of stratum corneum lipid.
- Interaction with intercellular protein.
- Improved partition of the drug, co-enhancer or solvent into the stratum corneum.

Permeation Enhancers[17]

PERMEATION ENHANCER	QUALITY	DOSAGE FORM
Oleic Acid	1%	Gel
Lecithin	5%	Gel
Urea	10%	Gel
Isopropyl Myristate	5%	Gel
Linoleic Acid	5%	Gel
Clove Oil	8%	Emulgel
Menthol	5%	Emulgel
Cinnamon	8%	Emulgel

• pH Adjusting Agent

These are the agents which are used to adjust and maintain the pH of the formulation.
Example: triethylamine, NaOH, etc.

PREPARATION OF EMULSION

Phase Inversion Method

Phase inversion method is a method in which W/O type of emulsion is formed by addition of aqueous phase to oil phase. When water is added to the already existing emulsion, inversion of emulsion occurs which yields O/W type of emulsion.

Wet Gum Method

Wet gum method is a method in which acacia is used as a gum [emulsifying agent]and oil is added to the gum drop by drop with continuous stirring.

The constituents added are same as that of the dry gum method where only the preparation method differs.

Continental and Dry Gum Method

Dry gum method is a method in which acacia is used as emulsifying agent, to this four times oil is added and triturated in mortar and pestle, to this mucilage water is added and triturated again until cracking sound is heard, thus the primary emulsion is formed.

Membrane Emulsification Method

Membrane emulsification method is a method in which drop by drop novel method is used to produce an emulsion. dispersed phase penetrates through porous membrane to the continuous phase when direct pressure is applied the droplets formed are separated from membrane due to shear motion between the continuous phase and the membrane.

METHOD OF PREPARATION[41,42,43]

Steps to prepare the emulgel.

STEP 1: Formulation of gel base.
STEP2: Formulation of Emulsion.
STEP 3: Incorporation of emulsion into gel base with continuous stirring.

1. Formulation of gel base

Gel was prepared by dissolving Carbopol powder in purified water in speed stirrer (50 rpm), and then the pH was adjusted to 6 – 6.5 using Triethanolamine. The methyl cellulose gel was prepared by dispersing methyl cellulose powder in heated purified water (80 °C), and the dispersion was cooled to room temperature and left overnight to ensure hydration of the gel.

Step 2: Formulation of emulsion

The aqueous phase was prepared by adding the required amount of tween 20 in purified water and the oil phase was prepared by adding certain amount of span 20 in liquid paraffin. The weighed quantity of drug was dissolved in suitable solvent. Methyl paraben and propyl paraben of required amounts were dissolved in propylene glycol and then both were mixed with aqueous phase. The oily and aqueous phases heated to 70-80° C separately. Then, the oil phase was added to the aqueous phase with continuous stirring at 50 rpm until cooled to room temperature.

Step 3: Formulation of emulgel

Mix the prepared emulsion into gel base of ratio 1:1 dropwise with continuous stirring until the homogenous emulgel is formed.

EVALUATION OF CURCUMIN EMULGEL[34-40]

1. Physical examination

The prepared formulation is visually examined for observations of physical properties like colour, consistency, phase separation, Uniformity and homogeneity.[1,2]

2. pH determination:
The digital pH meter is used for measuring the pH value of Emulgel formulation. Before use, pH meter should be calibrated with standard buffer solutions having pH 4-7. The pH measurements of each system were replicated three times for accurate results.

3. Spread ability
Spread ability is determined by apparatus suggested by Mutimer etal. spread ability is measured on the basis of "Slip" and "Drag" method. An excess of emulgel (about 2 g) under study is placed on the ground slide. The emulgel is then sandwiched between this slide and another glass slide having the dimension of the fixed. A 20gm weight is placed on the top of the two slides for 5 min to expel air and to provide a uniform film of the emulgel between the slides. Excess of the emulgel from the edges is scrapped off. A shorter time to reach standard distance show a better Spread ability.

4. Swelling index
Swelling index of the Emulgel formulation was determined by using porous aluminium foil. 1 gm of emulgel is placed on porous aluminium foil and then kept in a 50 ml beaker containing 10 ml 0.1 N NaOH. The samples were taken from the beakers at different time intervals and put it on dry place for some time, after it is reweighed.
Swelling index was calculated by following formula
(SW) % = [(Wt. – Wo) / Wo] × 100
Where, (SW) %=equilibrium swelling percent
Wo= emulgel weight at zero time
Wt.= weight of swollen Emulgel

5. Globule size and its determination
The globule size of the formulated emulgel is determined by using microscope, where the stage micrometre is calibrated using eye piece micrometre, little amount of prepared emulgel is taken and diluted using the amaranth dye or Sudan 3 dye, viewed under the microscope for globule size.
It can also be determined by using Malvern zeta sizer.

6. In vitro drug release study
Emulgel in vitro study were carried out on Franz diffusion cell using egg membrane, The egg membrane was clamped on to the hollow glass tube, having 2 chambers i.e., receptor chamber and donor chamber. Emulgel was applied onto the surface of egg membrane. The receptor chamber was filled with freshly prepared buffer (pH 7.4) solution to solubilize the drug. The samples (1 ml aliquots) were collected at suitable time interval and were analysed for drug content using ultraviolet (UV)-visible spectrophotometer after appropriate dilutions, Cumulative corrections are made to obtain the total amount of drug released at each time interval, using standard calibration curve.

7. Microbiological **assay**
Ditch plate method is used. It is a technique used to evaluate the bacteriostatic or fungistatic activity of a compound. It is mainly applied for semisolid formulations. Previously prepared agar dried plates are used. the emulgel formulations are placed in a ditch cut in the plate. Freshly prepared culture loops are used for the streaking across the agar, from the ditch to the edge of the plate. After incubation for 18–24 h at 25°C, the fungal growth is observed, and the percentage of inhibition is measured as follows.
% inhibition = L2/L1 × 100,
Where, L1 = Total length of the streaked culture, and L2 = Length of inhibition

8. Drug content determination
Drug concentration in gellified Emulsion was examined by using spectrophotometer, by dissolving known quantity of emulgel in a solvent (methanol) by Sonication. Absorbance was determined after suitable dilutions in UV/Visible spectrophotometer.

REFERENCES

1. Das S K, Khanum A, Ghosh A. Microemulsion based gel Technique- A Novel Approach for Sustained Delivery to Treat Fungal Infection. Indo American Journal of Pharmaceutical Research, 2019; 8(2): 1958.
2. Meenakshi D. Emulgel: a novel approach to topical drug delivery. Int J Pharm Bio Sci, 2013; 4(1): 847-856.
3. 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): 15-19.
4. Sharma S. Topical preparations are used for the localized effects at the site of their application by virtue of drug penetration into the underlying layers of skin or mucous membranes. Pharmaceutical reviews, 2008; 6: 1.
5. Laithy HM. and El shaboury KMF. The development of Cutina Lipogels and gel microemulsion for topical administration of fluconazole. Ame Pharm Sci. Pharm Sci Tech, 2003; 3:10 25.
6. Rieger MM, Lachman L, Lieberman HA, Kanig JL. The Theory and Practice of Industrial Pharmacy. 3rd ed., PA Lea and Febiger, Philadelphia, 1986; 502-533.
7. Tortora GJ, Derrickson B. Principles of anatomy and physiology. 11th 11. Ranade VV, Hollinger MA. Drug delivery system. 2 ed. John Wiley and Sons, 2007; 144-70.
8. Ranade VV, Hollinger MA. Drug delivery system. 2nd ed. CRC Press, 2010; 207-27.
9. Elias PM, Menon GK. Structural and lipid biochemical correlates of the epidermal permeability barrier. Adv Lipid Res, 1991; 24: 1-26.
10. Butler H. Poucher's perfumes cosmetics and soaps. 10th ed. Springer, India, 2010; 402.

11. Bruton L, Keith P, Blumenthal D, Buxton L. Goodman and Gillman's manual of pharmacology and therapeutics. 2nd ed. Mc Graw's Hill, 2008; 1086-94.
12. Arora R, Khan R, Ojha A, Upadhyaya K, Chopra H. Emulgel- A Novel Approach for Hydrophobic Drugs. International Journal of Pharmacy and Biological Science, 2017; 7(3): 43-45.
13. Vyas SP, Khar RK. Controlled drug delivery. 1st ed. Vallabah Prakashan, 2002; 416- 7.
14. Bonacucina G, Cespi M, Palmieri GF. Characterization and stability of emulsion gels based on acrylamide/sodium acryloyldimethyltaurate copolymer. AAPS Pharm Sci Tech, 2009; 10: 368-75.
15. Mortazavi SA, Aboofazeli R. An investigation into the effect of various penetration enhancers on percutaneous absorption of piroxicam. Iranian J Pharm Res, 2003; 2: 135-40.
16. Kumar L, Verma R. In vitro evaluation of topical gel prepared using natural polymer. Int J Drug Delivery, 2010; 2: 58-63.
17. Jacob SW, Francone CA. Structure and function of man. WB Saunders Co. Philadelphia, 1970; 55-60.
18. Pant S, Badola A, Baluni S, Pant W. A review on emulgel novel approach for topical drug delivery system. World J Pharm Pharm Sci, 2015; 4: 1728-43.
19. Sonaje S, Gondkar S, Saudagar R. Gellified emulsion: A new born formulation for topical delivery of hydrophobic drugs. World J Pharm Pharm Sci, 2013; 3: 233-51.
20. Dadwal M. Emulgel: A novel approach to topical drug delivery. Int J Pharm Sci, 2013; 4: 847-56.
21. Aher SD, Banerjee SK, Gadhave MV, Gaikawad DD. Emulgel: A new dosage form for topical drug delivery. Int J Inst Pharm Life Sci, 2013; 3: 1-10.
22. Ajazuddin A, Alexander A, Khichariya A, Gupta S, Patel RJ. Recent expansion in an emergent novel drug delivery technology: Emulgel. J Controlled Release, 2013; 171: 122-32.
23. Pant S, Badola A, Baluni S, Pant W. A review on emulgel novel approach for topical drug delivery system. World J Pharm Pharm Sci, 2015; 4: 1728-43.
24. . Yadav S, Mishra M, Tiwari A, Shukla A. Emulgel: A novel approach for enhanced topical drug delivery. Int J Curr Pharm Res, 2017; 9: 15-9.
25. Sathe S, Bagade M, Nandgude T, Kore K, Shete R. Formulation and evaluation of thermo reversible in-situ nasal gel of terbutaline sulphate. Indo Am J Pharm Res, 2015; 5: 3680-7.
26. Nandgude T, Thube R, Jaiswal N, Deshmukh P, Chatap V, Hire N. Formulation and evaluation of pH induced in-situ nasal gel of salbutamol sulphate. Int J Pharm Sci Nanotechnol, 2008; 1: 177-82.
27. . Taufik BN, Adhav AJ, Payghan SA. Composition of terbinafine HCL polymeric gel for mucosal drug delivery. Int J Biol Pharm Allied Sci, 2016; 5: 2146-68.
28. Jadhav CM, Kate V, Payghan SA. Formulation and evaluation of antifungal non-aqueous microemulsion for topical drug delivery of griseofulvin. Inventi Impact Pharm Tech, 2015; 1: 38-50.
29. Singla V, Saini S, Joshi B, Rana AC. Emulgel: A new platform for topical drug delivery. Int J Pharm Sci, 2012; 3: 485-98.
30. Yehia K, Abeer K. Preparation and evaluation of physical and rheological properties of clotrimazole emulgel. Int J Pharm Sci, 2011; 20: 19-27.
31. Khunt D, Mishra A, Shah D. Formulation design and development of piroxicam emulgel Int J Pharm Res, 2012; 4: 1332-1344.
32. Khullar R, Kumar D, Seth N, Saini S. Formulation and evaluation of mefenamic acid emulgel for topical delivery. Sci Pharm J, 2012; 20: 63-67.
33. Joshi B, Singh G, Rana A, Saini S. Development and characterization of clarithromycin emulgel for topical delivery. Int J Drug Dev Res, 2012; 4: 310-23.
34. Ranga P, Sellakumar V, Natranjan R, Mohan K. Formulation and in vitro evaluation ociprofloxacin loaded topical Emulgel. Int J Pharm Clin Sci, 2012; 1: 232-7.
35. Chavda VP, Patel J, Parmar K, Nakum S, Chavda JR. Preparation and evaluation of methyl salicylate Counter-irritant Emulgel of Mefenamic Acid. Int J Pharm medicinal Res, 2013; (1): 27-32
36. Kaushal R, Basarkar G. Formulation development and in vitro evaluation of and hydrochloride emulgel for topical fungal infection. Int J Pharm Sci, 2013; 21: 168-73.
37. Marwaha T, Bhise K. Formulation design and evaluation of anti-psoriatic emulgel. J Pharm Sci Innov, 2013; 2: 30-42.
38. Guideline IHT. Stability testing of new drug substances and products. Q1A (R2), current step, 2003; 4: 1-24.
39. Singh J, Gupta S, Kaur H. Prediction of in vitro drug release mechanisms from extended release matrix tablets using SSR/R2 technique. Trends Appl Sci Res, 2011; 6(4): 400-409.
40. Khambete H, Deveda P, Jain A, Vyas N, Jain S,. Gellified emulsion for sustain delivery of Itraconazole for topical fungal diseases. Int J Pharm Sci, 2010; 2: 104-12.
41. A COMPREHENSIVE REVIEW ON EMULGEL: A NEW APPROACH FOR ENHANCED TOPICAL DRUG DELIVERY Rani J. Rode*, Gouri R. Dixit, Kanchan P. Upadhye, Suparna S. Bakhle and Rohit T. Durge.
42. Emulgel: A Comprehensive Review for Topical Delivery of Hydrophobic Drugs Anil R. Phad , Nandgude Tanaji Dilip, R. Sundara Ganapathy.
43. Emulgel-Novel Trend in Topical Drug Delivery System - Review Article,Satya Lakshmi S, Divya R*, Srinivasa Rao Y, Kamala Kumari PV, Deepthi K.
44. http://dx.doi.org/10.24327/ijrsr.2020.1104.5247 (EMULGEL : A COMPREHENSIVE REVIEW

FOR NOVEL TOPICAL DRUG DELIVERY SYSTEM Vijayanta Dhawas, Disha Dhabarde and Shaktipal Patil)

45. http://dx.doi.org/10.22159/ijcpr.2017v9i1.16628 (EMULGEL: A NEW APPROACH FOR ENHANCED TOPICAL DRUG DELIVERY SUNIL KUMAR YADAV*, MANOJ KUMAR MISHRA, ANUPAMAA TIWARI, ASHUTOSH SHUKLA)
46. http://dx.doi.org/10.13005/bbra/2931 (Emulgel Approach to Formulation Development: A Review Brijesh Mahesh Patel, Ashwin Bhanudas Kuchekar and Saish Rajendra Pawar).