International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 6 Issue 4, May-June 2022 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Overview of Microemulsion

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ABSTRACT

Microemulsions are clear, stable and isotropic liquids. It is the mixture of oil, water and surfactant with the use of co-surfactants. It acts as a potential drug carrier for parenteral, topical and oral administration. The microemulsion is one of the most used novel drug delivery systems for pharmaceutical applications. They show favorable characteristics such as long shelf life, improved drug solubilization and ease of preparation. Most of the novel vehicles are used for sustained and controlled release systems. They are versatile systems that show a wide range of compounds mainly hydrophobic and hydrophilic domains. They aimed at controlling the bioavailability of the various drug molecules. The review puts forward the recent development of a micro emulsion-based system.

KEYWORDS: *Hydrophobic, Microemulsion, Surfactant, Winsor phase*

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How to cite this paper: Manisha Ankush Sukre | Sayali Dattu Dhepe | Dr. Vijaya Barge "Overview of Microemulsion" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-6 | Issue-4, June 2022, pp.657-669, URL: www.ijtsrd.com/papers/ijtsrd50106.pdf

IJTSRD50106

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INTRODUCTION

Combinatorial chemistry has led to the generation of a large number of new compounds. Other methods to improve solubility and oral bioavailability are reduction of particle size (micronization and nanosizing), cyclodextrin complexation, salt formation, co-solvent-based solubilization, and surfactant. The concept of microemulsion was introduced by Hoar and Schulman in the 1940s, it was a clear single-phase solution by triturating a milky emulsion with hexanol. The first microemulsion was prepared by dispersing oil in an aqueous surfactant solution and adding alcohol as a co-surfactant leading to a transparent stable microemulsion.

Microemulsions are the stable, isotropic and clear mixture of oil, water, surfactant and co-surfactants. These are thermodynamically stable mixtures. A microemulsion can be in oil form, water can also be an amphiphile, it is a single optically identical and thermodynamically stable solution. The alternatives for these are swollen micelle, transparent emulsion and oil and micelle solutions. They show advantages over conventional dosage forms such as scale-up, a spontaneous formation, ease of preparation and improved drug solubilization of hydrophobic drugs as well as bioavailability. The novel drug delivery system with the nature of enhancing the effectiveness of an existing drug is a recent development in pharmaceutical research.

Advantages of microemulsion

1. Preparation of microemulsion is easy and no energy is required due to thermodynamic stability.
2. The microemulsion is a reversible formation. The stability range of microemulsion at unstable low or high temperature, when the temperature returns to stability, microemulsion reforms.
3. It allows the self-emulsification of the system.
4. They have low viscosity compared to emulsions.
5. The solubilization of hydrophilic and lipophilic drugs, drugs insoluble in both aqueous and hydrophobic solvent, therefore it acts as super solvents.
6. The o/w or w/o microemulsion act as a potential reservoir for lipophilic and hydrophilic drugs.

7. It improves the efficacy of the drug allowing the total dose is reduced and also reducing side effects.
8. They can carry both hydrophilic and lipophilic drugs.
9. Microemulsions have a long shelf life.
10. It acts as a bioavailability enhancer for poorly water-soluble drugs.

Disadvantages of microemulsion

1. Limited solubilizing capacity for high melting substances.
2. A large amount of surfactant is required for stabilizing droplets.
3. The stability of microemulsion depends on environmental parameters such as temperature, and pH.
4. There is a limited choice of microemulsion components leading to difficulties in the formulation.
5. It also suffers from phase separation.

Structure of microemulsion

The micellar emulsion is a dynamic system in which the interface is continuously fluctuating. Structurally they are divided into oil in water, water in oil and bicontinuous microemulsion. In w/o microemulsion, water droplets are dispersed in the continuous oil phase. In o/w microemulsion, the oil droplets are dispersed in a continuous aqueous phase. In a bicontinuous system, the amount of water and oil are similar. The different mixtures of oil, water and surfactant form a wide variety of structures and phases depending upon the proportion.

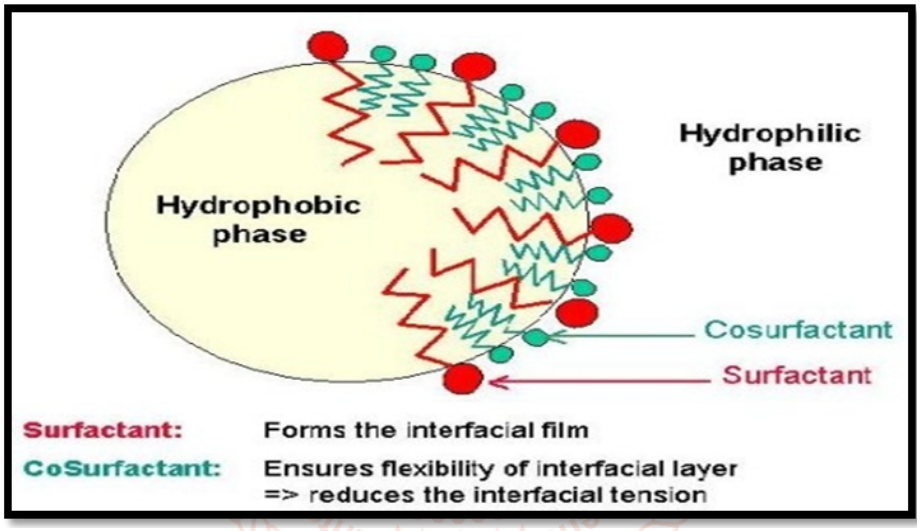


Figure 1: Structure of Microemulsion

Characteristics of microemulsion

If a surfactant possesses hydrophilic and lipophilic properties in the right concentration, a different oil and water system is produced. The system remains an emulsion but exists some characteristics different from the milky emulsion. This new system is termed a microemulsion. The interfacial tension between phases, amount of energy required for the formation of droplet size and visual; appearance are a few differences in the emulsion to microemulsion. Water in oil microemulsion is known as a reverse micelle. This system has the ability to solubilize both hydrophilic and hydrophobic substances. Microemulsion shows low viscosity and Newtonian characteristics. A variety of technologies are used to characterize different properties such as X-ray diffraction, light scattering, ultra-centrifugation, electrical conductivity and viscosity measurement.

Construction of phase diagram

Pseudo ternary phase diagrams of oil, water, surfactant, or co-surfactant mixture are constructed at a fixed co-surfactant or surfactant ratio. It is constructed to obtain the appropriate component and their concentration ranges that result in the large existence of microemulsion. It is also used to define the extent and nature of the microemulsion region. A large number of samples of different compositions are prepared. To study such a diagram comprising surfactant, oil and water at fixed pressure and temperature, the ternary diagram is used.

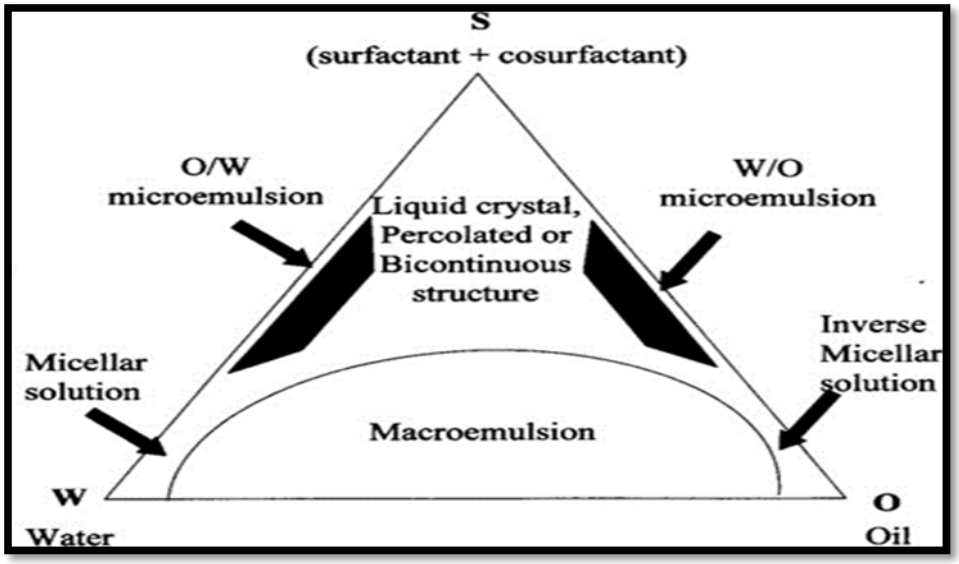
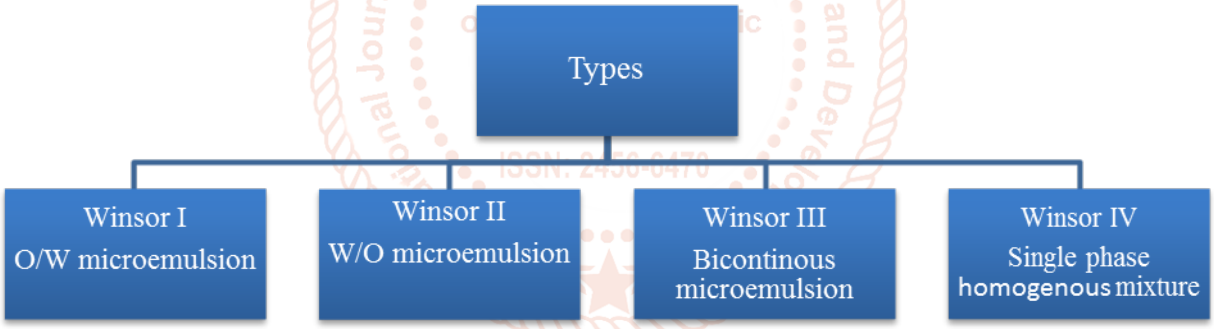


Figure 2: The pseudo ternary phase diagram of the microemulsion system of Oil (O), Water (W), Surfactant and Co- surfactant mixture (S)

The formation of a monophasic or biphasic system is confirmed by visual inspection. In case, turbidity appears with phase separation, the sample is a biphasic system. In the case, of a monophasic system, they ate visualized after stirring and samples are marked as points in the phase diagram. The area covered by these points is considered as the microemulsion region of existence. In the ternary phase diagram, each corner represents 100% concentrations.

CLASSIFICATION OF MICROEMULSIONS

According to Winsor, four types of microemulsion phases exist in equilibrium. These phases are also called Winsor phases.



- **Oil in water microemulsion or Winsor I**

In this phase droplets of oil are surrounded by a surfactant (and may be cosurfactant) film that forms the internal phase distributed in water, which is the continuous phase. This has a larger interaction volume than the w/o microemulsions.

- **Water in oil microemulsion or Winsor II**

In this phase droplets of water are surrounded by a continuous oil phase. These are referred to as "reverse micelles". A w/o microemulsion used orally or parenterally can be destabilized by an aqueous biological system.

- **Bicontinuous microemulsion or Winsor III**

In this phase, the oil and water phase are in similar concentrations. Both the phase exists as the continuous phase. Transitions occur from o/w to w/o microemulsion may pass through these Bicontinuous states. It shows non - Newtonian flow and plasticity. It is used for topical delivery of drugs or intravenous administration.

- **Single-phase homogeneous mixture or Winsor IV**

In a single-phase the oil, surfactants and water are homogenously mixed.

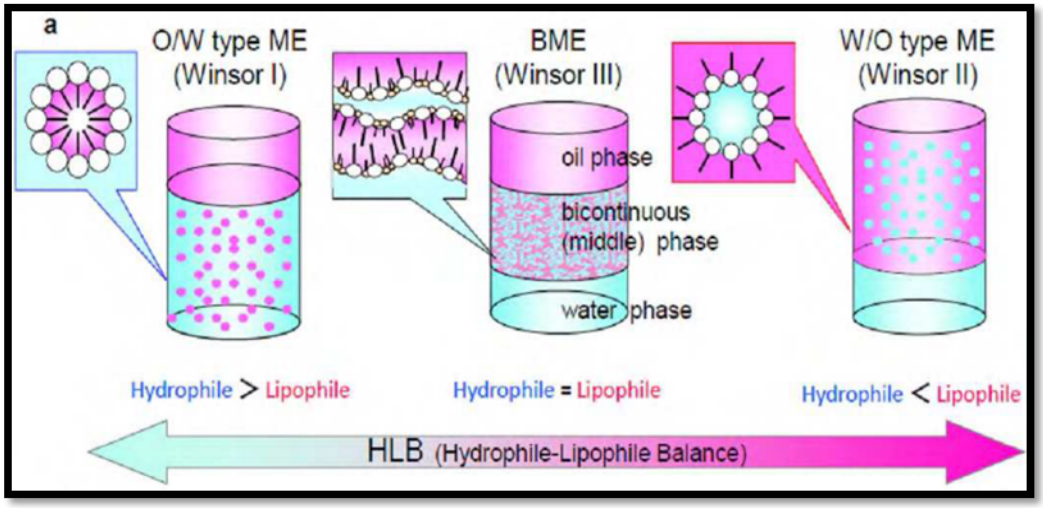


Figure 3: Types of Microemulsions

Difference between Emulsions, Microemulsions and Nanoemulsions

Table 1: Difference between Emulsions, Microemulsions and Nanoemulsions

Parameters	Emulsions	Microemulsions	Nanoemulsions
Appearance	Opaque or milky	Transparent or translucent	Transparent or translucent
Structure	Spherical droplets	Swollen micelles or sponge-like structures or droplets	Small encapsulated bioactive lipophilic compound
Droplet size	>500 nm	1- 100 nm	1-100 nm
System	Biphasic system	Monophasic system	Monophasic system
Stability	Kinetically stable, thermodynamically unstable	Kinetically unstable, thermodynamically stable	Kinetically stable, thermodynamically unstable
Viscosity	High	Low	Low
Nature	Anisotropic	Isotropic	Isotropic
Interfacial tension	High	Ultra-low	Low
Energy requirement	Very high	Low energy	Both high and low Energy
Microstructure	Static	Dynamic	Dynamic
Molecular Packing	Inefficient	Efficient	Efficient

THEORIES OF FORMATION OF MICROEMULSION

1. Thermodynamic theory
2. Solubilization theory
3. Interfacial or mixed film theory

➢ **Thermodynamic theory**

The stability of microemulsion can be expressed by a thermodynamic mechanism. The free energy of microemulsion formation is dependent on the lowering of surfactant of the oil-water interface, it changes the entropy of the system. It is found when microemulsion is formed there is a large change in ΔA value due to a large number of very small droplets are formed. The favorable entropic contribution is a very large dispersion entropy arising from the mixing of one phase in another phase. It also shows the change from other dynamic processes such as monomer- micelle surfactant exchange and surfactant diffusion in the interfacial layer. When there is significant favorable entropic change, the formation of negative free energy is achieved. As a result, microemulsification is spontaneously and thermodynamically stable.

$$\Delta Gf = \gamma \Delta A - T\Delta S$$

Where,

ΔGf= Gibbs free energy of formation

γ = Surface Tension of the oil-water interface

ΔA = Change in interfacial area

ΔS = Change in entropy of the system

➢ **Solubilization theory**

There is the formation of the oil-soluble phase and water phase by micelles or reverse micelles. In micellar formation, it gradually becomes larger and shows swelling forming certain size range results. The relationship between reverse micelles and water in oil microemulsion is explained with the help of a pseudo ternary phase diagram.

➢ **Interfacial theory**

It is also called interface mixed film theory or negative interfacial tension theory. According to this theory, the microemulsion has been capable to form instantaneous and spontaneously generate negative interfacial tension. This film may consist of surfactant and co-surfactant molecules. It is considered a liquid "two-dimensional" third phase in equilibrium with both oil and water. It is considered a duplex film i.e.; it gives different properties on the oil side and water side.

$$\gamma i = \gamma o/w \; - \; \pi i$$

Where,

γi= Interfacial tension

πi = Spreading pressure

$\gamma o/w$ = Oil-water interfacial tension without the film present

FACTORS AFFECTING FORMULATION OF MICROEMULSION

➢ **Property of surfactant:**

It contains two groups namely lipophilic and hydrophilic groups. The hydrophilic single-chain surfactant will dissociate completely in dilute solution and resulting in o/w microemulsion, when the surfactant is in presence of salt or when the high concentration surfactant, the degree of dissociation decreases ad it results in w/o microemulsion. Hence, the degree of dissociation is an important factor in the formation of the microemulsion. An increased hydrophobic chain length results in a bicontinuous phase.

➢ **Property of oil phase:**

The oil phase influenced penetration and it shows swelling in the tail group region of the surfactant monolayer. Swelling of tail results in increased negative curvature to w/o microemulsion. As the aromaticity of oil increases, a phase transition occurs from o/w to w/o.

➢ **Packing ratio:**

The Hydrophilic lipophilic balance (HLB) of surfactant determines the type of microemulsion. It has influenced packing and film curvature. The analysis of film curvature for surfactant association is an important factor in the formation of a microemulsion. The ability of surfactants to form particular aggregates to the geometry of the molecule itself is called a critical packing parameter (CPP). The CPP can be calculated using the equation:

$$CPP = V/a * l$$

Where,

V = The partial molar volume of the hydrophobic portion of the surfactant

a = The optimal head group

l = The length of the surfactant tail

- When the CPP has a value between 0 and 1 then o/w microemulsion forms its positive curvature because the interface curves towards the water.
- When the CPP > 1 then w/o microemulsion formed its negative curvature because the interface curves towards oil.
- When the CPP is equal to or close to 1, Bicontinuous microemulsion is formed.

➢ **Temperature:**

Temperature mainly determines the effective head group size of non-ionic surfactants. At low temperature, it shows hydrophilic and forms an o/w system. At higher temperature, they show lipophilic and show w/o system.

At intermediate conditions microemulsion, co-exists with excess water and oil and forms a bicontinuous phase.

➢ **Chain length, type and nature of co-surfactant**

The addition of short-chain co- surfactant results in positive curvature and o/w microemulsion is formed. While the addition of long-chain co-surfactant results in negative curvature and w/o microemulsion is formed. Alcohol is mostly used as a co-surfactant in microemulsion.

COMPOSITION OF MICROEMULSION

The major components of the microemulsion system are:

1. Oil phase
2. Aqueous phase
3. Surfactant
4. Co- surfactant

➢ **Oil phase:**

Oil is an important component of microemulsion. The selection of oil is of the two factors

A. The solubilizing potential of oil for the selected drug should be considered.
B. The surface of the microemulsion is enhanced.

Oil has the ability to solubilize lipophilic drugs. It is transported through the intestinal lymphatic system. Oil has low polarity and low miscibility with water. Examples are cyclohexane, mineral oil, toluene and vegetable oil.

➢ **Aqueous phase:**

The aqueous phase contains hydrophilic active ingredients and preservatives. Buffer solutions are used in the aqueous phase.

➢ **Surfactant:**

Surfactants also called referred to as surface-active agents. The surfactant is a substance that shows interfacial or superficial activity. It is used to lower the surface or interface tension. It has an affinity for polar and non-polar substances. Surfactants are a molecule that contains a polar head group and a polar tail group. The surfactant can arrange themselves in a variety of shapes. They show self-association due to inter and intramolecular forces as well as entropy consideration. At a low concentration of dispersed phase, spherical isolated droplets are present in microemulsion.

There are different types of surfactants in the development of microemulsion system

1. Cationic
2. Anionic
3. Nonionic
4. Zwitterionic/ Amphoteric

A nonionic surfactant is less toxic than an ionic surfactant agent. They show a high HLB value. The HLB value < 10 shows the formation of w/o microemulsion and the HLB value > 10 shows the formation of o/w microemulsion.

Table 2: Types of surfactants

Sr no.	Types of surfactants	Properties	Examples
1.	Cationic Surfactant	The hydrophilic group carries a positive charge. It is more expensive than compared to the anionic surfactant.	Alkyl ammonium chloride
2.	Anionic Surfactant	These are negatively charged surfactants.	Sodium lauryl sulfate Ammonium lauryl sulfate
3.	Nonionic surfactant	The hydrophilic group has no charge. It is stabilized by dipole and hydrogen bond interactions by the hydration layer.	Fatty alcohol: cetyl alcohol, stearyl alcohol Ethers: Brij, Decyl glucoside Esters: Glyceryl laurate, Polysorbates Block copolymers: Poloxamers
4.	Zwitterionic surfactant	It contains both positive and negative charges. They form microemulsions by the addition of co-surfactants.	Lecithin, Betaines

➢ **Co- surfactant:**

Single-chain surfactants alone are unable to reduce o/w interfacial tension sufficiently to form a microemulsion. The presence of co-surfactant allows flexibility of interfacial film-forming different curvatures to form

microemulsion over a wide range. Short to medium chain length alcohol is commonly used as a co-surfactant and reduces interfacial tension and increases the fluidity of the interface. Relatively 30% w/w is needed to produce effective microemulsion Ethanol, Propylene glycol, and Polyethylene glycol help to dissolve a large amount of either the hydrophilic surfactant or the drug of lipid base. Polymeric liquid and semi-solid excipient can be used alone or in a mixture with their lipid excipient to improve solubilizing power of formulation.

Table 3: Components of microemulsions

Component	Examples
Oil	Saturated fatty acid: lauric acid, capric acid Unsaturated fatty acid: oleic acid, linolic acid, linolenic acid Fatty acid ester: Ethyl or methyl ester of lauric, oleic acid and myristic acid
Surfactant	Polyoxyethylene / Polysorbate / Tween 20,40,60,80 Sorbitan monolaurate, Eggs lecithin Sodium dodecyl sulfate
Co- surfactant	Propylene glycol, Polyethylene glycol, Isopropyl alcohol, Isopropyl myristate, Ethanol, Propanol, Isopropanol

PREPARATION METHOD OF MICRO-EMULSION

1. Phase titration method
2. Phase inversion method

Phase titration method

In this method, the spontaneous emulsification process takes place and depiction is with the help of a phase diagram. Construction of the segment format is a beneficial strategy to learn about the complicated, collection of interactions that can take place when a specific element is mixed. The phase equilibrium and demarcation of the segment boundary are an important part of the study. The o/w or w/o microemulsion can be separated by thinking about the composition that it is oil-rich or water-rich.

Phase inversion method

Phase inversion occurs as a result of the addition of excess dispersed segment or response to temperature. During section inversion, there are physical modifications which include a change in particle measurement that can affect drug launch each in vivo and in vitro. This technique uses altering the spontaneous curvature of surfactant. During cooling, the drug crosses the factor of zero spontaneous curvature and minimal floor tension. There is the formation of a finely dispersed oil droplet. This is referred to as the phase inversion temperature method.

General Preparation method of microemulsion

- Generally, the drug is dissolved in the lipophilic part (oil) of the microemulsion.
- The water phase is combined with surfactant and the co-surfactant is added with constant stirring using a magnetic stirrer until the system becomes transparent.
- The amount of surfactant and co-surfactant to be added and the percent of oil phase are incorporated is determined with the help of a pseudo ternary phase diagram.
- Then finally, an ultrasonicator was used to achieve the desired size of dispersed globules. Lastly, it is allowed to equilibrate.

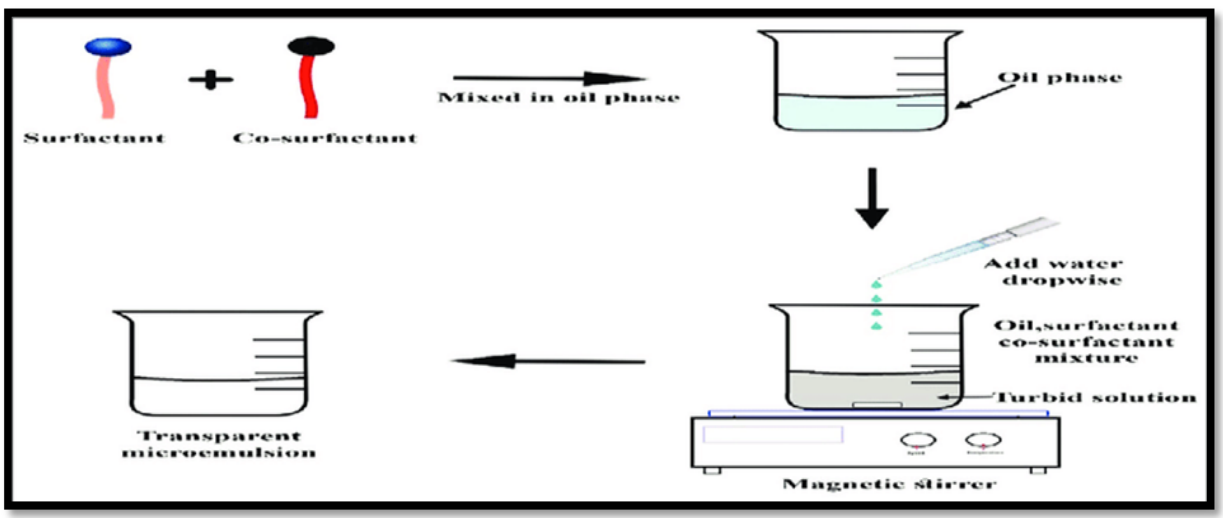


Figure 4: Preparation of microemulsion

EVALUATION OF MICROEMULSION

1. Physical appearance
2. pH
3. Viscosity
4. Scattering technique
5. Limpidity test
6. Drug stability
7. Determination of particle size
8. Zeta Potential
9. Drug solubility
10. In vitro drug release
11. Electrical conductivity
12. Drug content analysis

1. Physical appearance

The prepared microemulsion was inspected visually for its transparency, fluidity and homogeneity.

2. pH

The pH of the microemulsion was determined using a digital pH meter. Before measuring the pH, the pH meter should be calibrated with the standard buffer solution of pH 4 and 7. The measurement of the pH of the microemulsion is done in triplicate to avoid an error.

3. Viscosity

It has an important role in stability. Changes in rheological characteristics help in determining the microemulsion region and the other region. The viscosity of microemulsion was determined by using a Brookfield viscometer.

4. Scattering technique

It includes small-angle neutron scattering, small perspective x-ray scattering, and light scattering to determine the purpose of research on microemulsion. The monodisperse spheres and polydisperse systems are considered in microemulsion.

5. Limpidity test

It is also called as percent transmittance test. It is measured using a spectrophotometer.

6. Drug stability

The optimized microemulsion was unbroken beneath cold conditions 4-8 ℃ and elevated temperature of 50±2, once each two months the microemulsion will be analyzed for section separation.

7. Particle size determination

The size and distribution of microemulsions were obtained from Malvern Zetasizer 6.20 version. The principles of the laser scattering sample were followed. Malvern Zetasizer with laser scattering principle with argon laser was employed for evaluating the globule size and distribution of the sample. The size of microemulsions was assumed to be spherical. Measurement of droplet size is considered one of the important factors for microemulsion. Microemulsion formulation with larger globules leads to creaming or aggregation. Microemulsion with a small globule is said to be a stable formulation.

8. Zeta potential:

It is considered one of the important factors. It is a term that determines the stability of the microemulsions as well as the charge present in the formulation. A highly positive or highly negative charge indicates higher stability in the oil interface. It is dependent on the surfactant used. The Zeta potential is measured using the Zetasizer nano series which can measure the size between 0.6 -6000 nm. It is analyzed in triplicate and the mean value is calculated.

9. TEM Analysis:

Morphology of Microemulsion was studied using TEM, TOPCON 002B used at 200 KV and 0.18 nm. It provides point-to-point resolution. Increasing magnification, Bright-field images were used to find the type and size of the microemulsions. A small drop of diluted microemulsion was deposited on a copper holey film grid and observed by a fixation agent and dried in filtered air.

10. Drug excipient compatibility:

It is used to study the compatibility of drugs and excipients. The compatibility of drugs and excipients can be studied using Fourier transform infrared spectrophotometer. The sample is dried under a vacuum to prevent moisture. It is scanned at a suitable frequency.

11. Drug solubility

The drug was added in excess to the optimized microemulsion formulation as well as each ingredient of the formulation. After continuous stirring for 24 hrs at room temperature, samples were withdrawn and centrifuged at 6000 rpm for 10 minutes. The amount of soluble drug in the optimized formulation as well as each ingredient of the formulation was calculated by subtracting the drug present in the sediment from the total amount of drug added.

12. In vitro drug release

In diffusion, the study can be carried out on Franz diffusion cells within the volume of 20 ml. The receptor compartment was filled with buffer. The donor compartment consists of cellophane containing the microemulsion formulation and plain drug solution separately. At a predetermined time interval samples were withdrawn from the receptor compartment and analyzed for drug content using UV spectrophotometer at a specific wavelength.

13. Electrical conductivity

Electrical conductivity is utilized to identify the nature of the continuous phase. It is measured using an electro conductometer, use to identify whether there is an oil or water as a continuous phase. It also identifies the phase inversion phenomenon. For conductivity measurement, an electrode pair is attached to a lamp and a power source is attached to a microemulsion. If the formulation is o/w the lamp will glow as water is conducting current, if the formulation is w/o the lamp will not glow because the oil phase will not conduct current.

14. Drug content

The drug content of microemulsion can be measured by dissolving a known amount of formulation in a solvent and placing it in a dark place for 24 hours. The absorbance is measured after its suitable dilution at a specific wavelength.

$$Drug\ content = (Concentration\ of\ drug \times Dilution\ factor \times Volume\ taken) \times Conversion\ factor$$

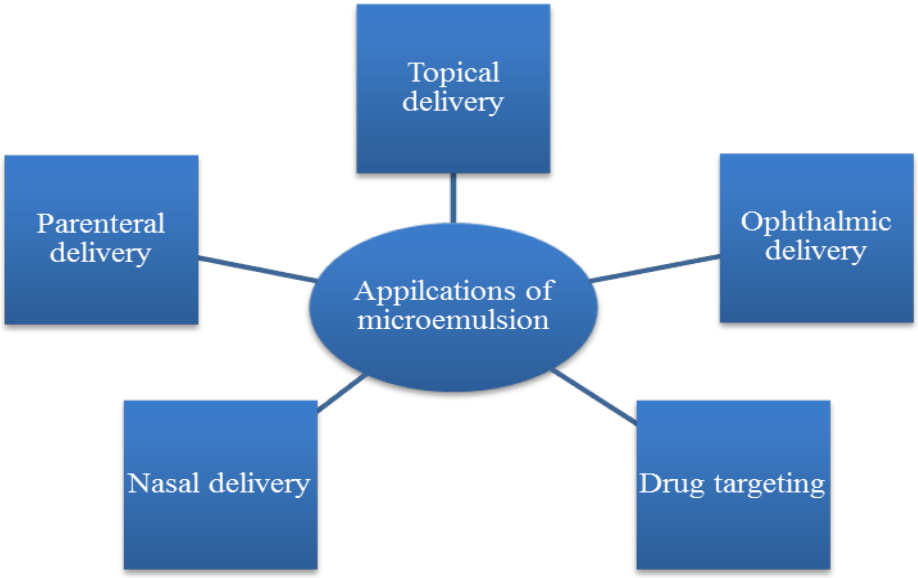
RATIONALE FOR MICROEMULSION

Microemulsions have gained significant attention due to their stability, solubility, simplicity and formulation aspects. The application of microemulsions is not only limited to oral, topical and parenteral routes but has also shown their potential in cosmetics as well as immunology, sensor devices and analytical chemistry. These formulations are often termed broad-spectrum applications in drug targeting and control release. These also protect the formulation from hydrolysis and oxidation. These facilitate increase patient compliance. Microemulsions are formulated keeping the idea in mind the use of unique characteristics such as minimum side effects and reduction in the volume of carrying vehicles.

APPLICATIONS OF MICROEMULSION

- **Parenteral delivery**

These are the administration through the intravenous route of a drug. As the low amount of drug is delivered to the target site, the drug has limited solubility. The advantages over microemulsion are that when delivered parenterally because of the fine particle microemulsion is clear more slowly than coarse particle emulsion. These microemulsions have a longer residence time in the body. The formulation of w/o microemulsion is beneficial in the delivery of the sparingly soluble drug, in this administration of suspension is not required.



➢ **Oral delivery**

The solubilization of BCS class II or class IV (poorly soluble drugs) is enhanced by microemulsion. The main approach for formulating an effective oral delivery system is because the drug efficiency can be restricted by instability or poor solubility in gastrointestinal fluid. It also overcomes the dissolution-related bioavailability problem. The varying solubility of a micro molecule is encapsulated for a polar, non-polar and interfacial domain, hydrophilic drug. These systems have been protecting the incorporated drug against oxidation, enzymatic degradation and enhancing membrane permeability. Commercially available microemulsions for oral delivery are Sandimmune Neoral ® (Cyclosporine A), Fortovase ® (Saquinavir), and Norvir ® (Ritonavir).

Table 4: According to BCS classification

Class	Permeability	Solubility
I	High	High
II	High	Low
III	Low	High
IV	Low	Low

➢ **Nasal delivery**

These are the microemulsion that enhances the uptake of the drug through the nasal mucosa. Mucoadhesive polymer improves the prolonged residence time. Diazepam is used in the emergency treatment of epileptics. The nasal absorption of diazepam is 2 mg kg-1 dose. The maximum drug plasma concentration is 2-3 minutes.

➢ **Topical delivery**

Topical delivery avoids first-pass metabolism. It also reduces the toxicity effect. They have the direct drug delivery and target ability of a drug to the affected area of skin and eyes. The area of drug penetration into the skin has a number of studies. In this penetration study they incorporate both hydrophilic (5 – fluorouracil, apomorphine hydrochloride, tetracaine hydrochloride) and lipophilic drugs (oestradiol, ketoprofen, felodipine) and enhance the penetration. In this formulation, skin-irritating aspects are considered.

➢ **Ophthalmic delivery**

In conventional dosage form, water-soluble drugs are delivered aqueous solution and water-insoluble drugs are formulated through suspension and ointment. Microemulsion has emerged as a promising dosage form for ocular use in achieving improved patient compliance and is favorable for ophthalmological use. OFX microemulsions are used as a promising strategy for ocular drug delivery. The anatomy, physiology and biochemistry of these organs render the entry of any other foreign materials. The main motto is to formulate a protective eye barrier without damaging the tissue. The eye is considered a unique and valuable organ. This is termed a window hinge. They are divided into traditional and new drug development. Topical application of the eye is the most acceptable route for the eye. Newer liposomes, Nanoemulsions, microemulsions, iontophoresis, and ocular inserts have been developed for increasing the bioavailability of the microemulsions.

➢ **Other application**

1. Skin penetration of lycopene is improved by microemulsions.
2. The microemulsion is a vehicle for the transdermal permeation of nimesulide.

3. Oil recovery, detergency, cosmetics, agrochemical, and food are enhanced by microemulsions.
4. Microemulsions are used as fuel, lubricant, cutting oils and corrosion inhibitors, coating and textile finishing.
5. Microemulsions are used in microporous media synthesis (microemulsion gel technique).
6. Microemulsions are an analytical technique.
7. Microemulsions as liquid or membrane, novel crystalline colloidal arrays as a chemical sensor material.
8. Microemulsions in biotechnology.

Table 5: Research work carried out on Microemulsions

Drug Name	Category	Route of administration	Purpose/ Result
Piroxicam	NSAID	Oral	Increased the solubility
Acyclovir	Antiviral	Oral	Improved bioavailability
Ketoprofen	NSAID	Transdermal	Improved the solubility
Itraconazole	Antifungal	Parenteral	For better absorption
Ibuprofen	NSAID	Topical	Increased the solubility
Chloramphenicol	Anti-bacterial	Ocular	Enhancement of Permeability
Dexamethasone	Anti-inflammatory/ Corticosteroids	Topical- ocular	Improved bioavailability
Fenofibrate	Antilipemic	Self- Micro- emulsifying	Increased the solubility
Aceclofenac	NSAID	Dermatological	Improved the solubility

FUTURE PROSPECTIVE

Microemulsion acts as a modern colloidal drug carrier system. It also acts as a high solubilization capacity and improves drug delivery. The main approach is to increase the solubility of poorly soluble drugs enhance bioavailability reduce special variability. It also acts alternative for controlling drug release. Several innovations are included in microemulsion technology. This formulation can be easily scaled up, it is important from an industrial point of view. Also, conventional drug delivery and microemulsion-based product are used in combination example cosmetic formulation. The recent research is carried out for safe, efficient and compatible microemulsion leading further to enhanced use of the novel vehicle. Microemulsions are used for cosmetic purposes and drug targeting and also extraordinarily drug delivery carriers for human betterment, essential ethical consideration.

CONCLUSION:

Microemulsions are very important in drug delivery as well as in the industrial process. They are used to optimize drug targeting and increase systemic absorption. They are primarily used as novel solutions for poorly soluble substances and lipophilic substances. They are used to protect liable drugs, and control drug release and patient variability. It has considered a full potential and novel drug delivery system. The current research work is focused on safe, efficient and more compatible microemulsions. They enhance the utility of novel vehicles. It is used to formulate most of the routes. these formulations are used to pass the various drug barrier and reach the target. They show their potential in multipurpose drug delivery systems, show a higher percentage of surfactants and they are used for the formulation of the microemulsion.

PATENT ABILITY:

The main idea behind formulating the microemulsions are the unique characteristics featured by them. The ease of application makes them far better dosage form than other. Microemulsions show wide range of applicability, as they can deliver through all major routes of drug delivery. They show enhanced bioavailability for lipophilic drugs. They show great potential to carry hydrophilic as well as lipophilic drugs. Drugs which are formulated using microemulsions show longer shelf life than other biphasic dosage forms. The recent studies in formulation of low HLB surfactant with a High HLB surfactant are need to be carried out.

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IJTSRD International Journal of Trend in Scientific Research and Development ISSN: 2456-6470