International Journal for Pharmaceutical Research Scholars (IJPRS)

V-6, I-1, 2017 ISSN No: 2277 - 7873

REVIEW ARTICLE

Emulgel: A New Platform for Dermatological Diseases

Verma Sachin[*1], Khushboo[2], Mishra Ankita[1]

[1]*Department of Pharmaceutics, Goel Institute of Pharmacy & Sciences, Lucknow, U.P., India.*

[2]*Department of Pharmaceutics, Naraina Vidya Peeth Group of Institution, Kanpur, U.P., India.*

Manuscript No: IJPRS/V6/I1/00016, Received On: 18/02/2017, Accepted On: 24/02/2017

ABSTRACT

Recently, emulgel has emerged as one of the most interesting topical preparation in the field of pharmaceutics. Gel formulation commonly offer faster drug release than conventional ointments and cream. Major limitation of gel is in the difficulty of hydrophobic drugs delivery. So in order to cover up this lacking a recent emulsion based approach is being used so that even a hydrophobic therapeutic moiety can enjoy the unique properties of gel. The use of gels and emulsion as combined dosage form result in to formation of emulgel showing dual release. With this approach the use of polymers with enhanced effect in release pattern has been emerged providing sustained and controlled release. The presence of a gelling agent in the water phase converts a classical emulsion in to an emulgel. These emulgel show major advantages on novel vesicular system as well as on conventional system in various aspects. Emulgel have several favorable properties for dermatological use such as being thixotropic, greaseless, easily spreadable, easily removable, emollient, non-staining, long shelf life, biofriendly, transparent, pleasing appearance and fragrance. So emulgel can be used as better topical drug delivery systems over present systems. The use of emulgels can be expanded in analgesic, anti-inflammatory, antifungal, anti acne drugs and various cosmetic formulations. This review article is focused on its properties, advantages, formulation considerations and its recent advances in research field.

KEYWORDS

Skin, Emulsion, Gel, Hydrophobic drugs, Topical drug delivery system, Permeation enhancers

INTRODUCTION

The emulgel has emerged as one of the useful semisolid drug system has been improved the stability of emulsion by incorporating in to a gel matrix. Many advantages of gels, a major limitation is in the delivery of hydrophobic drugs. To overcome this limitation an emulsion based approach is being used so even a hydrophobic therapeutic moiety can enjoy the property of gels. When gels and emulsion was used in combined form then the dosage formed is called as emulgel[1].

***Address for Correspondence:**
Verma Sachin
Department of Pharmaceutics,
Goel Institute of Pharmacy & Sciences,
Lucknow, U.P India.
E-Mail Id: vermasachin10892@gmail.com

Management of illness through medication has entered an era of rapid growth. Today, there are a host of drugs for combating virtually every disease or condition known to man and a variety of means by which these drugs are delivered to the human body for therapy such as tablet, capsules, aerosols, suppositories, etc., often referred to as conventional drug formulations.[2] The drugs have been applied to human body via various routes namely oral, sublingual, rectal, parentral, etc. For the treatment of illness over the last decades. The topical drug delivery system is generally used where these systems of drug administration fails or in local skin infection, like local fungal infection.[3]

The formulations are available in different forms like from solid through semisolid to liquid. Drugs are administered topically for their action at the site of application for systemic effects.[4]

Route of Drug Administration

Most drugs can be administered by a variety of routes. The choice of appropriate route in a given situation depends both on drug as well as patient related factors.

Routes can be broadly divided in to those for local action and systemic action.

Local Route

Local route can only be used for localized lesions at accessible site and for a drug whose systemic absorption from these sites is minimal or absent. These include- Topical route, deeper tissues, and Arterial supply.

Systemic Route

The drug administration through systemic routes is intended to be absorbed in to the blood stream and distributed all over, including the site of action through circulation. It includes- Oral, Sublingual/Buccal route, Rectal, Cutaneous, Inhalation, Nasal, Parentral, Vaginal route.[5]

Topical Route

Topical delivery can be defined as the application of a drug containing formulation to the skin to directly treat cutaneous disorder (e.g. acne, psoriasis) with the intent of containing the pharmacological or other effect of the drug to the surface of the skin or within. For diagnosis and treatment, skin provides direct accessibility as a target organ which becomes a unique aspect of dermatological pharmacology.[6]

Advantages of Topical Route

1) Avoidance of first pass metabolism.
2) Convenient and easy to apply.
3) Avoidance of the risks and inconveniences of intravenous therapy and of varied conditions of absorption, like pH changes, presence of enzymes, gastric emptying time.
4) Ability to easily terminate the medications, when needed.
5) Ability to deliver drug more selectively to a specific site.
6) Avoidance of gastro-intestinal incompatibility.
7) Providing utilization of drugs with short biological half-life, narrow therapeutic window.
8) Improve patient compliance.
9) Provide suitability for self-medication.[7, 8, 9]

Disadvantages of Topical Route

1) Skin irritation of contact dermatitis may occur due to drug excipients.
2) Poor permeability of some drug through the skin.
3) Possibility of allergic reactions.
4) Drug of larger particle size not easy to absorb through the skin.[10]

Skin

The skin is a large multilayered organ that in the average adult weighs about eight pounds, excluding fat. It covers a surface exceeding 20,000 cm^2 and has varied functions and properties. The skin serves as a barrier against physical and chemical attack. Some materials, such as nickel ions, mustard gas, and the oleoresin from Rhus toxicodendron, commonly known as poison ivy, can penetrate barrier, but most substances cannot. The skin act as thermostat in maintaining body temperature, shields the body from invasion by microorganism, protect against U.V. rays, and play a role in the regulation of blood pressure.

Anatomically, the skin has many histological layers, but in general, it is described in terms of three tissue layers:

The Epidermis

The Dermis

The Hypodermis

The Epidermis

The epidermis is approximately 50-150 µm thick and consists largely of constantly renewing,

outward moving cells called keratinocytes. Apart from these cells, most of the antigen-presenting Langerhans cells are located in the epidermis. The outermost layer of the epidermis is the stratum corneum or horny layer, which consist of compacted dead keratinized cells in stratified layer with a density of 1.55. Because of the dense nature of the stratum corneum, values of diffusion co-efficient in this tissue are a thousand or more times smaller than in any other skin tissue, which results in higher resistance and general impenetrability.

The stratum corneum is the rate limiting barrier that restricts the inward and outward movement of chemical substances. Structurally, the stratum corneum is heterogeneous tissue composed of flattened keratinized cells, the outer layer of which are less densely packed then those adjacent to the underlying granular layer.

There is a limited knowledge of the chemical composition of the barrier. The main cellular components are the proteins, lipid, and water combine in to ordered structure. The approximate composition in the drug state is 75-85% protein, 15-20% lipid, and water.

Beneath the stratum corneum are the metabolically active layers of the epidermis.

The identifiable strata, top to bottom are:

a) Stratum granulosam (The granular layer)

b) Stratum spinosum (The multicellular spinosum or prickle layer)

c) Stratum germinativum (The basal or germinal layer) -That lies right above the dermis. In some histological displays' a fourth, upper transitional and translucent layer- stratum lucidum, is also distinguishable.

The Dermis

The next distinctive histological layer as shown in (Figure 1) is the dermis or corium, which is approximately are eighth of an inch thick and constitutes the main mass of the skin. The dermis essentially consists of about 80% protein in a matrix of mucopolysaccharide "ground substance" contained and supported within the dermis are numerous blood vessels, lymphatics, and nerves, as well as the epidermal appendages such as the hair follicles, sebaceous glands and sweat glands. Hair follicles are distributed over the entire skin surface with the exception of the soles of the feet, the palms of the hand, the red portion of the lips, and the selected portion of the sex organ. Each hair follicle is associated with one or more sebaceous glands, which are outgrowths of epithelial cells.

The sweat glands are divided in to eccrine and apocrine types. They are widely distributed over the surface of the body. The accrine glands are particularly concentrated in the palms and soles. The principal function of the glands is for heat control, as they secrete a dilute salt solution. The apocrine glands are found in the axillae (armpits), in anogenital regions, and around nipples.

Hypodermis

The dermis rests on the hypodermis which is composed of loose fatty connective tissue. Its thickness varies considerably over the surface of the body as well as between individuals.

Routes of Penetration

There are three potentials portal of entry:

- Through the follicular region (transfollicular)
- Through the sweat ducts.
- Through the unbroken stratum corneum between the appendages (transepidermal).[11]

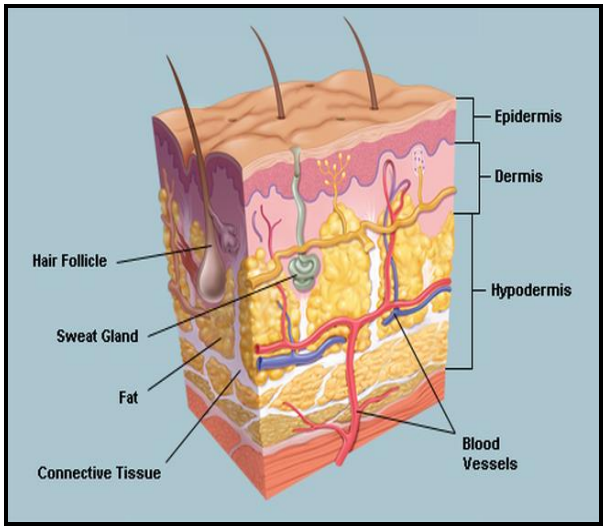


Figure 1: Skin

Factor Affecting of Drug Absorption

There are two types of factor that affect the drug absorption

A) Physiological Factor

It includes

1. *Skin thickness:* Skin thickness varies from epidermis to subcutaneous layer. Epidermis has high thickness about 100-150 µm. Skin on the sole and palm has a high rate of diffusion.
2. *Lipid content:* It is an effective water barrier, percutaneous penetration increases when lipid in stratum corundum is low.
3. *Density of hair follicles:* Hair follicles infundibulum has a large storage capacity about 10 times more than the stratum corneum.
4. *Density of sweat glands*
5. *Skin pH:* Sweat and fatty acids secreted from sebum influence the pH of the skin surfaces.
6. *Skin temperature:* Increase in skin temperature give rise to increase in rate of skin permeation.
7. *Hydration of skin:* Hydration of skin can enhance permeation of skin.
8. *Inflammation of skin:* Skin inflammation disrupts the continuity of stratum corneum increases permeability.

B) Physiochemical Factor

1. Partition co- efficient
2. Molecular weight (< 400)
3. Degree of ionization (only unionized drugs get absorbed well)
4. Effect of vehicles.[12,13,14]

Factors to be considered when choosing a Topical Preparation

1. Match the types of preparation with the type of lesions. For example, avoid greasy ointments for acute weepy dermatitis.
2. Effect of 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.
3. 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 concern.
4. The medication should not affect the skin type.
5. Match the preparations with the site (e.g. gel or lotion for hairy areas). [15,16]

Methods to Enhance Drug Penetration and Absorption

1. Physical enhancement
2. Chemical enhancement
3. Biochemical enhancement
4. Super saturation enhancement.[17,18]

Advantages of using Emulgel as a Drug Delivery System

Hydrophobic drugs can be easily incorporated in to gels using o/w emulsion

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

Better Loading Capacity

Other novel approaches like noisome and liposome's 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.

Better Stability

Other transdermal preparations are comparatively

less stable than emulgels like ointment show rancidity due to presence of oil, cream show phase inversion and breaking and powders are hygroscopic in nature.

Production Feasibility and Low Preparation Cost

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

No Intensive Sonication

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

Controlled Release

It can be used to prodrug the effect of drug having shorter half life.

Patient Compliance

They have better patient compliance due to less greasy and easy to apply.[19,20]

Disadvantages of Emulgel

1- Skin irritation on contact dermatitis.

2- Bubbles formed during emulgel formulation.

3- Possibility of allergenic reactions.

4- Drugs having large particle size (>400 daltons) are not easily absorb or cross through the skin barrier.[21]

Types of Emulgel

The emulgel are classify in to following three categories, which are-

Macro-emulsion Gel

The particle size of the globules in these emulgels is more than 400 nm. They are apparently obscure. They can be offset using surface element agents.[22,23]

Nano – Emulgel

These are confined by joining of nano-emulsion in to gel. Nano-emulsions are thermodynamically enduring clear scattering of oil and water offset by proximity of surfactants and cosurfactants. These emulgels have a globule size of less than 100 nm.[24,25]

Micro Emulsion based Emulgel

These emulgels includes joined properties of micro emulsion and gel giving high bioavailability of prescription. The globule size degree from 10-100 nm.[26]

Important Constituent of Emulgel Preparation

1- Vehicles

Aqueous phase

Oils / lipids

2- Emulsifying agents/ Emulsifiers

3- Gelling agent

4- Permeation Enhancers.

Ideal Properties of Additives

1. They must be non-toxic
2. They must be commercially available in acceptable grades.
3. Their cost must be acceptably cheap.
4. They must not be contraindicated.
5. They must be physically and chemically stable by themselves and in combination with drugs and other components.
6. They must be color compatible.[27]

Vehicle

The vehicle is an important link between drug potency and therapeutic effectiveness, since extensive pharmaceutical research has shown that the composition of the vehicle can profoundly influence the rate and extent of absorption (bioavailability). In the rational design of dermatologic vehicles that maximize bioavailability, two factors are of critical importance: solubilizing the drug in vehicle and maximizing movement (partitioning) of drug from vehicle to stratum corneum.[28]

These are of two types –

Aqueous material: These form the aqueous phase of the emulsion mainly used are water, alcohol etc.

Oils: These agent forms the oily phase of the emulsion. 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.[29]

Sr No.	Chemical	Quantity	Dosage forms
1	Light liquid paraffin	7.5%	Emulgel & Emulsion
2	Isopropylmyristate	7-7.5%	Emulsion
3	Isopropylstearate	7-7.5%	Emulsion
4	Isopropylpalmitate	7.7.5%	Emulsion
5	Propyleneglycol	3-5%	Gel

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.eg Polyethylene glycol 40 stearate, Sorbitan monooleate (Span 80), Polyoxyethylene sorbitan monooleate (Tween 80), Stearic acid, Sodium stearate.[30]

Gelling Agent

These are one of the thickening authorities used to manufacture the consistency of the formulation. Gelling administrators encounter an abnormal state of cross interfacing or alliance when hydrated and scattered in the disseminating medium, or when separated in the scrambling medium. This cross-interfacing or relationship of the scattered stage will change the thickness of the scrambling medium. The improvement of the diffusing medium is constrained by the scattered stage, and the consistency is extended.[31,32]

Types of Gelling Agents

Many different type of polymers acting as gelling agent.

1) ***Natural polymers:*** Proteins like gelatin, casein, collagen, egg whites, polysaccharides like guar gum, acacia, tragacanth, bug bean gum, pectin, starch, xanthan gum, dextran, succinoglucon.
2) ***Semi synthetic Polymers:*** Cellulose subordinates like carboxymethyl cellulose, ethyl cellulose, hydroxyethyl cellulose, hydroxylpropyl cellulose, magnesium aluminium silicate (veegum), methylcellulose, sodium alginate, etc.

Synthetic Polymers

Carbopoles are also known as Carbomers, Poloxamers (Pluronics) Polyvinyl alcohol.[33,34]

Sr. No.	Gelling agent	Quantity	Dosage Form
1	Carbopol 934	0.5- 2%	Emulgel
2	Carbopol 940	0.5-2%	Emulgel
3	HPMC 2910	2.5%	Emulgel
4	HPMC	3.5%	Gel
5	Sodium CMC	1%	Gel

Permeation Enhancer

Permeation enhancers are the substances that reduce the skin ability to perform its barrier function and makes skin more permeable and they allow drug molecules to cross the skin at a faster rate.

These substances can increase the drug diffusivity in the stratum corneum by dissolving

the skin lipids or by denaturating skin proteins.[35,36]

The mechanism of action of permeation enhancers are –

1- Disruption of the highly ordered structure of stratum corneum lipids.

2- Interactions with intracellular proteins.

3- Improvement in partitioning of drug.[37,38]

Sr. No.	Penetration enhancers	Quantity	Dosage form
1	Cinnamon	8%	Emulgel
2	Menthol	5%	Emulgel
3	Clove Oil	8%	Emulgel
4	Linoleic acid	5%	Gel
5	Isopropyl myristate	5%	Gel
6	Urea	10%	Gel
7	Lecithin	5%	Gel
8	Oleic acid	1%	Gel

Emulgel Formulation

Formulation of Emulsion either o/w or w/o

Oil time of the emulsion was set up by dissolving emulsifiers e.g. cross 20 in oil vehicle like liquid paraffin while the watery stage is set up by dissolving hydrophilic emulsifiers like tween 20 in refined water. The medicine was separated in watery dissolvable like ethanol. Both the plans of solution and added substances are mixed with watery stages were freely warmed to 70^0c then the smooth stage was added to watery stage with constant blending. This mixture was cooled to room temperature to shape on emulsion.

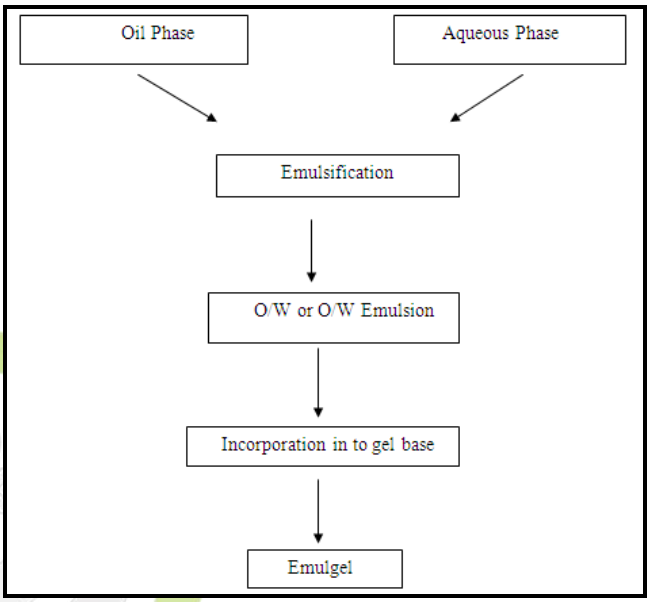
Formulation of Gel Base

The gel stage is set up by dissolving the polymer in the separated water with enduring mixing at moderate pace using mechanical shaker and the pH was adjusted.

Incorporation of Emulsion in to Gel base with Continuous Blending

The gel stage is mixed in to the emulsion stage in the extent of 1.1 procure emulsion.[39,40]

The flow chart of emulgel preparation is shown as follows-



Characterization of Emulgel

1) Physical Examination
2) pH examination
3) Rheological Studies
4) Spreading co-efficient
5) Swelling index
6) Extrudability studies of topical emulgel (tube test)
7) Globule size and its distribution in emulgels
8) Drug content determination
9) Ex-vivo Bioadhesive strength measurement of topical emulgel
10) Skin irritation test (patch test)
11) Stability test.[41,42,43]

Physical Examination

The well prepared emulgel formulations were

inspected visually for their color, homogeneity, consistency, grittiness, phase sepration.[44]

pH Examination

The pH values of 1% solution of the prepared Gellified emulsion are measure by a digital pH meter which was calibrated with standard buffer solution. The measurement of pH of each system was replicated 3 times.[45]

Rheological Studies

The consistency of the organized emulgel arrangements is generally chosen using a cone and plate viscometer with shaft 52 or 7 which is connected with a thermostatically controlled streaming water shower kept up at 25°C. The arrangement whose thickness was to be determined was taken into a holder secured with thermostatic coat. In the blink of an eye the Spindle was allowed to move uninhibitedly into the emulgel definition and the examining demonstrated was noted.[32,46]

Spreading co-efficient

Spreadability is determined by apparatus suggested by Mutimer et al which is suitably modified in the laboratory and used for the study. It consist of a wooden block, which is provided by a pulley at one end by this method spreadability is measured on the basis of "Slip" and "Drag" characteristics of emulgel . 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 80 gm with the help of string attached to the hook and the time (in sec.) required the top slide to cover a distance of 7.5cm be noted. A shorter interval indicates better spreadability. The spreadability was calculated by following formula-

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

Where,

S = Spread ability

M = Weight tied to upper slide

L = Length moved by the glass slide

T = The time in seconds taken to separate the slide completely.[1,47,48]

Swelling Index

To determine the swelling index of prepared topical emulgel, 1gm 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. Swelling index is calculated by using following formula,

$$\text{Swelling index (SW) \%} = [(w_t - W_0)/W_0] \times 100$$

Where, SW % = equilibrium percent swelling.

W_t= weight of swollen emulgel after time t.

W_0= original weight of emulgel at zero time.[1,49]

Extrudability Study of Topical Emulgel [Tube Test]

It is a usual empirical test to measure the force required to extrude the material from the tube. The method applied for determination of applied shear in the region of the rheogram corresponding to a shear in the 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 0.5cm ribbon of emulgel in 10 sec. more quantity extruded better is extrudability. The measurement of extrudability of each formulation is in triplicate and the average values are presented. The extrudability is then calculated by using following formula:

Extrudability = Applied weight to extrude emulgel from tube (in gm.) / Area (in cm^2).[1,50]

Globule Size and its Distribution in Emulgel

Globule size and distribution is determined by Malvern zeta seizer. A 1.0 gm sample is dissolved in purified water and agitated to get homogeneous dispersion. Sample was injected to photocell of zetasizer. Mean globule diameter and distribution is obtained.[14]

Drug Content Determination

The drug content is measured by using UV spectrophotometer. Separate known measure of emulgel is dissolvable (methanol) by sonication method. Reasonable weakening is to be made to choose the absorbance of each in UV/ VIS spectrophotometer.[32,51]

Ex-vivo Bioadhesive Strength Measurements of Topical Drug 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 are 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 are 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 minutes. Weight is added slowly at 200 mg/ min to the left-hand pan until the patch detached from the skin surface. The weight (gram force) required to detach the emulgel from the skin surface gives the measure of bioadhesive strength.[52] The bioadhesive strength is calculated by using following formula:

Bioadhesive Strength = Weight required (in gm) / Area (cm^2)

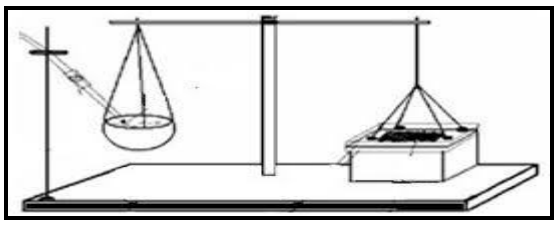


Figure 2: Setup for Bioadhesive test

Skin Irritation Test

A 0.5 gm sample of the test article was then applied to each site (two sites per rabbit) by introduction under a double gauze layer to an area of skin approximately 1"x 1" (2.54 x 2.54 cm^2). The Gellified Emulsion is applied on the skin of rabbit. Animals were returned to their cages. After a 24 hour exposure, the Gellified Emulsion is removed. The test sites were wiped with tap water to remove any remaining test article residue.[19, 51]

In vitro Release Studies

Franz diffusion cell (with effective diffusion area 3.14 cm^2 and 15.5 ml cell volume) was used for the drug release studies. Gellified Emulsion (200 mg) was applied on to the surface of egg membrane evenly. The egg membrane was clam ped between the donor and the receptor chamber of diffusion cell. The receptor chamber was filled by freshly prepared PBS (pH 5.5) solution to solubilize the drug. The receptor chamber was stirred by a magnetic stirrer. The samples (1.0 ml aliquots) were collected at suitable time interval. Samples were analyzed for drug content by UV visible spectrophotometer after appropriate dilutions. Cumulative corrections were made to obtain the total amount of drug release at each time interval. The cumulative amount of drug released across the egg membrane was determined as a function of time.[53]

Microbiological Assay

The Ditch plate technique was used for the microbial assay of emulgel. It is a strategy used for the appraisal of bacteriostatic or fungistatic development of a compound. It is generally associated for semisolid formulations. Previously prepared Sabouraud's agar dried plates were used. Three gram of the Gellified Emulsion is placed in a ditch cut in a plate. Freshly prepared culture loops are streaked across the agar at a right angle from the ditch to the edge of the plate. After incubation for 18 to 24 hours at 25^0c, the fungal growth was observed and the percentage inhibition was measured as follows[1].

% inhibition = L2 / L1 × 100

Where, L1= total length of the streaked culture.

L2 = length of inhibition.

Stability Studies

The prepared emulgels were packed in aluminum collapsible tubes (5 gm) and subjected to stability studies at 5^0c, 25^0c / 60 RH, 30^0c/65 % RH, and 40^0c/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 profile.[41,54]

CONCLUSION

As the emulgel is the recent technique for the topical drug delivery it is better suitable for hydrophobic drugs and obviously it is a very good technique for the drug delivery of hydrophobic and hydrophilic dug combination. Mainly the hydrophobic drug formulation can be developed using emulgel technique because it contains both oil and aqueous phase, but hydro gels are not suitable for hydrophobic drugs. In future, topical drug delivery will be used extensively to impart better patient compliance. Since Emulgel is helpful in enhancing Spread ability, adhesion, viscosity and extrusion, this novel drug delivery will become a popular formulation in future.

ACKNOWLEDGMENT

This review is written in dedication of the God almighty for blessing me with the peace of mind, courage and strength, also with affectionate dedication to my loving parents, sisters, brothers and my dear friends who throughout the year have given me lot of encouragement, valuable ideas and timely support whenever needed.

I am very thankful to Director, HOD and all faculty teachers of Department of Pharmaceutics Goel Institute of Pharmacy & Sciences, Lucknow, for their hearty cooperation and most valuable guidance throughout my review article.

REFERENCES

1. Panwar, A. S., Upadhyay, N., Bairagi, M., Gujar, S., Darwhekar, G. N., & Jain, D. K. (2011). Emulgel: a review. *Asian Journal of Pharmacy and Life Science ISSN*, *2231*, 4423.
2. Jain, N. K. Controlled and Novel Drug Delivery, 1_{st} Edition, CBS Publishers & Distributors Pvt. Ltd. Page no.-100.
3. Surver C. et al (2002). "Bioavailability and Bioequivalence", Dermatological and Transdermal Formulation, Marcal Dekker, New York, In: K. A. Walter (eds.), page no. 323-327, 403.
4. Khullar, R., Saini, S., Seth, N., & Rana, A. C. (2011). Emulgels: a surrogate approach for topically used hydrophobic drugs. *International Journal of Pharmacy and Biological Sciences*, *1*(3), 117-128.
5. Tripathi, K. D. (2013). *Essentials of medical pharmacology*. JP Medical Ltd. Pg 5-6.
6. Arora, V., Kumar, P., & Sharma, R. Emulgels: A Review for Topical Drug Delivery of Hydrophobic Drugs.
7. Khullar, R., Saini, S., Seth, N., & Rana, A. C. (2011). Emulgels: a surrogate approach for topically used hydrophobic drugs. *International Journal of Pharmacy and Biological Sciences*, *1*(3), 117-128.
8. Bhowmik, D. (2012). Recent advances in novel topical drug delivery system. *The Pharma Innovation*, *1*(9). 12-31.
9. Devada, P., Jain, A., Vyas, N., & Jain, S. (2011). Development of antifungal emulsion based gel for topical fungal infection. *International Journal of Pharmaceutical Research and Development*, *3*(2), 18-25.
10. Eswaraiah, S., Swetha, K., Lohita, M., Preethi, P. J., Priyanka, B., & Reddy, K. K. (2014). Emulgel: Review on Novel Approach to Topical Drug Delivery. *Asian Journal of Pharmaceutical Research*, *4*(1), 4-11.
11. Lachman Leon, Lieberman A. Herbert, The Theory and Practice of Industrial Pharmacy, CBS Publishers & Distributors (P) Ltd. Pg.534-536.
12. Kalia, Y. N., & Guy, R. H. (2001). Modeling

transdermal drug release. *Advanced Drug Delivery Reviews*, *48*(2), 159-172.

13. Ayub, A. C., Gomes, A. D., Lima, M. V., Vianna-Soares, C. D., & Ferreira, L. A. (2007). Topical delivery of fluconazole: in vitro skin penetration and permeation using emulsions as dosage forms. *Drug Development and Industrial Pharmacy*, *33*(3), 273-280.
14. Hardenia, A., Jayronia, S., & Jain, S. (2014). Emulgel: An emergent tool in topical drug delivery. *International Journal of Pharmaceutical Sciences and Research*, *5*(5), 1653.
15. Gaur, P. K., Mishra, S., Purohit, S., Dave, K. (2009). Transdermal Drug Delivery System A Review, (2), 14-20.
16. Joshi, B., Singh, G., Rana, A. C., Saini, S., & Singla, V. (2011). Emulgel: a comprehensive review on the recent advances in topical drug delivery. *International Research Journal of Pharmacy*, *2*(11), 66-70.
17. Pathan, I. B., & Setty, C. M. (2009). Chemical penetration enhancers for transdermal drug delivery systems. *Tropical Journal of Pharmaceutical Research*, *8*(2), 173-179.
18. Subramanian, N., Ghosal, S. K., & Moulik, S. P. (2005). Enhanced in vitro percutaneous absorption and in vivo anti-inflammatory effect of a selective cyclooxygenase inhibitor using microemulsion. *Drug Development and Industrial Pharmacy*, *31*(4-5), 405-416.
19. Panwar, A. S., Upadhyay, N., Bairagi, M., Gujar, S., Darwhekar, G. N., & Jain, D. K. (2011). Emulgel: a review. *Asian Journal of Pharmacy and Life Science ISSN*, *2231*, 4423.
20. Wang, M., & Fang, L. (2008). Percutaneous absorption of diclofenac acid and its salts from emulgel. *Asian Journal of Pharmaceutical Science*, *3*, 131-41.
21. Vats, S., Saxena, C., Easwari, T. S., & Shukla, V. K. (2014). Emulsion Based Gel Technique: Novel Approach for Enhancing Topical Drug Delivery of Hydrophobic Drugs. *International Journal for Pharmaceutical Research Scholars*, *3*(2), 650-653.
22. Jain, A., Gautam, S. P., Gupta, Y., Khambete, H., & Jain, S. (2010). Development and characterization of ketoconazole emulgel for topical drug delivery. *Der Pharmacia Sinica*, *1*(3), 221-231.
23. Khullar, R., Kumar, D., Seth, N., & Saini, S. (2012). Formulation and evaluation of mefenamic acid emulgel for topical delivery. *Saudi Pharmaceutical Journal*, *20*(1), 63-67.
24. Shakeel, F., Baboota, S., Ahuja, A., Ali, J., & Shafiq, S. (2008). Skin permeation mechanism and bioavailability enhancement of celecoxib from transdermally applied nanoemulsion. *Journal of Nanobiotechnology*, *6*(1), 8.
25. Pratap, S. B., Brajesh, K., Jain, S. K., & Kausar, S. (2012). Development and Characterization of a Nanoemulsion Gel formulation for Transdermal delivery of Carvedilol. *International Journal of Drug Development and Research*, 4, 151-161.
26. Bachhav, Y. G., & Patravale, V. B. (2009). Microemulsion-based vaginal gel of clotrimazole: formulation, in vitro evaluation, and stability studies. *AAPS PharmSciTech*, *10*(2), 476-481.
27. Pant, S., Badola, A., Baluni, S., & Pant, W. (2015). A Review on Emulgel Novel Approach for Topical Drug Delivery System, *World Journal of Pharmacy and Pharmaceutical Sciences*, 4(10), 1728-1743.
28. Mohamed, M. I. (2004). Optimization of chlorphenesin emulgel formulation. *The AAPS journal*, *6*(3), 81-87.
29. Jones, D. S., Woolfson, A. D., & Brown, A. F. (1997). Textural, viscoelastic and mucoadhesive properties of pharmaceutical gels composed of cellulose polymers.

International Journal of Pharmaceutics, *151*(2), 223-233.

30. Kogan, A., & Garti, N. (2006). Microemulsions as transdermal drug delivery vehicles. *Advances in Colloid and Interface Science*, *123*, 369-385.
31. https://en.wikipedia.org/wiki/thickening.
32. latha Samala, M., & Sridevi, G. (2016). Role of Polymers as Gelling Agents in the Formulation of Emulgels. *Polymer Sciences*.
33. Jain, A., Deveda, P., Vyas, N., Chauhan, J., Khambete, H., & Jain, S. (2011). Development of antifungal emulsion based gel for topical fungal infection (s). *International Journal of Pharmaceutical Research Development*, 2, 784-790.
34. Raymond, C. R., Paul, J. S., Marian, E. Q. (2009). Hand book of pharmaceutical Excipients. London, Chicago, Pharmaceutical press (6th Ed) pp: 110-114.
35. Pathan, I. B., & Setty, C. M. (2009). Chemical penetration enhancers for transdermal drug delivery systems. *Tropical Journal of Pharmaceutical Research*, *8*(2).
36. Kasliwal, N., Derle, D., Negi, J., & Gohil, J. (2008). Effect of permeation enhancers on the release and permeation kinetics of meloxicam gel formulations through rat skin. *Asian J Pharm Sci*, *3*(5), 193-199.
37. Bronaugh, R. L., & Maibach, H. I. (1989). *Percutaneous absorption: mechanisms--methodology--drug delivery* (Vol. 8). Marcel Dekker Inc.
38. Williams, A. C., Barry, B. W. (2004). Penetration enhancers. *Advance Drug Delivery Review*, 56, 603- 618.
39. Meenakshi, D. (2013). Emulgel: A novel approach to topical drug delivery. *International Journal of Pharma and Bio Sciences*, *4*(1), 847-856.
40. Mohamed, M. I. (2004). Optimization of chlorphenesin emulgel formulation. *The AAPS journal*, *6*(3), 81-87.
41. Singla, V., Saini, S., Joshi, B., & Rana, A. C. (2012). Emulgel: A new platform for topical drug delivery. *International Journal of Pharma and Bio Sciences*, *3*(1), 485-498.
42. Sanjay, J. B., Padsalg, A., Patel, K., & Mokale, V. (2007). Formulation, development and evaluation of Fluconazole gel in various polymer bases. *Asian Journal of Pharmaceutics*, *1*, 63-68.
43. Meenakshi, D. (2013). Emulgel: A novel approach to topical drug delivery. *International Journal of Pharma and Bio Sciences*, *4*(1), 847-856.
44. Mohamed, M. I. (2004). Optimization of chlorphenesin emulgel formulation. *The AAPS Journal*, *6*(3), 81-87.
45. Varma, V. N. S. K., Maheshwari, P. V., Navya, M., Reddy, S. C., Shivakumar, H. G., & Gowda, D. V. (2014). Calcipotriol delivery into the skin as emulgel for effective permeation. *Saudi Pharmaceutical Journal*, *22*(6), 591-599.
46. Narendran, H., Koorapati, S., & Mamidibathula, L. (2013). Formulation and Evaluation of Aceclofenac-Lycopene Transemulgel. *World Journal of Pharmaceutical Research*, *2*(4), 1036-1045.
47. Yadav Kumar S., Manoj, M. K., Tiwari A., Shukla, A. (2017). Emulgel: A New approach for enhanced Topical Drug Delivery, *International Journal of Current Pharmaceutical Research*, 9(1).
48. Jones, D. S., Woolfson, A. D., & Brown, A. F. (1997). Textural, viscoelastic and mucoadhesive properties of pharmaceutical gels composed of cellulose polymers. *International Journal of Pharmaceutics*, *151*(2), 223-233.
49. Patel, R. P., Patel, G., & Baria, A. (2009). Formulation and evaluation of transdermal patch of aceclofenac. *International Journal of Drug Delivery*, *1*(1), 41-51.
50. Usmania, A. B., Mahesh, K. K., Khemchand, S. I. (2016) Emulgel: A Comprehensive review including patents.

World Journal of Pharmacy and Pharmaceutical Sciences, 5, 751-768.

51. Praveen, C., Amit, A., Prashant, M., Pramod, K., & Devidas, S. (2009). Development and In Vitro Evaluation of Thermorevesible Nasal Gel Formulations of Rizatriptan Benzoate. *Indian Journal of Pharmaceutical Education and Research*, *43*(1), 55-62.
52. Hardenia, A., Jayronia, S., & Jain, S. (2014). Emulgel: An emergent tool in topical drug delivery. *International Journal of Pharmaceutical Sciences and Research*, *5*(5), 1653.
53. Masmoudi, H., Piccerelle, P., Le Dréau, Y., & Kister, J. (2006). A rheological method to evaluate the physical stability of highly viscous pharmaceutical oil-in-water emulsions. *Pharmaceutical Research*, *23*(8), 1937-1947.
54. Kute, S. B., & Saudagar, R. B. (2013). Emulsified gel A Novel approach for delivery of hydrophobic drugs: An overview. *Journal of Advance Pharmacy Education & Research*, *3*(4). 368-376.

