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NANOEMULGEL"-A BRIDGE BETWEEN NANOTECHNOLOGY AND DERMATOLOGICAL APPLICATION: A REVIEW

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ABSTRACT
Nanoemulgel is a drug delivery system being explored for topical formulations. It consists of an emulsion incorporated into a gel base, which is prepared using a gelling agent. Lipophilic drugs can be easily incorporated and the skin permeability of the incorporated drugs can be enhanced. It can also be targeted more specifically to the site of action and avoid first-pass metabolism. It solves major issues such as limiting the use of lipophilic drugs, poor oral bioavailability, and unpredictable pharmacokinetic and absorption variations. Nanoemulgel is a formulation-related intervention to improve drug absorption and the therapeutic profile of lipophilic drugs. It is widely used in the treatment of acne, pimple, psoriasis, fungal infection, and inflammation caused by osteoarthritis and rheumatoid arthritis. It can be delivered via ocular, vaginal, dental, and nose-to-brain routes for the treatment of diverse local and systemic ailments. Despite having a few limitations, nanoemulgel formulation is a potential and promising candidate for the topical delivery of lipophilic drugs in the future.

KEYWORDS: Gels, Nanoemulsion, Nanoemulgel, Gelling agents, Hydrophobic drug.

INTRODUCTION
Conventional drug delivery systems have been the foundation of pharmaceutical formulations for many years, providing effective means of administering medications to patients. These systems encompass a variety of dosage forms and delivery routes that have been extensively studied and utilized in clinical practice. These include tablets, capsules, solutions, suspensions, creams, ointments, and gels. While conventional dosage forms have been widely used and proven effective, they often come with certain disadvantages when compared to novel topical dosage forms. Conventional topical drug delivery systems, such as creams and ointments, often exhibit limited drug penetration and can leave residues on the skin, compromising patient compliance and treatment efficacy.[1]

Topical drug administration is the simplest and easiest route of localized drug delivery anywhere in the body, with the help of routes such as ophthalmic, rectal, vaginal, and skin. These are applied as a wide spectrum of preparations for both cosmetic and dermatological uses, for healthy or diseased skin. Topical drug delivery can be defined as the application of a drug-containing formulation to the skin to treat cutaneous disorders directly. The topical drug delivery system is generally used where other routes (like oral, sublingual, rectal, and parental) of drug administration fail or do not show much effect in local skin infections like fungal infections. The main advantage of the topical delivery system is to bypass first-pass metabolism and also avoidance of the risks and inconveniences of intravenous therapy and to avoid varied conditions of absorption, like pH changes, the presence of enzymes, and gastric emptying time is another advantage of this system. Topical drug delivery systems include a large variety of pharmaceutical dosage forms like semisolids, liquid preparation, sprays, and solid powders. The most widely used semisolid preparation for topical drug delivery includes gels, creams, and ointments.[2]

Physiology of Skin: The skin is the body's largest single organ, occupying about 15% of the total adult body weight. It combines with the mucosal lining of the respiratory, digestive, and urogenital tracts to form a capsule that separates the internal body structure from the external environment. For an average 70 kg human with a skin surface area of 1.8 m^2, a typical square area that covers 10 hair follicles, 12 nerves, 15 sebaceous glands,100 sweat glands, and 3 blood vessels with 92 cm of total length. The pH of the skin varies from 4 to 5.6, sweat and fatty acids secreted from sebum influence the pH of the skin surface. The temperature of the skin varies in a range of 30 to 40 degrees depending on the environmental conditions. Skin performs various vital functions, including protection against external physical,

chemical, and biological assailants, as well as prevention of excess water loss from the body, and plays a role in thermoregulation. The skin is continuous, with the mucous membrane lining the body's surface.[3]

Cutaneous membrane is divides into 3 parts: **Epidermis, Dermis, Hypodermis**

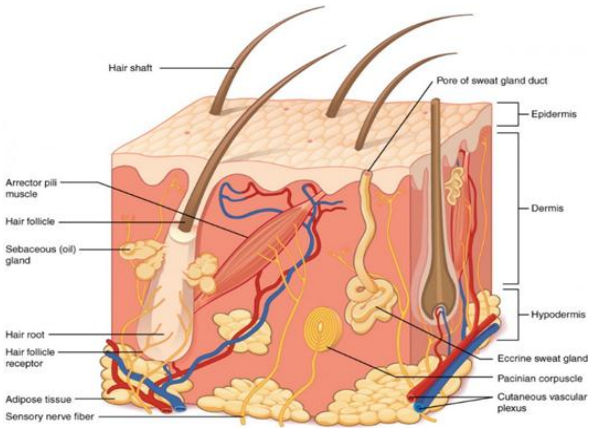

Fig.no.1: Structure of skin.

a) Epidermis: Epidermis is the outermost arena of the skin, containing stratified squamous epithelium which has 2 layers, stratum basale – the deepest layer and stratum corneum – the superficial layer. Stratum corneum, which is the outer layer of skin, becomes hard due to the process of keratinisation and act as physical barrier to most drugs. Stratum corneum composed of 10 to 20 cells layers. Cell of Stratum corneum are flat and plate-like with 2500 µm wide, 34-44µm long, 0.5 to 0.20µm thick. Lipid content of Stratum corneum includes glycosphingolipid, a neutral lipid, phospholipids, cholesterol sulphate and keratin as protein. Stratum Basale lies between the stratum corneum and the dermis having thickness of 50-100µm. Cell structure of this layer are similar to other living tissues. The water content of this layer is around 90% mainly contain melanin and Langerhans cells.[4]

The layers of epidermis are

- Stratum Germinativum (Growing layer)
- Malpighion Layer (pigment Layer)
- Stratum Spinosum (prickly cell layer)
- Stratum Granulosum (Granular Layer)
- Stratum Lucidum
- Stratum Corneum (Horny layer).[5]

b) Dermis/Corium: It is the deeper and thicker (2000 to 3000µm) region beneath the epidermis. It is mostly contracted with structural fibrin and very few cells same as found in normal tissue. Dermal papillae are the outermost layer having signalized projection. It also contains oil-secreting glands, sweat glands, nerve ending and hair follicles. Elastic and collagenous fibers within dermis provide stretchability and tone to the skin. The density of its fibre meshwork, and therefore its physical properties, varies within an area, in different parts of the body, with age and sex[6]

c) Hypodermis/Subcutaneous layer: The hypodermis, composed of loose connective tissue varies in thickness, and merges with the deep lower part of the dermis. Apart from this, it is also composed of secretary sweat glands, fibrous tissue containing blood vessels and lymph vessels, and cutaneous nerves. Many consider that drug gets absorbed into the systemic circulation without passing through this layer by means of blood vesicles and sweat glands.[7]

Factors Affecting Topical Absorption of Drug

a. Physiological factors

i. Lipid content of the skin - They act as barrier for drug absorption and by lowering this barrier property leads to increased penetration.
ii. Thickness of different skin layers -Greater the thickness lowers the penetration rate, like palm and sole shows higher diffusion rate compare to other surfaces.
iii. Hair follicles density - large storage, about 10-12 times than Stratum corneum.
iv. Skin pH.
v. Hydration of skin.
vi. Sweat gland density.
vii. Inflammation of skin disrupted stratum corneum has higher permeability.
viii. Blood flow.
ix. Skin temperature.[8]

b. Physicochemical factors

i. Partition coefficient - higher log p value give rise to absorption.
ii. Effect of vehicles - hydro alcoholic gel provides the most efficient absorption through skin.
iii. Degree of ionisation.
iv. Molecular Weight. (Less than 400 Dalton).[9]

Emulsion as a dispersed system, consists of small droplets which is well distributed into immiscible vehicle which is either o/w or w/o phase. Emulsions are classified according to their droplets size as **macroemulsion** (droplet of 1 to 100 µm of diameter), **microemulsion** (droplet between 10-100 nm) and **nanoemulsion** (droplet size 20-200 nm diameter) Macroemulsion are also known as the conventional emulsion/colloidal emulsion. Generally unstable, the droplets settle and basically float with the dispersed phase and the medium phase, and the solid particles adsorbed on the surface are unstable. Microemulsion is an isotropic liquid system with more uniform size and good physiochemical properties and is more stable and requires less emulsifying agent[8].Nanoemulsion is a potential drug delivery system mainly used for hydrophobic drugs because it has several characteristics like enhanced drug solubility, good thermodynamic stability, easy manufacturing, nano sized droplets, high interfacial area, good appearance, faster absorption.

Nanoemulsions are novel drug delivery system consisting of emulsion with nano sized particles (10^{9}) having a diameter from 50 to 1000 nm and the nanoemulsion is either oil-in-water or water-in-oil in nature, where the particle is either dispersed in oil or water phase respectively. In pharmaceutical field, nanoemulsion is used for oral, topical and parentral route for drug delivery.[10]

Nanoemulsion used for topical application is a promising and alternative drug delivery system to enhance penetration and to target poorly soluble drugs, either by increasing its absorption of particle through the skin, better retention time of drug in the target area and eventually they result in less side effects and faster absorption. In addition, the small size of particles, the more amount of drug is able to be incorporated in the formulation, which subsequently increases the thermodynamics towards the skin. Moreover, the drug affinity for partitioning increases permeation of drug into the skin. The greatest problem in transdermal drug delivery refers to barrier properties of stratum corneum, a 10 µm to 20 µm thick tissue layer with great composed structured lipid/protein matrix.[11-12]

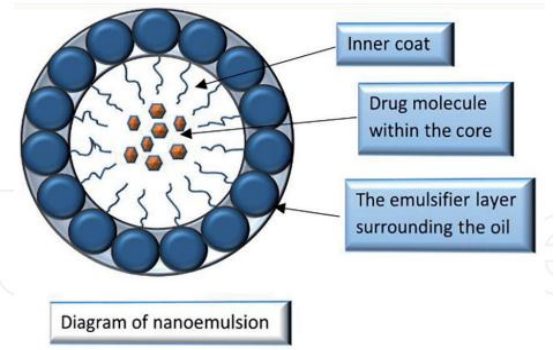

Fig. No. 2: Diagram of Nanoemulsion.

Important Components of Nanoemulsion

The main components of Nanoemulsion are

Oil: The selection of the oil phase is one of the most important parameters to obtain a stabilized Nanoemulsion. So, the oil used in the nanoemulsion should be such that it should solubilize the maximum amount of drug. A combination of oils can also be used to solubilize the maximum amount of the drug. Oils used in Nanoemulsion are generally mineral oils used as the vehicle for drugs E.g: castor oil, various fixed oils (cottonseed oil, maize oils, arachis oil) olive oil, coconut oil, eucalyptus oil, rose oil, clove oil etc.[13]

Aqueous Phase: Commonly distilled water is used as a aqueous phase for the preparation of Nanoemulsion and Hydrogel.[14]

Surfactant: Surfactants are one of the vital components used for stabilizing the nanoemulsion system. The anionic, cationic, and non-ionic, and zwitter ion types of surfactants are used in nanoemulsion preparation. Due to the different chemical properties selection of proper surfactant will play a very important role in stabilizing the nanoemulsion. For the formulation of stable nanoemulsion, we have to select the surfactant based on their HLB value.[15]

Cosurfactant: Cosurfactant is the one which plays an important role in reducing the polarity of surfactant and helps to obtain a stable nanoemulsion. There are a lot of varieties of cosurfactants available, which mainly act on surfactant interface & short- to medium-chain length alcohols (C3-C8). These cosurfactants are helpful in increasing the penetration of oil into the skin and obtaining a stabilized formulation.[16]

Preservatives: Preservatives are one of chemical agents which is used to preserve the substance from microbial attack and to improve the shelf life of a product. Commonly used preservatives are phenoxyethanol, benzalkonium chloride, methyl paraben, and propyl paraben.[17-18]

Permeation Enhancers: They interact with different skin constituents to produce a reversible temporary increase in permeability. They can act by one or more mechanisms like disrupting the highly compact structure of stratum corneum, improving the partition of drug or solvent or co-enhancer into the stratum corneum, interacting with the intercellular protein. Causing some conformational changes in protein or solvent swelling is the key for alternating polar paths. Some enhancers improve the fluidity of protein in stratum corneum, where some act on both pathways by disrupting multilaminate pathway. They can increase the diffusion of drug through skin proteins. Type of enhancer has a significant impact product designing E.g., Eucalyptus oil, Linoleic acid, Lecithin, Oleic acid, Chenopodium oil, Isopropyl myristate, Urea.[19]

Nanoemulsification applications

(i) Oral Nanoemulsion- The poorly water-soluble drugs have low bioavailability because they have a low rate of dissolution; therefore O/W Nanoemulsion for these drugs lead to increase its solubility, absorption, and bioavailability after oral administration of the drugs.

(ii) Delivery of nanoemulsion to the eyes- For better lipophilic medication distribution to the eye, O/W nanoemulsion is utilized for pharmaceuticals like erythromycin and pilocarpine.

(iii) Nasal distribution of nanoemulsions- Has various advantages over parenteral and intravenous routes, including skipping the liver's initial metabolic process and extending the period that the nasal mucosa is in touch with the nanoemulsion droplet, which increases drug absorption.

(iv) Transdermal nanoemulsion for drug delivery- The chemical compound can infiltrate the skin layer via the stratum corneum, sweat ducts, or hair follicles, obstructing drug absorption and decreasing

bioavailability. To improve therapeutic targeting and manage drug redistribution within the lymphatic and blood vessels, a nanoemulsion for transdermal delivery is developed. Nano-sized emulsions can permeate skin pores, allowing for systemic distribution. Nanoemulsion is also regarded as a promising technology due to its advantages, which include low preparation costs, high storage stability, the absence of organic solvents, and thermodynamic stability.

(v) Nanoemulsion in cosmetics- Nanoemulsion is thought to be an effective carrier for delivering controlled amounts of cosmetics and makes it easier for active ingredients to disperse throughout the skin layer. Since microemulsions experience flocculation, creaming, and sedimentation, nanoemulsions are employed in cosmetic products.[20]

Nanoemulgel, also known as a nanogel or nanosuspension gel, combines the advantages of both nanoemulsion and gel systems, making it potentially superior in certain applications factors such as the nature of the active ingredients, target site, release profile requirements and formulation considerations. The production of nanoemulgel is mostly dependent on the hydrogel. This is due to the incorporation of nanoemulsions into the hydrogel matrix, which improves skin penetration. Nanoemulgel is a new formulation for medication delivery by topical application. Because nanoemulgel contains less medicine, it minimizes the likelihood of side effects associated with high drug doses. It also improves drug absorption at submicron sizes (up to 10–200 nm). The nanoemulgel acts as a drug reservoir, influencing drug release from the system's inner to outer phases. When nanoemulgel comes into contact with the skin, it causes the gel to release oil droplets, which then penetrate the stratum corneum of the skin and deliver the medicine. Because nanoemulgel pocesses have good adhesion properties and drugs are highly soluble in the oil phase, there is a higher concentration gradient towards the skin and increased drug penetration. Nanoemulgel is an emergency approach used for topical medication delivery that is now being investigated in the treatment of many types of skin problems caused by viral, bacterial, and fungal infections such as eczema, psoriasis, herpes simplex, acne and others.[21]

Nanoemulgel mainly acts as an alternative formulation to increase the efficacy of poorly soluble drugs. They increase the absorption of drugs through the skin. Nanoemulgel can be hypothesized so they can easily penetrate the rough surface of plaques & psoriatic skin by swelling of skin lipids. By this, they achieve enhanced penetration through the pores to the skin. And, it can be easily loaded into gel which will improve the delivery of drugs to the skin by hydration. And also, it enhances retention of drugs in the skin.[22]

Advantages of Nanoemulgel

1. Increases the absorption rate.
2. Solubilises the lipophilic drug.
3. Increased bioavailability.
4. Enhances local drug delivery.
5. Controlled release of drug which is having the short half-life.
6. Nontoxic and non-irritant.
7. Better loading of drug compared to other formulation.
8. Helpful in taste masking.
9. Patient compliance.
10. Rapid and efficient penetration of drug moiety.[23]

Application of Nanoemulgel

1. Used as an anti-inflammatory agent
2. As anti-psoriatic
3. As an anti-fungal agent
4. Used in alopecia.[24]

Method of preparation of nanoemulgel

Nanoemulgel development is a multistep process in which a formed nanoemulsion is combined with a suitable gel base.

Step 1: Preparation of Nanoemulsion: Nanoemulsions are prepared spontaneously by blending the compositions and lowering the interfacial tension between the oil/water interfaces, or by introducing high energy into the heterogeneous mixture. Thus, high-energy and low-energy emulsification processes may be used to develop a thermodynamically stable nanoemulsion.[25]

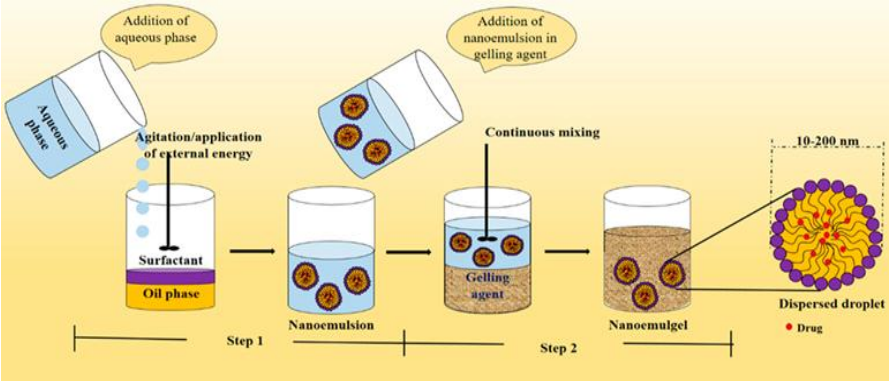

Fig. No. 3: Preparation of Nanoemulgel.

1. **High-energy method**: - Nanoemulsion droplet sizes usually range from 5 to 500 nm. To achieve this size range, it requires a lot of mechanical energy. High-energy input for fabrication can be accomplished using a variety of techniques, including high-pressure homogenizers, ultrasound generators, microfluidizers, and high-speed homogenizers. The most important benefit of a high-energy mediated nanoemulsion formulation is the use of low emulsifier concentration. The formation of an emulsion by mechanical stirring, with droplet size in the micron range, is the first step in using high-energy techniques. The second step is breaking huge droplets into small droplets with high-energy equipment. Used to turn the emulsion into a nanoemulsion.[26]

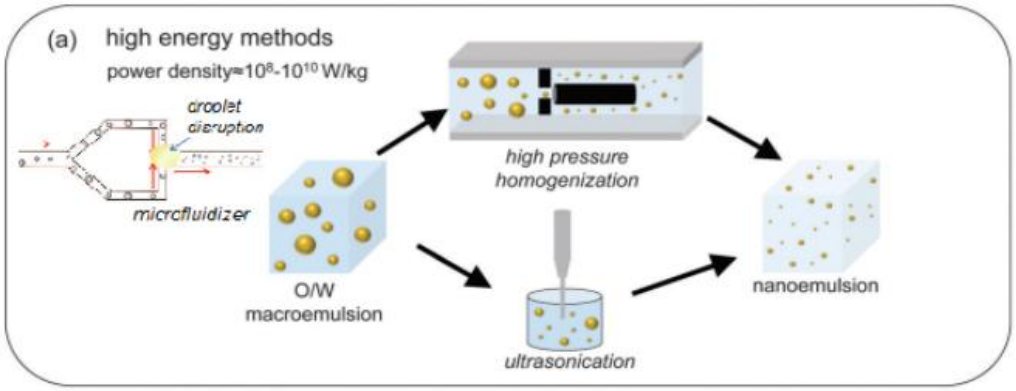

Fig. No. 4: High energy method.

2. **Ultrasonication**: In this method the rough emulsion is converted into desirable nanoemulsion using a sonicator- probe. High-intensity sound waves having a frequency of even more than 20 kHz are generated by the sonicator probe, which has the ability to shatter the rough emulsion into nano-sized droplets (5-500nm). Different types of probes with varying dimensions are available for a reduction in size up to recommended values. The sonication input intensity, time, and the probe type affect the droplet scale.[26]
3. **High-pressure homogenization technique**: Numerous forces such as hydraulic shear, severe turbulence and cavitation, are frequently utilized for the development of nanoemulsions. The surfactants and co-surfactants that are passed through a small orifice of a piston homogenizer under high pressure (500-5000 psi) to generate nanoemulsions. The problem of coalescence that would occur can be solved by incorporating excess surfactants into the mixture. High-pressure homogenization is a highly effective method and a cost-effective technology that can be used on both a small and a large scale to prepare nanoemulsions of extremely low particle size (up to 1 nm). The droplet size varies according to homogenization cycles and dispersed and continuous phase viscosities. The main drawbacks include consumption of a lot of energy and raising the temperature during the processing, which may lead to component deterioration. This approach works well for a nanoemulsion that has a 20% oil content since a high volume of oil in the formulation decreases the method's productivity.[27]
4. **Microfluidization**: This approach uses a microfluidizer device, which utilizes a high-pressure positive displacement pump (500- 20,000 psi) to force the product through an interaction chamber with stainless steel microchannels on the contact area, resulting in the creation of very small sub-micron particles. The mixture is circulated through the microfluidizer till it reaches the desired particle size. The final product is filtered to separate the smaller droplets from the bigger ones and produce a homogeneous nanoemulsion.[27]
5. **High-speed homogenization (rotor-stator homogenizer):** High-speed homogenizers are commonly used in industry for emulsification, dispersion, and comminution. They are simple to mount in existing vessels and tanks, and they are inexpensive to buy. Rotor-stator processes are often used in the emulsification method of preference in many manufacturing industries. Many studies prove that it is possible to produce nanoscale droplets through using rotor-stator processes. However, this necessitates the precise selection of method and formulation parameters.[28]
6. **Low-energy method**: The production of nanoemulsions using a low-energy emulsification process uses less energy than high-energy methods. They produce nanoemulsions by utilizing the system's inherent chemical energy and just by requiring mild stirring. Low-energy approaches include phase inversion methods and spontaneous emulsification.[28]

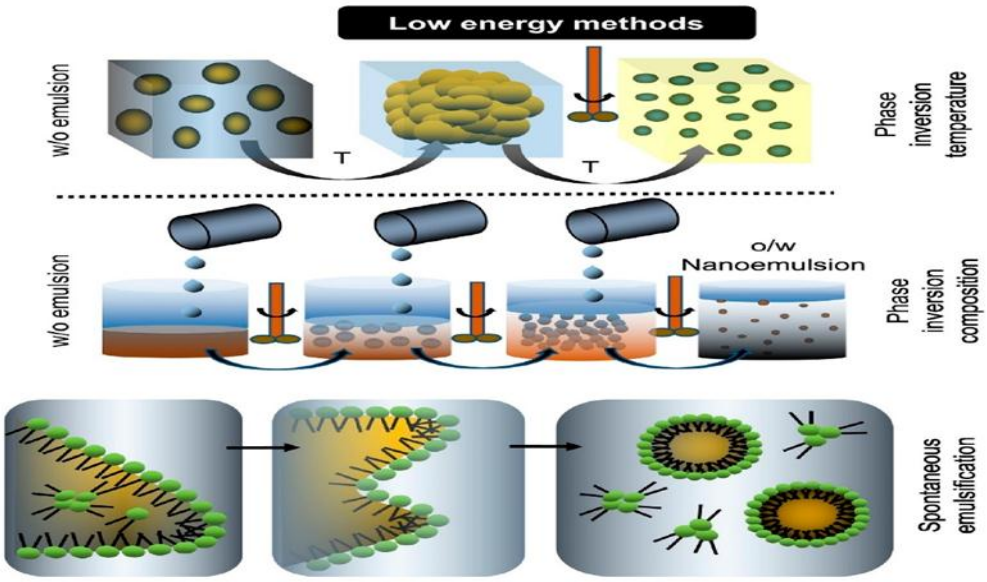

Fig. No.5: Low energy method.

7. **Spontaneous emulsification**: One of the most practical methods of nanoemulsion preparation is spontaneous emulsification. It consists two liquid components, one of which is aqueous phase and the other is organic phase. Solvents, surfactants, and co-surfactants that are water miscible are shifted from the organic phase to the aqueous phase. The process starts with an organic phase, such as oil and surfactant, being introduced into an aqueous phase, which is made up of water and co-surfactant. Massive turbulence at the phase interface is caused by the rapid migration of water-miscible components into the aqueous phase, which increases the oil–water interfacial area. As a result, small oil droplets form spontaneously.[28]

8. **Phase Inversion composition (PIC)**: A more advanced type of spontaneous emulsification is phase inversion composition (PIC). Unlike the high-energy method, this method produces nanoemulsions at room temperature and does not necessitate the use of energy-intensive equipment. A laboratory-grade magnetic stirrer is used to mix oil and surfactant while water is added drop by drop. Then, as the volume of water is elevated, a w/o nanoemulsion is produced initially, followed by an o/w nanoemulsion at the inversion point, all without using much energy. PIC method for the preparation of nanoemulsion is shown in figure.[28]

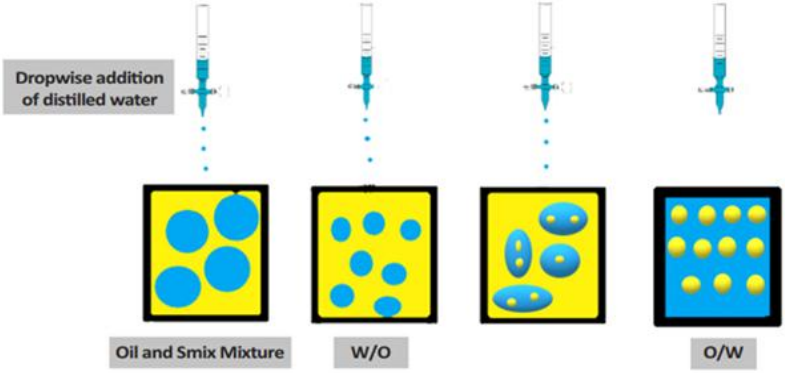

Fig. No. 6: Phase inversion composition.

Step 2: Preparation of nanoemulgel: For the preparation of gelling agent, first dissolve the polymer in purified water, and then stir it with a mechanical stirrer. After preparing the nanoemulsion and gelling agent, the two are constantly mixed until nanoemulgel forms. Water-in-oil (w/o) or oil-in-water (o/w) nanoemulsions are thickened and semi-solidified with the help of several polymeric gelling agents.[28]

Polymeric gelling agents: Natural Agar, Tragacanth, Guar gum, Xanthan Gum, Semi-synthetic and Synthetic Carbapol, Poloxamer, HPMC (cellulose derivatives).[29]

Evaluation of Nanoemulgel

1. **Physical examination:** The prepared formulation is inspected visually for their appearance, phase

separation, grittiness, homogeneity, and consistency.[29]

2. **Centrifugation stability study:** Formulations are diluted with purified distilled water. Then Nanoemulsion is centrifuged at 1000 rpm for 15 minutes at 30°C and observed for any change in homogeneity of formulations.[29]
3. **Measurement of pH:** of Formulations is dissolved in distilled water and pH was determined using digital pH meter.[29]
4. **Viscosity determination**: Using a Brookfield DV III ultraV 6.0 cone and plate rheometer, the viscosity of the formulation is determined.[30]
5. **Percentage transmittance:** Measured using Shimadzu UV-VIS spectrophotometer percentage transmittance of the nanoemulsion is determined.[30]
6. **Particle size analysis**: Based on the laser light scattering phenomenon, the particle size of the nanoemulsion is determined using a photon correlation spectrometer.[30]
7. **Zeta potential**: The zeta potential is measured by zeta sizer using double distilled water. The formulation of about(0.1ml) is diluted 100 times, then it creates surface charges, and the emulsifier acts as a mechanical barrier. The stable nanoemulsion will be formed, when there is a more negative zeta potential and it will affect net charge of the droplets.[30]
8. **Size of globules:** 1.0 gm of formulation is dissolved in water and agitated to ensure dispersion prior to placing the sample into the Malvern zeta sizer's photocell to measure globule size.[31]
9. **Measuring the strength of bio adhesives:** One glass slide is fastened to each of the apparatus's arms, and these slides are sandwiched between two more glass plates. The additional weight is added using only one plate. An exact one gram of nanoemulgel is placed in the middle of two slides that contain samples of hairless rat skin. It is possible to separate two glass slides that have been sandwiched together by applying pressure to only one of the slides. After then, an additional weight is added each minute until the surface of the skin begins to crack. The strength of the bio adhesive is determined by determining the amount of weight necessary to detach the nanoemulgel from the skin. The formula that is used to determine it is as follows.

$$\text{Bio adhesive Strength} = W / A$$

Where, W is the required weight in grams and A is the area (cm^2).[31]

10. **Spreadability of Gellified Nanoemulgel:** It may be calculated using the Multimer-recommended slip and drag basis. A glass slide of comparable size is sandwiched in between the bottom ground slide, which is attached with a wooden block and 2 g of Nanoemulgel, and the top ground slide, which is fastened with a hook and 500 mg of weight. More pressure was put on the pan connected to the second slide after five minutes. By timing how long it took the upper slide to advance 5 cm and then using the following calculation, the spreadability is determined.

$$\text{Spreadability } (S) = M * L / T$$

Where, M is the upper slide's weight,
L is the length of the glass slides, and
T is the time it takes for the upper slide to cover the distance.[32]

11. **Drug entrapment efficiency (EE%)**: Measured by using an aqueous medium by measuring the concentration of the free drug. Then it will influence the release of characteristics of drug molecules, this is first important. The nanoemulsion formulation after the separation of entrapped drug is determined by the amount of drug encapsulated per unit weight of nanoparticles[32]

$$E = \frac{\text{Weight of total drug in formulation - weight of the drug in aqueous phase} \times 100}{\text{Weight of drug in the formulation}}$$

12. **Drug content:** The drug content is determined using a UV-visible spectroscopic technique. A volume-equivalent dose of drug is dispersed in an appropriate amount of sample. The samples were measured at their maximum. The results were obtained in triplicate.

$$\text{Amount of drug} = \text{concentration from the standard graph} \times DF / 1000$$

Where DF = dilution factor.[32]

13. ***In vitro* drug diffusion study**: The drug release investigations are conducted using the Franz diffusion cell. A volume equal to a 500 mg dose is put across the drug release membrane. The donor and receptor chambers of the diffusion cell are separated by a cellophane membrane. To solubilize the medication, the receptor chamber is filled with a solution of newly produced phosphate buffer pH and methanol (80:20). The magnetic stirrer is used to agitate the receptor chamber. The samples are taken at appropriate time intervals, and the drug concentration is determined using a UV-visible spectrophotometer at maximum after adequate dilutions.[33]
14. **Stability studies at different temperature conditions**: Temperature stress studies are conducted by storing the formulation at different temperature conditions. Each formulation is stored in sealed glass containers in a refrigerator (4°C), at ambient temperature (25°C), and at accelerated temperature (40°C) for 90 days. After 1, 7, 14, 21, 30, 45, 60, and 90 days, the formulations are evaluated for any physical change (such as clarity, phase separation, precipitation of drug, color change), drug content, and pH.[34]

CONCLUSION

Topical nanoemulgels have been shown to be a more effective and convenient medication delivery technique.

Gel and non-greasy qualities improve patient compliance, and the lack of oil as a base improves medication release as compared to other formulations. The use of nanoemulsion in a gel matrix allows the formulation to dual-regulate the released system, resolving problems such as creaming and phase separation associated with classical emulsions with better spreadability. In some topical illnesses, a nanoemulsion-loaded gel is more beneficial. The future of nanoemulsion-gel-based formulations may provide a better and more dependable alternative for hydrophobic drug delivery. Many medications used to treat skin infections are hydrophobic in nature, and such treatments can be successfully transmitted as nanoemulgels where drugs are included.

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