WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.453
Volume 14, Issue 15, 1675-1684. Review Article ISSN 2277–7105

A REVIEW ON MICROEMULSION AND ITS HISTORY

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Article Received on
21 June 2025,

Revised on 11 July 2025,
Accepted on 31 July 2025,

DOI: 10.20959/wjpr202515-37850

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• ABSTRACT

Clear, thermodynamically stable, isotropic liquid mixes of oil, water, and surfactant—often in conjunction with a co- surfactant—are known as microemulsions. Depending on their structure, they can be categorised as bi-continuous systems, water-in-oil (w/o), or oil-in-water (o/w). They are distinguished by extremely low interfacial tension between the water and oil phases. Because of their compounds, pharmaceutical specialists are interested in microemulsions. Enhancing the microemulsion's dissolving rate and impact on oral and other delivery methods was the aim of the study. These flexible and adaptive delivery methods enhance the solubilization of lipophilic medications and, consequently, their bioavailability while offering protection against oxidation and enzymatic hydrolysis. They can be delivered continuously and precisely via the ocular, dental, pulmonary, vaginal, and topical channels in addition to the oral and intravenous methods.

• **KEYWORDS:** Microemulsion, components, phase behaviour, delivery system.

• INTRODUCTION

Micro-emulsions are isotropic, thermodynamically stable combinations of water, oil, and one or more surfactants that have drawn a lot of interest from a variety of industries, including the food, cosmetic, and pharmaceutical sectors. These systems are distinguished by their special qualities, which include stability, transparency, and the capacity to dissolve hydrophilic and lipophilic substances.

- History and development

Hoar and Schulman first proposed the idea of micro- emulsions in the 1940s. Since then, a great deal of research has been done to comprehend the basic ideas and uses of micro-emulsions.

- Development and growth

Micro-emulsions received a lot of interest from the scientific community in the 1960s and 1970s.

Researchers started looking into the characteristics and uses of micro-emulsions, such as their application in.

1. The ability to deter: micro-emulsions were utilised as detergents to get rid of stains and clean surfaces.
2. Micro-emulsions in pharmaceuticals were looked into as a possible medicine delivery method.
3. Micro-emulsions were used in cosmetics. Used in lotions and creams and other skincare products.

- **Advances and innovations**

Significant progress was made in the field of micro- emulsions during the 1980s and 1990s. New methods for creating micro-emulsions were created by researchers, including:

1. Homogenisation under high pressure: This method made it possible to produce microemulsions with tiny droplets.
2. Microfluidization: This process made it possible to create micro-emulsions with consistent droplet sizes.

- Modern application (2000s- present)

Micro-emulsions have been used in a number of disciplines recently, including:

1. Micro-emulsions in nanotechnology are utilised as models for nanoparticle production.
2. Biotechnology: Biomolecules like proteins and DNA are delivered by micro-emulsions.
3. Food industry: Food items use microemulsions as a way to deliver flavours and nutrients.

Types

- Winsor 1 (two phase system)

The lower (o/w) micro emulsion phase and the upper oil layer are in balance.[2]

Microemulsions of the oil-in-water kind A surfactant (and sometimes cosurfactant) layer envelops oil droplets, forming the continuous phase that is diffused internally in water. Compared to w/o microemulsion, this kind of microemulsion often has a greater interaction volume.

- Winsor 2 (two phase system)

Lower surplus water is in equilibrium with the top (w/o) microemulsion.[2] Microemulsions of the water-in-oil kind consist of water droplets encircled by an uninterrupted oil phase. These are known as "reversemicelles," in which the fatty acid tails face into the oil phase and the surfactant's polar headgroups face into the water droplets. The aqueous biological system has the potential to destabilise a w/o microemulsion administered parenterally or orally.[5]

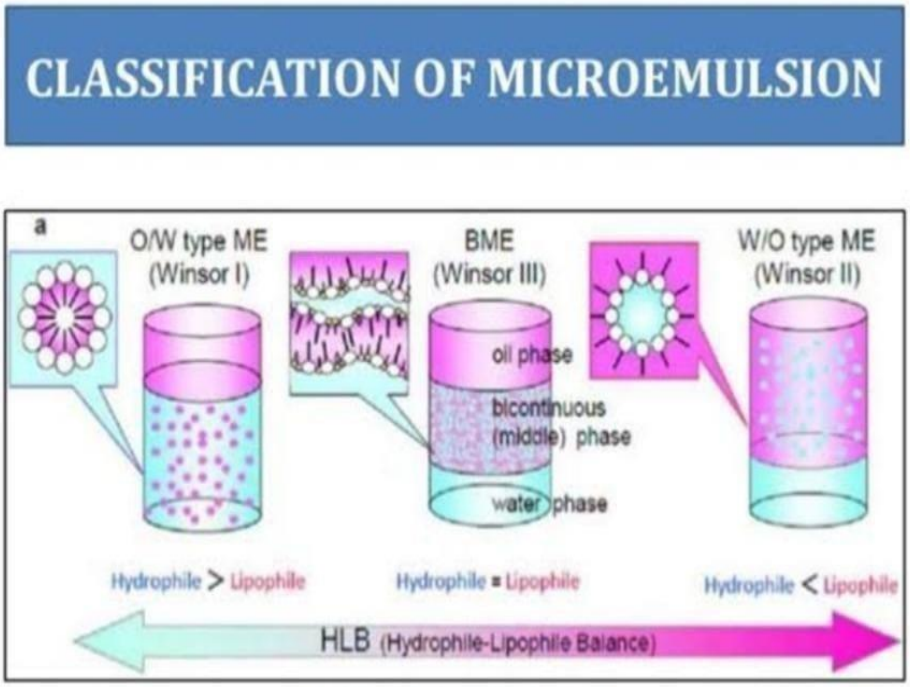
- Winsor 3 (three phase system)

In equilibria with upper phase oil and lower phase water, the middle bi-continuous phase of o/w and w/o is known as[2] In a bicontinuous microemulsion system, the proportions of water and oil are comparable; in this instance, both phases are continuous. When water and oil are mixed, an uneven channel forms that resembles a "sponge-phase." This bi-continuous state may be traversed by microemulsions changing from o/w to w/o. Bi-continuous microemulsions can exhibit plasticity and non-Newtonian flow. These characteristics make them particularly helpful for intravenous administration or topical medication delivery.[9]

- Winsor 4 (single phase system)

It creates a uniform blend of water, oil, and surfactant.

[2] Winsor was the first to propose the R-ratio as a characterisation notion to explain how solvents and amphiphiles affect interfacial curvature. The R-ratio contrasts an amphiphile's ability to dissolve in water with its ability to disperse into oil. The interfacial zone forms a distinct curvature if one phase is preferred. Therefore, the interface's area of contact with oil grows while its area of contact with water decreases if $R > 1$. As a result, oil becomes the continuous phase, and type II (Winsor II) is the matching characteristic system.
Likewise, $R = 1$ denotes a balanced interfacial layer.[10]



Types of Microemulsion

Diagram of classification of microemulsion

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

Table of Component of micro-emulsion system.

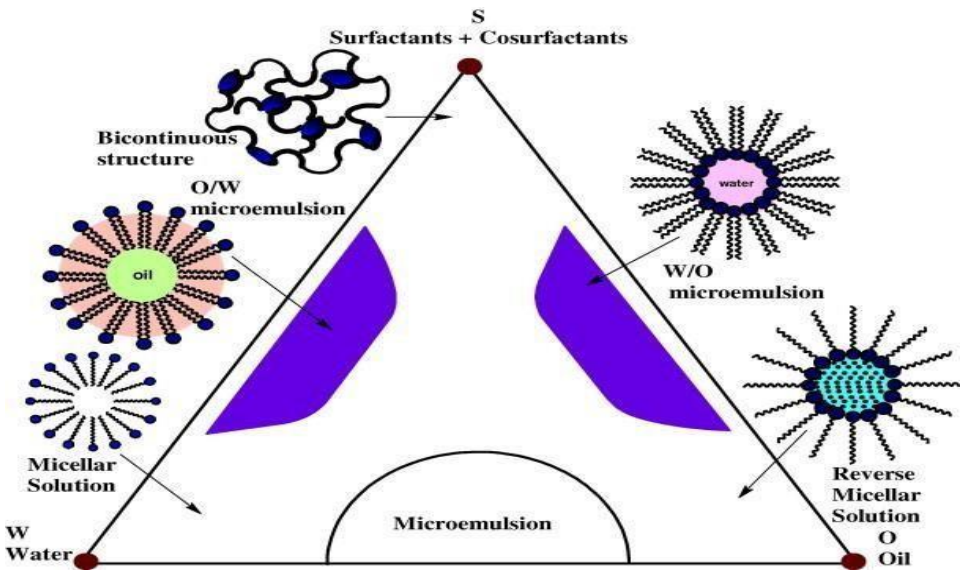
Component	Example
Oil	1. saturated fatty acid – lauric acid, carpic acid. 2. unsaturated fatty acid – oleic acid. Linolic acid. 3. fatty acid - ester-ethyl or methyl ester of lauric, oleic acid myristic acid.
Surfactant	1. Polyoxyethylene/polysorbate/ tween 20,40,60,80. 2. sorbitan monolaurate, eggs lecithin 3-sodium dodecyl sulphate.
Co-surfactant	1. ethanol, propanol, butanol isopropanol, pentanol, hexanol. 2. polyoxyethylene -10-oelyl ether. 3. sodium monohexyl phosphate. 4. cinnamic alcohol.

Components of microemulsion is a

- Structure of Microemulsion

Micellar emulsions, also known as microemulsions, are dynamic systems with an interface that fluctuates spontaneously and continually. They are separated structurally into three categories: bi-continuous microemulsion, water in oil (w/o), and oil in water (o/w). Water droplets are distributed In the continuous oil phase in w/o micro emulsions, whereas oil droplets are distributed in the continuous aqueous phase in o/w micro emulsions.[13] Bicontinuous microemulsions may form in a system with comparable water and oil contents. Depending on the component quantities, the mixture of oil, water, and surfactants can take on a wide range of structures and phases.

- Method of Microemulsion



Characteristics

- A distinct oil and water system will be created if a surfactant with balanced hydrophilic and lipophilic qualities is applied in the suitable concentration.

Although the system is still an emulsion, it differs from the milky emulsions previously addressed in a few ways. "Micro emulsions" are the new systems.

[3] Comparing emulsions to micro emulsions reveals changes in droplet sizes, visual appearance, energy required for creation, and interfacial tension between phases.

- Even at high droplet concentrations, the viscosity of micro emulsions is comparable to that of water.[10] They are very dynamic systems with reversible droplet coalescence because of the continuous microstructure alterations. Numerous methods are used to describe the various characteristics of microemulsions.[15]

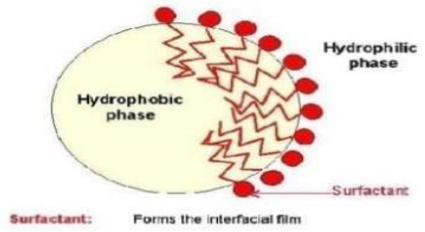
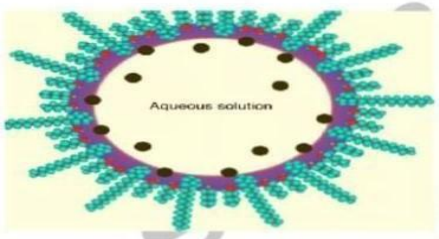
Characteristic	Emulsion	Microemulsion	Nanoemulsion
Appearance	Opaque	Transparent	Transparent to slightly opaque
Size (nm)	>200	1 -100	1 -100
Advantages	Require fewer amounts of surfactants (~ 5%)	Spontaneously formed Thermodynamically stable under certain conditions (pH, temperature…)	Very thermodynamically and kinetically stable Require fewer amounts of surfactants (~ 5%)
Disadvantages	Thermodynamically unstable and thus do not form spontaneously Require input of energy through shaking, homogenizing or exposure to power ultrasound	Require more surfactants (>20%) Stability of microemulsions is easily compromised by dilution, heating or changing pH levels.	Require input of energy and specialized equipment to be produced

Advantages Of Microemulsion Over Other Dosage Forms

- Increase the rate of absorption
- Eliminates variability in absorption
- Helps solublize lipophilic drug.

Provides a aqueous dosage form for water insoluble drugs

- Increases bioavailability
- Rapid and efficient penetration of the drug moiety
- Helpful in taste masking
- Liquid dosage form increases patient compliance.
- Less amount of energy requirement.

Sr. No.	CONVENTIONAL (MACRO) EMULSION	MICRO-EMULSION
1		
2	Two phase system renders it thermodynamically unstable	One phase system renders it thermodynamically stable
3	Poorer long term storage stability and often tend to coalesce, creaming / sedimentation or phase separation	Better long term storage stability
4	Comparatively less bioavailability	Reduction in dose by the enhancement in bioavailability
5	Comparatively less lipophilic transport	Enhanced lymphatic transport due to lipids[6]

 Method of Preparation

1. Phase titration

Phase diagrams can be used to illustrate microemulsions, which are made using the spontaneous emulsification method (also known as the phase titration method). A helpful method for examining the intricate sequence of interactions that can happen when several components are combined is to construct a phase diagram. Depending on the chemical makeup and concentration of each component, microemulsions and different association structures (such as emulsion, micelles, lamellar, hexagonal, cubic, and various gels and oily dispersion) are generated.

2. Phase Inversion Method

By adding an excessive amount of the dispersed phase, the phase inversion method causes microemulsions to undergo phase inversion. Rapid physical changes, such as variations in particle size, take place during phase inversion and can impact medication release both in vitro and in vivo. This can be accomplished with nonionic surfactants by altering the temperature, which will cause a transitional phase inversion, or a change from an oil-in-water microemulsion at low temperatures to a water-inoil microemulsion at higher temperatures.[11]

A point of zero spontaneous curvature and low surface tension is crossed by the system during cooling, which encourages the development of finely distributed oil droplets.

- Factors affecting the Microemulsion

Packing ratio: By altering the packaging and, consequently, the film's curvature, the HLB of surfactant affects the kind of microemulsion.

Surfactant property: Surfactants are two examples of hydrophilic and lipophilic groups. Hydropyl single-chain surfactants, like cetyl ammonium bromide, tend to form o/w microemulsions and completely dissociate into a diluted solution.

Property of the oil phase :- The oil phase affects a curvature by entering and expanding the tail group area of a surfactant monolayer, which results in an amplified negative curvature to the W/O microemulsion.[5]

Temperature: One of the most important factors in determining temperature is the effective head group size of non-ionic surfactants. At low temperatures, the hydrophilic and the normal O/W system are created.

CONCLUSION

Microemulsions have outstanding solubility qualities and are thermodynamically stable. These characteristics can be applied to various lipophilicity levels. They can be utilized to maximize drug targeting without increasing systemic absorption at the same time. Microemulsions have gained interest as a novel medication delivery technology in recent years due to their significance in a variety of applications.

Microemulsion systems have been the subject of extensive research over the past 20 years in an effort to provide innovative solutions.

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