ISSN : 2320 4850

BI MONTHLY

AJPRD

Asian Journal of Pharmaceutical Research And Development

(An International Peer Reviewed Journal of Pharmaceutical Research and Development)

Volume - 02 Issue - 02 MAR-APR 2014

website: www.ajprd.com
editor@ajprd.com

Asian Journal of Pharmaceutical Research and Development
(An International Peer-Reviewed Journal of Pharmaceutical Research and Development)
www.ajprd.com
ISSN 2320-4850

Research Article

EMULGEL: A RECENT APPROACH FOR TOPICAL DRUG DELIVERY SYSTEM

R. P. Singh*, S. Parpani, R. Narke, R. Chavan

Sinhgad College of Pharmacy, Department of Pharmaceutics, Vadgaon (Bk), Pune – 411041, Maharashtra, India

Received: April 2014 ***Revised and Accepted: May 2014***

ABSTRACT

Topical drug delivery system can be defined as direct effects of formulation or drug containing medication to the skin to get localizing effect of drug or directly cure cutaneous disorders. Emulgels has to be used as a topical drug delivery system for hydrophobic drugs. When gels and emulsions are used in combined form the dosage forms are referred as emulgels. Emulgels have emerged as one of the most interesting topical delivery system as it has dual release control system i.e. gel and emulsion. The major objective behind this formulation is delivery of hydrophobic drugs to systemic circulation via skin. In recent years, there has been great interest in the use of novel polymers which can function as emulsifiers and thickeners because the gelling capacity of these compounds allows the formulation of stable emulsions and creams by decreasing surface and interfacial tension and at the same time increasing the viscosity of the aqueous phase. In fact, the presence of a gelling agent in the water phase converts a classical emulsion into an emulgel. Emulgels for dermatological use have several favourable properties such as being thixotropic, greaseless, easily spreadable, easily removable, and emollient, no staining, water-soluble, longer shelf life, and bio-friendly, transparent & pleasing appearance. These emulgels are having major advantages on novel vesicular systems as well as on conventional systems in various aspects. Various permeation enhancers can potentiate the effect. So emulgel formulations can be used as better topical drug delivery systems over present conventional systems available in market.

Keywords: *Topical drug delivery system, Emulgels, Hydrophobic drugs, Gelling agents, enetration enhancers.*

INTRODUCTION

Over the last decades, the treatment of illness has been accomplished by administering drug to human body via various routes namely oral, sublingual, rectal, parental etc. The topical drug delivery system is generally used where these systems of drug administration fails or in local skin infection like fungal infection. Topical drug delivery system can be defined as direct effects of formulation or drug containing medication to the skin to get localizing effect of drug or directly cure cutaneous disorders [1].

*Address for correspondence:
R. P. Singh
Sinhgad College of Pharmacy,
Department of Pharmaceutics,
Vadgaon (Bk), Pune – Maharashtra, India
E- mail: rudra.p.s007@gmail.com

Dermatological products applied to skin are diverse in formulation and range in consistency from liquid to powder but the most popular products are semisolid preparation [2]. Topical drug delivery system has several advantages such as ability to deliver drug more selectively to a specific site, avoidance of gastro-intestinal incompatibility & metabolic degradation associated with oral administration [3].

The release rates of drugs from topical preparations depend directly on the physiochemical properties of the carrier and the drug employed [4, 5]. In topical drug delivery system drug diffuses out of the delivery system, reaches to the site of action and gets absorbed by the skin [6]. Increasing the release rate of the drug from the dosage form might therefore improve percutaneous absorption [7]. Moreover topical deliveries

provide an increased bioavailability by avoiding first pass metabolism effect by liver and a consistent delivery for extended period [8, 9].

When gels and emulsions are used in combined form the dosage forms are referred as emulgel [10]. As the name suggest they are the combination of emulsion and gel. In recent years, there has been great interest in the use of novel polymers with complex functions as emulsifiers and thickeners because the gelling capacity of these compounds allows the formulation of stable emulsions and creams by decreasing surface and interfacial tension and at the same time increasing the viscosity of the aqueous phase. In fact, the presence of a gelling agent in the water phase converts a classical emulsion into an emulgel.

Both oil-in-water and water-in-oil emulsions are used as vehicles to deliver various drugs to the skin. Emulsions possess a certain degree of elegance and are easily washed off whenever desired. They also have a high ability to penetrate the skin. Emulgels for dermatological use have several favourable properties such as being thixotropic, greaseless, easily spreadable, easily removable, and emollient, no staining, water-soluble, longer shelf life, and bio-friendly, transparent & pleasing appearance.

Now emulgels have been used for treatment of various kinds of skin disorder such as those infected by viral, bacterial, and fungal species (eczema, Herpes simplex, acne) [11]. Research works on antifungal drugs incorporated to Emulgel have been carried by different scientist to judge its efficacy against fungal infection such as candidacies. Species causing candidacies are Candida albicans, Candida glabrata, Candida parapsilosis, Candida tropicalis and Candida krusei [12, 13]. Preparing Emulgels was found useful in combating fungal infection.

Scientist has been trying to develop Emulgel of various drugs to treat various kinds of skin disorder. Acne is one of the major skin disorder common among adolescents. Factors that are responsible for acne are hormones, excess sebum, dead cells, propionibacterium acne's and inflammatory response [14, 15]. Approaches should be taken to develop emulsion based, gel for treatment of such kinds of disorder. Anti-aging areas are yet to be explored researches on its cream based formulations have been done using varieties of herbal moieties such as Glycyrrhizaglabra, Curcuma longa, seeds of P. coliforlia, Cassia tora, Acacia catechu & Punicagranatum. Emulgel containing anti-inflammatory drug (Diclofenac) is used for relief of pain in muscle and joints [16, 17].

Effort to cure diseases has been leading in the discovery of various drugs, medicine and delivery systems. To get therapeutic response of drug required for treatment of disease different routes of administration are followed. Route of administration depends on type and severity of disease. For skin disorders topical route is most preferred. Use of topical agents requires an appreciation of the factors that influence percutaneous absorption [18]. Molecules can penetrate the skin by three routes:

- Through intact stratum corneum,
- Through sweat ducts, or
- Through the sebaceous follicle.

The surface of the stratum corneum presents more than 99% of the total skin surface available for percutaneous drug absorption. Passage through this outermost layer is the rate-limiting step for percutaneous absorption [19]. The major steps involved in percutaneous absorption include the establishment of a concentration gradient, which provides the driving force for drug movement across the skin; release of drug from the vehicle (partition coefficient); and drug diffusion across the layers of the skin (diffusion coefficient).

Preferable characteristics of topical drugs include low molecular mass (600 Da), adequate solubility in oil and water, and a high partition coefficient. Except for very small particles, water soluble ions and polar molecules do not penetrate intact stratum corneum. Topical formulation can be used to manipulate the barrier function of the skin, for example, topical antibiotics and antibacterial help a damaged barrier to ward off infection, sun screening agents and the horny layer protect the viable tissues from Ultraviolet radiation and emollient preparations restore pliability to a desiccated horny layer [20].

RATIONALE OF EMULGEL AS A TOPICAL DRUG DELIVERY SYSTEM

There are many medicated products are applied to the skin or mucous membrane that either enhance or restore a fundamental function of skin or pharmacologically alter an action in the underlined tissues. Such products are referred as topical or dermatological products [21]. Many widely used topical agents like ointments, creams lotions have many disadvantages. They have very sticky causing uneasiness to the patient when applied. Moreover they also have lesser spreading coefficient and need to apply with rubbing [22], and they exhibit the problem of stability also.

Due to all these factors within the major group of semisolid preparations, the use of transparent gels has expanded both in cosmetics and in pharmaceutical preparations. A gel is colloid that is typically 99% wt liquid, which is immobilized by surface tension between it and a macromolecular network of fibers built from a small amount of a gelating substance present. In spite of many advantages of gels a major limitation is in the delivery of hydrophobic drugs. So to overcome this limitation an emulsion based approach is being used so that even a hydrophobic therapeutic moiety can be successfully incorporated and delivered through gels.

ADVANTAGES OF USING EMULGELS AS A DRUG DELIVERY SYSTEM

Hydrophobic drugs can be easily incorporated into gels using emulsions

Most of the hydrophobic drugs cannot be incorporated directly into gel base because solubility act as a barrier and problem arises during the release of the drug. Emulgel helps in the incorporation of hydrophobic drugs into the oil phase and then oily globules are dispersed in aqueous phase resulting in o/w emulsion. And this emulsion can be mixed into gel base. This may be proving better stability and release of drug than simply incorporating drugs into gel base [23, 24].

Production feasibility and low preparation cost

Preparation of emulgels comprises of simpler and short steps which increases the feasibility of the production. There are no specialized instruments needed for the production of emulgels. Moreover materials used are easily available and cheaper. Hence, decreases the production cost of emulgels.

Controlled release

Emulgels can be used to prolong the effect of drugs having shorter T1/2.

Patient compliance

They are less greasy and easy to apply.

No intensive sonication

Production of vesicular molecules needs intensive sonication which may result in drug degradation and leakage. But this problem is not seen during the production of emulgels as no sonication is needed.

Better loading capacity

Other novel approaches like niosomes and liposomes are of nano size and due to vesicular structures may result in leakage and result in lesser entrapment efficiency. But gels due to vast network have comparatively better loading capacity [25].

Better stability

Other transdermal preparations are comparatively less stable than emulgels. Like powders are hygroscopic, creams shows phase inversion or breaking and ointment shows rancidity due to oily base. [26-29].

FACTORS AFFECTING TOPICAL ABSORPTION OF FORMULATIONS [30, 31]

Physiological Factors

- Skin thickness.
- Skin pH.
- Hydration of skin
- Inflammation of skin
- Lipid content.
- Blood flow
- Density of hair follicles.
- Density of sweat glands.

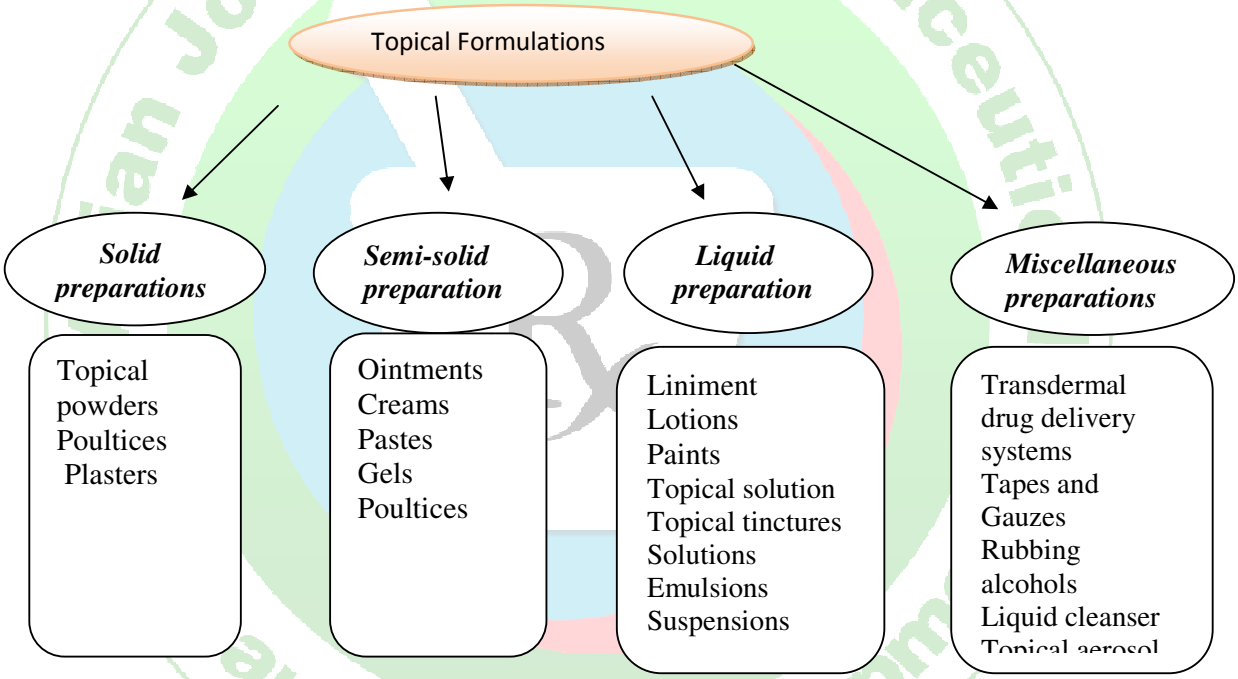
Physiochemical Factors

- Partition coefficient.
- Molecular weight (<400 Dalton).
- Degree of ionization (only unionized drugs gets absorbed well).
- Effect of vehicles

FACTORS TO BE CONSIDERED WHEN CHOOSING A TOPICAL FORMULATION [32]

- Effect of the vehicle e.g. an occlusive vehicle enhances penetration of the active ingredient and improves efficacy. The vehicle itself may have a cooling, drying, emollient, or protective action.
- Match the type of preparation with the type of lesions. For example, avoid greasy ointments for acute weepy dermatitis.
- Match the type of preparation with the site (e.g., gel or lotion for hairy areas).
- Irritation or sensitization potential, Generally, ointments and w/o creams are less irritating, while gels are irritating. Ointments do not contain preservatives or emulsifiers if allergy to these agents is a concern.
- The medication should not affect the skin type [33].

VARIOUS DOSAGE FORMS USED FOR TOPICAL DRUG DELIVERY SYSTEM [34]



Formulation of emulgels

Vehicles

The vehicle has following properties.

- Efficiently deposit the drug on the skin with even distribution.
- Release the drug so it can migrate freely to the site of action.
- Deliver the drug to the target site.
- Sustain a therapeutic drug level in the target tissue for a sufficient duration to provide a

Pharmacologic effect.

- Appropriately formulated for the anatomic site to be treated.
- Cosmetically acceptable to the patent.
- Due to the efficiency of the epidermal barrier, the amount of topical drug that gets through the stratum corneum is generally low. Rate and extent of absorption vary depending on characteristics of the vehicle but is also influenced by the active agent itself [35].

Aqueous Material

This forms the aqueous phase of emulsion. The commonly used agents are water, alcohols etc [36, 37].

Oils

For externally applied emulsions, mineral oils, either alone or combined with soft or hard paraffin, are widely used both as the vehicle

for the drug and for their occlusive and sensory characteristics [38]. Widely used oils in oral preparations are non-biodegradable mineral and castor oils that provide a local laxative effect, and fish liver oils or various fixed oils of vegetable origin (e.g., arachis, cottonseed, and maize oils) as nutritional supplements. Some are discussed in table 1.

Table I: Use of Oils

Sr. No.	Chemical	Quantity	Dosage form	References
1	Isopropyl myristate	According to phase diagrams	Emulsion	Subramanian, N. Drug Dev. Ind. harm.
2	CAPMUL	According to phase diagrams	Emulsion	Subramanian, N. Drug Dev. Ind. Pharm
3	Isopropyl Myristate	7-7.5%	Emulsion	Montenegro, L., Drug Dev. Ind. Pharm
4	Isopropyl palmitate	7-7.5%	Emulsion	Montenegro, L., Drug Dev. Ind. Pharm
5	Isopropyl stearate	7-7.5%	Emulsion	Montenegro, L., Drug Dev. Ind. Pharm
6	Light Liquid Paraffin	7.5%	Emulsion	Mohamed, M.I.,AAPS
7	Light Liquid Paraffin	7.5%	Emulsion	Jain, Ankur. IJPRD
8	Propylene glycol	3-5%	Gel	Arellano, A., European J. Pharm. Sci.

Emulsifiers

Emulsifying agents are used both to promote emulsification at the time of manufacture and to control stability during a shelf life that can vary from days for extemporaneously prepared emulsions to months or years for commercial preparations e.g. Polyethylene glycol 40 stearate, Sorbitan mono-oleate (Span 80), Polyoxyethylene sorbitan monooleate (Tween 80), Stearic acid and Sodium stearate.

Gelling Agents

These are the agents used to increase the consistency of any dosage form can also be used as thickening agent given in table 2.

Table II: Use of Different Gelling Agents

Sr. No.	GELLING AGENT	QUANTITY	DOSAGE FORM	REFERENCES
1	Carbapol-934	1%	Emulgel	Mohamed, M.I.,AAPS
2	HMPC 2910	2.5%	Emulgel	Mohamed, M.I.,AAPS
3	Carbapol-940	1%	Emulgel	Jain, Ankur. IJPRD
4	*Aegelmarmelos* Polymer(natural)	1%	Gel	Kumar, L., Int. J. Drug Del.
5	Sodium CMC	1%	Gel	Singh, S., Pak J. Pharm. Sci.
6	Xanthan Gum	1%	Gel	Singh, S., Pak J. Pharm. Sci.
7	Poloxamer 407	1%	Gel	Singh, S., Pak J. Pharm. Sci.
8	HPMC	3.5%	Gel	Gupta, A., Drug Invention Today

Penetration Enhancers

In order to promote absorption of drugs, vehicles often include penetration enhancing ingredients that temporarily disrupts the skin barrier, fluidize the lipid channels between corneocytes, alter the partitioning of the drug into skin structures, or otherwise enhance delivery into skin So called penetration enhancers some of these materials given in table 3 [39].

Table III: Use of Penetration Enhancers

Sr. No.	Permeation Enhancers	QUANTITY	DOSAGE FORM	REFERENCES
1	Oleic Acid	1%	Gel	Mortazavi, S.A., Iranian Journal of Pharmaceutical Science
2	Lecithine	5%	Gel	Mortazavi, S.A., Iranian Journal of Pharmaceutical Science
3	Isopropyl myristate	5%	Gel	Mortazavi, S.A., Iranian Journal of Pharmaceutical Science
4	Urea	10%	Gel	Mortazavi, S.A., Iranian Journal of Pharmaceutical Science
5	Eucalyptus oil	NA	None	Pathan, I.B. , Trop J Pharm Res
6	Chenopodium oil	NA	None	Pathan, I.B. , Trop J Pharm Res
7	Pyrrolidones	NA	None	Pathan, I.B. , Trop J Pharm Res
8	Laurocapran	NA	None	Pathan, I.B. , Trop J Pharm Res
9	Dimethyl sulphoxides	NA	None	Pathan, I.B. , Trop J Pharm Res
10	Linoelic Acid	5%	Gel	Kasliwal, N., AJPS
11	Menthol	4-6%	NA	Shojaei, A.H., European Jounal of Pharmaceutics

METHOD OF PREPARATION

There are various methods of formulation of Emulgel, employing different kinds of ingredient.

- Chemical enhancement
- Physical enhancement.
- Biochemical enhancement
- Super saturation enhancement.

Research work (optimization of chlorphenesin in Emulgel) includes formation of emulsion (o/w or w/o), followed by addition of gelling agent to form Emulgel. Here first step involves formation of aqueous phase of emulsion. Aqueous phase of emulsion is prepared by first dissolving tween 20 in purified water, then solution of propylene glycol is prepared by dissolving methyl paraben and propyl paraben in propylene glycol and then both the solutions are mixed and set aside. Oily phase of emulsion is prepared by dissolving span 20 in light liquid paraffin. Formation of emulsion involves separate heating of oily and aqueous phase to 70–80 °C then both the phases are mixed with constant stirring until cooled to room temperature. Gel phase of Emulgel is prepared by dispersing HPMC or Carbopol in water. HPMC is required to soak overnight in water, while Carbopol gel is prepared by simply dispersing it in purified water. When both the components both emulsions & gel get ready then the Emulgel is prepared by mixing emulsion with gel in 1:1 ratio with gentle stirring [40].

Research work based on design & characterization of Emulgel for buccal administration. Here formulation of Emulgel involves three steps (1) polymer dispersion in water, (2) neutralization of the polymeric aqueous dispersion and (3) emulsification of the oil phase. With respect to the first step, three different TR-1 percentages, namely 0.3,

0.4 and 0.5%, w/v, are required. First step involves suspension of polymer in deionized water with continuous stirring at 900 rpm for 20 min at room temperature using a mechanical stirrer equipped with a three blade helical impellers & then slurry is neutralized with NaOH solution (18%w/v) to final pH value of 5.5, 6.0 and 6.5. The neutralization process causes the distension of polymer chains resulting in clear stable gels. Now for the complete hydration of polymer gels are required to be stored at 4 0C for 24 h before the addition of oil phase. After completing the hydration of gel different quantities of oil phase at three o/w ratio (w/w) 0.5, 1.0 and 1.5 respectively are added with stirring at 800 rpm (80 °C) there after it is left for cooling and its pH is measured [41].

Research work based on different methods to develop Emulgel for clotrimazole delivery. This method involves the preparation of oily phase of emulsion by dissolving drug and span 60 in oily phase (jojoba oil) with the aid of magnetic stirrer at 75 0C with subsequent cooling followed by addition of Carbopol to the oily phase. Secondly aqueous phase is prepared by dissolving Brij-35 in propylene glycol. Third step involves addition of oily phase to the aqueous phase following their emulsification using the over head mixer for 10 min at 1400 rpm, and then introducing emulsion into the homogenizer for 5 min at 10,000 rpm. Gellification of emulsion involves addition of gelling agent triethanolamine (formulae containing Carbopol either alone or in combination) and/or HPMC to the emulsion using over head mixer at 200 rpmfor 45 min thereby adjusting the pH of formulation containing Carbopol to 5.5–6.5 using TEA [42]. The flow chart of emulgel preparation is shown in figure 1.

These are the common steps to prepare the emulgel:

STEP 1: Formulation of Emulsion either O/W or W/O

STEP 2: Formulation of gel base

STEP 3: Incorporation of emulsion into gel base with continuous stirring.

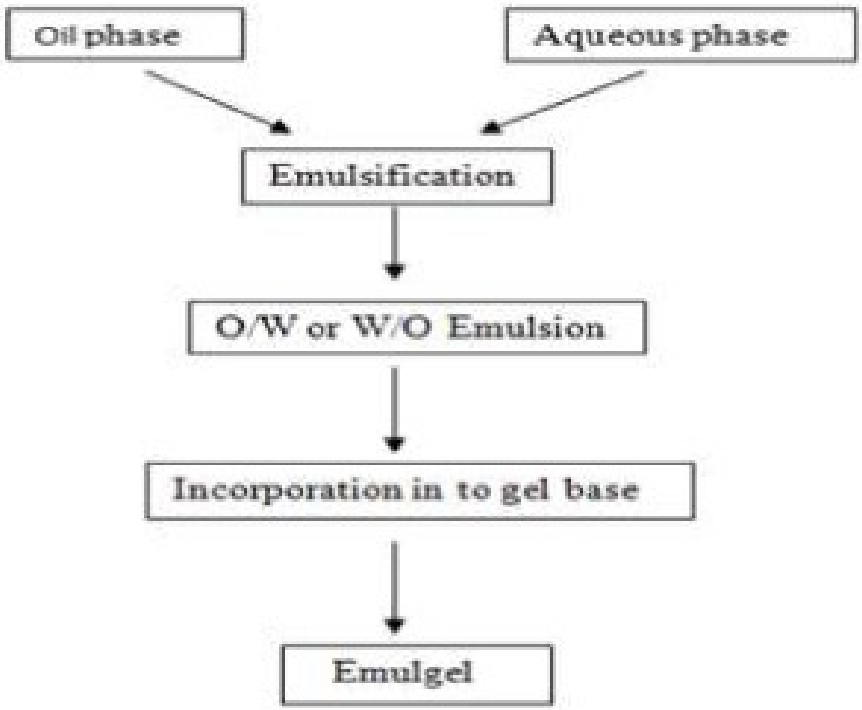


Figure 1: Common stages to prepare emulgels

CHARACTERIZATION AND EVALUATION OF EMULGELS

Physical Examination

The prepared emulgel formulations are inspected visually for their color, homogeneity, consistency and phase separation [43, 44].

Photo microscopy

Optimized batch of the emulgel was viewed under light microscope to study the globular structure in gel base. The emulgel was suitably diluted, mounted on glass slide and viewed by light microscope under magnification of 40.

Globule size

The globule size obtained was determined using Zetasizer (Malvern Instrument 3000HSA, UK). The sample was suitably diluted and the globule size was measured at 25 0C.

Rheological studies

The viscosity of the different emulgel formulations is determined at 25 0C using a cone and plate viscometer with spindle 52 (Brookfield Engineering Laboratories,) and connected to a thermostatically controlled circulating water bath [45].

Determination of pH

The pH measurements were done using a digital pH meter (Thermo scientific) which was calibrated with standard buffer solutions. The measurements of pH of each system were replicated three times [46].

Determination of viscosity

The viscosity of the prepared formulations was determined at ambient temperature using Brookfield digital viscometer (DV-II +Pro) with spindle no. 96 at 0.1, 0.5, 1 and 1.5 rpm.

Determination of thixotropic characteristics

The formulations were subjected to different rates of shear using GEMINI 200: Rheometer, at constant temperature (250C). the measuring system employed was the cone and plate system having 40 mm diameter and 40 angles. The rheogram was constructed by plotting rate of shear against shear stress.

Swelling Index

To determine the swelling index of prepared topical emulgel, 1 gm of gel is taken on porous aluminum foil and then placed separately in a 50 ml beaker containing 10 ml 0.1 N NaOH. Then samples were removed from beakers at different time intervals and put it on dry place for some time after it reweighed [47].

Swelling index is calculated as follows:

Swelling Index (SW) % = [(Wt – Wo) / Wo] × 100.

Where, (SW) % = Equilibrium percent swelling,

Wt = Weight of swollen emulgel after time t,

Wo = Original weight of emulgel at zero time.

Spreading Coefficient

Spreadibility is determined by apparatus which is suitably modified in the laboratory and used for the study. It consists of a wooden block, which is provided by a pulley at one end. By this method, spreadibility is measured on the basis of 'Slip' and 'Drag' characteristics of emulgels. A ground glass slide is fixed on this block. An excess of emulgel (about 2 gm) under study is placed on this ground slide. The emulgel is then sandwiched between this slide and another glass slide having the dimension of fixed ground slide and provided with the hook. A 1 kg 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 is scrapped off from the edges. The top plate is then subjected to pull of 80 gm. With the help of string attached to the hook and the time (in seconds) required by the top slide to cover a distance of 7.5 cm be noted. A shorter interval indicates better spread ability [48, 49].

Drug Content Determination

Take 1gm of emulgel. Mix it in suitable solvent. Filter it to obtain clear solution.

Determine its absorbance using UV spectrophotometer. Standard plot of drug is prepared in same solvent. Concentration and drug content can be determined by using the same standard plot by putting the value of absorbance [50].

Drug Content = (Concentration × Dilution Factor × Volume taken) × Conversion Factor.

Skin Irritation Test (Patch Test)

The preparation is applied on the properly shaven skin of rat and its adverse like change in color, change in skin morphology should be checked up to 24 h. The total set of 8 rats can be used of the study. If no irritation occurs the test is passed. If the skin irritation symptom occurs in more than 2 rats the study should be repeated [51].

Extrudability Study of Topical Emulgel (Tube Test)

It is a usual empirical test to measure the force required to extrude the material from tube. The method applied for determination of applied shear in the region of the rheogram corresponding to a shear rate exceeding the yield value and exhibiting consequent plug flow. In the present study, the method adopted for evaluating emulgel formulation for extrudability is based upon the quantity in percentage of emulgel and emulgel extruded from lacquered aluminum collapsible tube on application of weight in grams required to extrude at least 0.5 cm ribbon of emulgel in 10 s. More quantity extruded better is extrudability. The measurement of extrudability of each formulation is in triplicate and the average values are presented [52].

The extrudability is than calculated by using the following formula:

Extrudability = Applied weight to extrude emulgel from tube (in gm) / Area (in cm2).

Ex–Vivo Bioadhesive Strength Measurement of Topical Emulgel

(Mice Shaven Skin) The modified method is used for the measurement of bioadhesive strength. The fresh skin is cut into pieces and washed with 0.1 N NaOH. Two pieces of skin were tied to the two glass slide separately from that one glass slide is fixed on the wooden piece and other piece is tied with the balance on right hand side. The right and left pans were balanced by adding extra weight on the left – hand pan. 1 gm of topical emulgel is placed between these two slides containing hairless skin pieces, and extra weight from the left pan is removed to sandwich the two pieces of skin and some pressure is applied to remove the presence of air. The balance is kept in this position for 5 min. Weight is added slowly at 200 mg/ min to the left – hand pan until the patch detached from the skin surface. The weight (gm force) required to detach the emulgel from the skin surface gave the measure of bioadhesive strength [53].

The bioadhesive strength is calculated by using following:

Bioadhesive Strength = Weight required (in gm) / Area (cm2).

In Vitro Release/Permeation studies:

In vitro release studies were carried out using Franz diffusion cell [54].

Stability studies

The prepared emulgels were packed in aluminium collapsible tubes (5 g) and subjected to stability studies at 5°C, 25°C/ 60% RH, 30°C/65% RH, and 40°C/75% RH for a period of 3 months. Samples were withdrawn at 15-day time intervals and evaluated for physical appearance, pH, rheological properties, drug content, and drug release profiles [55, 56].

MARKETED PREPARATIONS

Some preparations of Emulgel are commercially available in markets which are listed as following in Table 4.

Table IV: Marketed Emulgel Preparations

Sr. No.	Drug	Product Name	Manufacturer
1	Miconazole nitrate, Hydrocortisone	Miconaz-H-emulgel	Medical union Pharmaceuticals
2	Diclofenac diethyl ammonium	Voltaren emulgel	Novartis Pharma
3	Metronidazole	Lupigyl gel	Lupin Pharma
4	Clindamycin, Adapalene	Excex gel	Zee laboratories
5	Benzoyl peroxide	Pernox gel	Cosme Remedies Ltd
6	Aceclofenac, Methyl salisylate,Capsaicin	Acent gel	Intra labs India Pvt Ltd
7	Kojic acid, Dipalmitate Arbutin, Octinoxate	Kojivit gel	Micro Gratia Pharma
8	Clobetasol propionate	Topinate gel	Systopic Pharma
9	Clindamycin phosphate Allantoin	Clinagel	Stiefel Pharma
10	Tezarotene	Zorotene gel	Elder Pharmaceuticals
11	Clotrimazole, Beclomethasone Dipropionate, Neomycin	Cloben gel	Indoco Remedies
12	Nadifloxacin	Nadicin cream	Psychoremedies
13	Azithromycin	Avindo gel	Cosme Pharma laboratories

FUTURE PROSPECTS

Hydrophobic behavior of drugs is one of the most common problems faced during formulation & development of any new formulation. This behavior is responsible for poor water solubility and bioavailability of drugs. Many numbers of drugs are hydrophobic in nature and its delivery to the biological system has been challenging. For topical delivery of drugs different delivery systems such as ointments, lotion, creams and pastes are applied. These topical formulations generally include large number of oleaginous bases such as petrolatum, bees wax or vegetable oils that themselves are hydrophobic in nature that do not allow the inclusion of water or aqueous phase.

It makes them an excellent emollient but retards the release of drugs and makes the product thick & greasy. Whereas gel provides aqueous environment to drug, favors its dissolution and provides quicker release of drug as compared to other topical delivery systems. Emulsion based gel provides a suitable medium for delivery of such hydrophobic drugs where such drugs can be incorporated into its oily phase and delivered to skin. All such advantages of Emulgel over other topical delivery systems make them more efficient & productive. In future these properties will be used to deliver more number of topical drugs in the form of Emulgel.

CONCLUSION

After the vast study, it can be concluded that the emulgels appear better & effective drug delivery system as compared to other topical drug delivery system. The comprehensive analysis of rheological and release properties will provide an insight into the potential usage of Emulgel formulation as drug delivery system. As the emulgel is the recent trend for topical drug delivery system. Obviously it is a very good approach for drug delivery of combination of hydrophilic and hydrophobic drugs. In future, topical drug delivery will be used extensively to impart better patient compliance. Since emulgel possesses an edge in terms of spreadibilty, adhesion, viscosity and extrusion, they will become a popular

drug delivery system. Moreover, they will become a solution for loading hydrophobic drugs in a water soluble gel bases.

REFERENCES

1. *Zignani M., Tabatabay C., Gurny R., Topical semi-solid drug delivery: kinetics and tolerance of ophthalmic hydrogels, Adv. Drug Deliv. Rev 1995; 16:51–60.*
2. *Gupta A, Mishra AK, Singh AK, Formulation and evaluation of topical gel of diclofenac sodium using different polymers, Drug Invention Today 2010; 2:250-253.*
3. *Kikwai L, Babu RJ, Prado R., In vitro and in vivo evaluation of topical formulations of spantide II, AAPS PharmSci Tech 2005; 6:E565–E572.*
4. *Foldvari M., Non-invasive administration of drugs through the skin: challenges in delivery system design, Pharm. Sci. Technol. Today 2000; 3: 417–425.*
5. *Elsayed MM, Abdallah OY, Naggar VF., Lipid vesicles for skin delivery of drugs: reviewing three decades of research. Int. J. Pharm 2007; 332:1–16.*
6. *Shokri J, Azarmi S, Fasihi Z., Effect of various penetration enhancers on percutaneous absorption of piroxicam from emulgel, Res. Pharm. Sci 2012; 7:2225–2234.*
7. *Zi P, Yang X, Kuang H., Effect of HP beta CD on solubility and transdermal delivery of capsaicin through rat skin, Int. J. Pharm 2008; 358: 151–158.*
8. *Moshfeghi AA, Peyman GA., Micro- and nanoparticulates. Adv. Drug Deliv. Rev 2005; 57: 2047–2052.*
9. *Rosen H, Abribat T., The rise and rise of drug delivery, Nat. Rev. Drug Discov 2005; 4: 381–385.*
10. *Mohamed MI, Topical Emulsion- Gel Composition Comprising Diclofenac Sodium, AAPS 2004; 6.*
11. *Raut S, Uplanchiwar V, Bhadoria S., Comparative evaluation of zidovudine loaded hydrogels and emulgels, Res. J. Pharm. Technol 2012; 5:41–45.*
12. *Ghorab D.M, Amin MM, Khowessah OM., Colon-targeted celecoxib-loaded Eudragit(R) S100-coated poly-epsilon-caprolactonemicroparticles: preparation, characterization and in vivo evaluation in rats, Drug Deliv 2011; 18: 523–535.*
13. *Mundada AS, Avari JG., Novel biomaterial for transdermal application: in vitro and in vivo characterization, Drug Deliv 2011; 18: 424–431.*
14. *Utreja P, Jain S, Tiwary AK., Localized delivery of paclitaxel using elastic liposomes: formulation development and evaluation, Drug Deliv 2011; 18: 367–376.*
15. *Thakur NK, Bharti P, Mahant S., Formulation and characterization of benzoyl peroxide gellified emulsions, Sci. Pharm 2012; 80:1045–1060.*
16. *Caddeo C, Sales OD, Valenti D., Inhibition of skin inflammation in mice by diclofenac in vesicular carriers: liposomes, ethosomes and PEVs, Int. J. Pharm 2013; 443:128–136.*
17. *Rahmani-Neishaboor E, Jallili R, Hartwell R., Topical application of a film-forming emulgel dressing that controls the release of stratifin and acetylsalicylic acid and improves/prevents hypertrophic scarring, Wound Repair Regent 2013; 21:55–65.*
18. *Stanos SP., Topical Agents for the Management of Musculoskeletal Pain, J Pain Symptom Manage, March 2007; 33.*
19. *Jain A, Deveda P, Vyas N., Development of Antifungal Emulsion Based Gel for Topical Fungal Infection(S), IJPRD 2011; 2:12.*
20. *Bruton L, Keith P, Blumenthal D, Buxton Z., Goodman & Gillman's Manual of Pharmacology and Therapeutics, Mc Graw's Hill 2008; 1086-1094.*
21. *Gupta A, Mishra AK, Singh AK., Formulation and evaluation of topical gel of diclofenac sodium using different polymers, Drug Invention Today 2010; 2:250-253.*
22. *Cecv G., Preclinical characterisation of NSAIDs in ultra deformable carriers or conventional topical gels, International journal of pharmaceutics 2008.*
23. *Panwar AS, Upadhyay N, Bairagi M., Emulgel: a review. Asian J. Pharm. Life Sci 2011; 1:2231–4423.*
24. *Sarisozen C, Vural I, Levchenko T., PEG-PE-based micelles co-loaded with paclitaxel and cyclosporine A or loaded with paclitaxel and targeted by anticancer antibody overcomes drug resistance in cancer cells, Drug Deliv 2012; 19:169–176.*
25. *Baibhav J, Gurpreet S, Rana AC., Emulgel: a comprehensive review on the recent advances in topical drug delivery, Int. Res. J. Pharm 2011; 2:66–70.*
26. *Kale AA, Torchilin VP., "Smart" drug carriers: PEGylated TATp-modified pH-sensitive liposomes, J. Liposome Res 2007; 17:197–203.*
27. *Kale AA, Torchilin VP., Enhanced transfection of tumor cells in vivo using "Smart" pH-sensitive TAT-modified pegylated liposomes, J. Drug Target 2007; 15:538–545.*
28. *Ajazuddin A, Alexander B, Amarji P., Synthesis, characterization and in vitro studies of pegylated melphalan conjugates, Drug Dev. Ind. Pharm 2013; 39:1053–1062.*
29. *Philippova OE, Khokhlov AR., 1.13—polymer gels, in: Editors-in-Chief: M. Krzysztof, M. Martin (Eds.) Polymer Science: A Comprehensive Reference. Elsevier, Amsterdam 2012; 339–366.*
30. *Kalia YN, Guy RH., Modeling transdermal drug release. Adv Drug Deliv Rev 2001; 48:159-72.*
31. *Ayub CA, Gomes ADM, Lima MVC, Topical Delivery of Fluconazole: In Vitro Skin Penetration and Permeation Using Emulsions as Dosage Forms Drug, Dev. Ind. Pharm 2007; 33:273-280.*
32. *Gaur PK, Mishra S, Purohit S., Transdermal Drug Delivery System: A Review. AJPCR 2009; 2: 14-20.*
33. *Subranayam N, Ghosal SK, Moulik SP., Enhanced in Vitro Percutaneous Absorption and In Vivo Anti Inflammatory Effect of a Selective Cyclooxygenase Inhibitor Using Micro emulsion. Drug Dev and Industrial Pharm 2005.*
34. *Djordjevic J., Michniak B., Uhrich Kathryn E, AAPS PharmSciTech 2003; 5(4):1-12.*
35. *Bonacucina G., Cespi M., Palmieri GF, Characterization and Stability of Emulsion Gels Based on Acrylamide/Sodium Acryloyldimethyl Taurate Copolymer, AAPS Pharm SciTech 2009; 10 (2).*
36. *Curr AEB, Transdermal Drug Delivery: Penetration Enhancement Techniques Heather. Drug Deliv 2005; 2:23-33.*
37. *Rutrer N., Drug absorption through the skin: a mixed blessing .Arch Dis Child 1987; 62:220-221.*
38. *Zhang XL, Zhao R, Qian W., Preparation of an emulgel for treatment of aphthous ulcer on the basis of carbomers, Chin. Pharm. J 1995; 30:417-418.*
39. *Mortazavi SA, Aboofazeli R., An Investigation into the Effect of Various Penetration Enhancers on Percutaneous Absorption of Piroxicam, Iranian Journal of Pharmaceutical Research 2010; 58-63.*
40. *Mohamed MI, Optimization of chlorphenesin emulgel formulation. AAPS J 2004; 6: e26.*

41. Perioli L, Panago C, Mazzitelli S., Rheological and functional characterization of new anti-inflammatory delivery system designed for buccal administration, Int. J. Pharm 2008; 356:19–28.
42. Shahin M, Hady SA, Hammad M., Novel jojoba oil based emulsion gel formulations for clotrimazole delivery, AAPS Pharm. Sci. Technol 2011; 12:239–247.
43. Kasliwal N, Derle D, Negi J., Effect of permeation enhancers on the release and permeation kinetics of meloxicam gel formulations through rat skin, Asian J. Pharm. Sci 2008; 3(5):193–199.
44. Jain A, Gautam SP, Gupta Y., Development and characterization of ketoconazole emulgel for topical drug delivery, Der Pharmacia Sinica 2010; 1(3): 221-231.
45. Bonacucina G, Cespi M, Palmieri GF, Characterization and stability of emulsion gels based on acrylamide/sodium acryloyldimethyl taurate copolymer, AAPS Pharm SciTech 2:10.
46. Kaur LP, Garg R., Gupta GD, Development and evaluation of topical gel of Minoxidil from different polymer bases in application of alopecia, Int J Pharm and Pharma Sci 2010; 2(3): 43-47.
47. Patel RP, Patel G., Baria A., Formulation and evaluation of transdermal patch of aceclofenac, Int. J. Drug Del 2009; 1: 41 – 51.
48. Gupta GD, Gound RS, Release rate of nimesulide from different gellants, Indian J Pharm Sci 1999; 61:229-234.
49. Gupta G.D., Gaud RS, Release rate of tenoxicam from acrypol gels, Ind. Pharm2005; 69–76.
50. Chaudhari P, Ajab A, Malpure P, Kolsure P., Development and in-vitro evaluation of thermo reversible nasal gel formulations of Rizatriptan benzoate, Indian J. Pharm. Edu. Res 2009; 43: 55-62.
51. Murty SN, Hiremath SRR, Physical and chemical enhancers in transdermal delivery of terbutaline sulphate, AAPS Pharm. Sci. Tech 2001; 2:1–5.
52. Chakole CM, Shende MA, Khadatkar SN, Formulation and development of novel combined halobetasol propionate and fusidic acid ointment, Int J Chem Tech Res 2009; 1: 103-116.
53. Choi HG, Yong CS, Sah H., Physiochemical characterization of diclofenac sodium loaded poloxamer gels as a rectal delivery system with fast absorption, Drug Dev. Ind. Pharm 2003; 29: 545–553.
54. Kakkar AP, Gupta A., Gelatin based transdermal therapeutic system, Ind. Drugs 1992; 29: 308–312.
55. Tadros TF, Future developments in cosmetic formulations. Int J Cos Sci 1992; 14 (3): 93-111.
56. ICH Harmonized Tripartite Guidelines. Stability testing of new drug substances and products. ICH Committee. Federal register 2003; 68: 6571718.