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A Review: Microemulsions: A Potential Bioavailability Carrier

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Abstract : Microemulsions are dispersions of oil and water that are clear, transparent, and thermodynamicallystable,thatarestabilisedbyaninterfacialsurfactantcoating,sometimesin combination with a co-surfactant. Because of its improved drug solubilization capability, long shelf life, ease of preparation, and better bioavailability, microemulsion formulation has recently attracted a lot of attention for the delivery of hydrophilic and lipophilic drugs as drug carriers. We have discussed the benefits, drawbacks, kinds, structures, formulations, factors affecting formulation, preparations, characterisation, and medicinal applications of microemulsions in this review. The review is structured in such a way that a beginner to the area may quickly comprehend the key points of this revolutionary delivery mechanism.

Key words : Microemulsion, Surfactant , Co-surfactant, Characterization & Evaluation of Microemulsion , Pharmaceutical applications.

Introduction:

A microemulsion is a dispersion made up of oil, surfactant, cosurfactant, and aqueous phase that forms a single liquid solution with optical isotropy and thermodynamic stability with droplet diameters ranging from 10 to 100 nanometers. Microemulsions are macroscopically isotropic mixtures made up of three different components : hydrophilic, hydrophobic, and amphiphilic. Their thermodynamic stability and nanostructure are two key features that set them apart from conventional emulsions, which are thermodynamically unstable. In the1950s, Schulman 1 and Winsor 2 discovered microemulsions for the first time. The term "microemulsions" was coined to describe multi-component systems containing non-polar,

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aqueous, surfactant, and cosurfactant components. Oil-in-water (o/w), water-in-oil (w/o), and bicontinuous phase microemulsions are the three types of conventional microemulsions. Microemulsions provide several advantages, including improved medication solubility, increased bioavailability, protection of unstable pharmaceuticals from environmental conditions, and a long shelf life[4,5].

History:

Hoar and Schulman first proposed the notion of microemulsion in 1943; they createdthefirstmicroemulsionsbydispersingoilinanaqueoussurfactantsolutionandadding an alcohol as a co-surfactant, resulting in a transparent, stable formulation[6]. The presence of this theoretical structure was later proved by the application of multiple technologies, and we may now utilise Attwood's definition: "A microemulsion is a transparent, single optically isotropic, and liquid that is thermodynamically stable made up of water, oil, and amphiphilic chemicals (surfactant and co-surfactant)"[7].

Advantages and Disadvantages of Microemulsion based system Advantages :** [8,9,10]

As a method of drug delivery, microemulsions have various advantages.

1. Microemulsions are self-emulsifying systems that are thermodynamicallystable.
2. Microemulsions operate as super solvents for pharmaceuticals, allowing them to dissolve both hydrophilic and lipophilic medications, as well as those that are both aqueous and water-based solutions are insoluble. Hydrophobic solvents.
3. Lipophilic or hydrophilic dispersed phases (oil-in-water, O/W, or water-in-oil, W/O microemulsions) can operate as a reservoir for lipophilic or hydrophilic medicines, respectively. Pseudo-zero-order kinetics can be calculated using the volume of the dispersed phase, the drug's partition, and the drug's transport velocity.
4. Microemulsion droplets have a mean diameter of less than 0.22 mm. This results in a broad interfacial region, from which the drug is promptly released into the external phase when absorption (in vitro or in vivo) occurs, keeping the external phase concentration close to initial levels.
5. Being able to transport both lipophilic and hydrophilic medications.
6. Because of their improved thermodynamic stability, microemulsions are simple to make and do not require a considerable amount of energy during preparation.
7. In comparison to primary and multiple emulsions, microemulsions have a low viscosity.
8. The use of microemulsion as a delivery mechanism can increase a drug's efficacy by lowering the overall dose and thereby reducing side effects.
9. Microemulsion formation can be reversed. When the weather is cold or hot, they may become unstable, However, if the temperature falls within the stable range, the microemulsion reforms.

Disadvantages :** [8,9,10]

1. For droplet stabilisation, a considerable number of S/Cs is required.
2. The system's high-melting chemicals have a limited solubilizing capacity.
3. In order to be used in pharmaceutical applications, the surfactant must benontoxic.
4. EnvironmentalfactorsTemperatureandpHaretwoexamplesthataffectthestabilityof microemulsions. As the microemulsion is administered to patients, these parameters alter.

Types of Microemulsion :** [11,12]

Microemulsion phases are divided into four categories, that exist in equilibria, according to Winsor, and Winsor phases are the name given to these stages.

They are,

1. **Winsor I:** The lower (o/w) microemulsion phases are in equilibrium with the upper (o/w) microemulsion phases top surplus oil in a two-phase microemulsion**.**

2. **Winsor II**: The top (with or without) microemulsion phase equilibrium of microemulsion phases with lower surplus water in a two-phasesystem.

3. **Winsor III:** There are three phases in all, the (o/w plus w/o) intermediate microemulsion phase, also known as bicontinous) is in balance with a higher level of excess oil and a lower level of excess water.

4. **Winsor IV:** Oil, water, and surfactant are homogeneously combined in a single phase.

Structure of Microemulsion :[13]

Microemulsions are living organisms with a constantly changing interface. fluctuating on its own. Oil-in-water (o/w), water-in-oil (w/o), and bicontinuous microemulsions are the three types. Surfactants and/or co-surfactants in the right proportions stabilises the interfacein each of the three categories microemulsions. Depending on the quantities of the components, a combination of oils, water, and surfactants can produce a large number of structures and phases. In this aspect, The surfactant film's elasticity is crucial.. A The surfactant film will be flexible allow for the emergence of a variety of structures, including droplet-like forms, aggregates, and bicontinuous structures, hence expanding the spectrum of microemulsions that can exist. The existence of bicontinuous structures will be hampered by an extremely stiff surfactant coating, which will limit the range of existence. Depending on the component ratio, structural studies can indicate the presence of normal emulsions, anisotropic crystalline hexagonal or cubic phases, and lamellar structures are all examples of anisotropic crystalline hexagonal or cubic phases in addition to microemulsions. The interior a microemulsion vehicle's structure is critical for phase diffusivity as a result of this, drug diffusion in the corresponding phases. Researchers have been working feverishly to comprehend the microemulsion system's intricate phase behaviour and diverse microstructures[13].

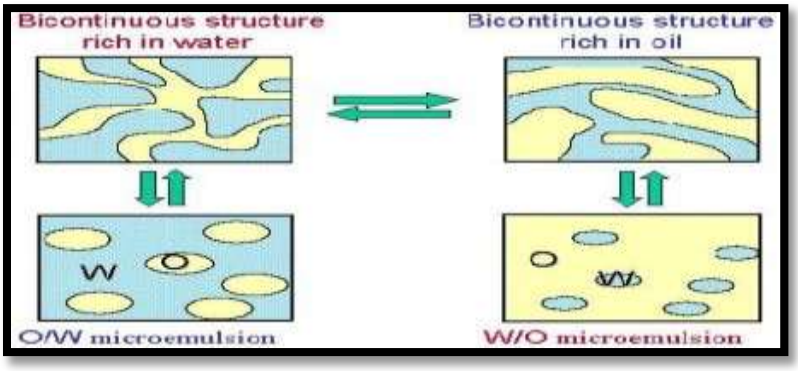

Fig : Structure of microemulsion

Consider these elements during microemulsion preparation

Three important conditions

1. Surfactants election is crucial because an ultra low interfacial tension(10-3mN/m)must be achieved at the oil/water interface, which is a prerequisite for the production of microemulsions.
2. Surfactant concentration must be sufficient to supply the quantity of surfactant molecules required to stabilise the micro droplets created by ultra low interfacial tension.
3. To stimulate the creation of microemulsions, the contact flexibility or fluidity is required enough.

❖ **Difference between emulsion and microemulsion:**(14)

SN	Emulsion	Microemulsion
1.	Emulsions are made up of spherical droplets of one phase spread in another..	They switch between different configurations all the time, from droplet- like inflated micelles to bi-continuous structures..
2.	Droplet diameter ranges from 1 to 20 mm.	Droplet size ranges from 10 to 100 nanometers.
3.	Because the bulk of emulsion droplets is greater than the wavelength of light, and most oils have higher refractive indicesthan water, most emulsions are opaque(white).	Microemulsions can be transparent or clear because their droplets are only a fifth of the wavelength of light, theyonly scatter a sliver oflight.
4.	Normal emulsion droplets, Size doesn't matter, Until coalesance or Ostwald ripening occurs, they exist as separate creatures.	Inafraction of a second, a microemulsion droplet may vanish, while another droplet emerges spontaneously elsewhere in the system.
5.	They may be steady for an extended period of time, will ultimately undergo phase separation on standing to attain a minimum in free energy They're both kinetically and thermodynamically stable.	More stable in terms of thermodynamics than macroemulsions and Assuming no changes in composition, can have an almost endless lifespan, temperature and pressure are inextricably linked.
6.	They have a phobia of lyophilia.	They're on the cusp between lyophilic and lyophobic colloids.
7.	Their creation necessitates a lot of movement.	The majority of the time, this is accomplished by gently mixing the materials together.

Ingredients of Microemulsion [14,15]

There are manyoils and surfactants that can be utilised as microemulsion system components, but their toxicity, irritation risk, and unknown mode of action limit their utilisation. Materials must be biocompatible, non-toxic, and therapeutically acceptable, and emulsifiers must be used in the proper concentration range to produce a gentle and non-aggressive microemulsion.

Main components of microemulsion are

1. Oil phase
2. Aqueousphase
3. Surfactants
4. Co –solvents

1. Oil Phase

The capacity component made up of oil to enter As a result, the surfactant monolayer's tail group region swells. effects curvature. Short-chain The tail group region is penetrated by oils. More

deeply than long-chain alkanes, causing this region to expand and result in enhanced curve that is not positive (as well as decrease deficiency HLB). Saturated(forinstance,lauric, myristic, as well as capric acid) as well as unsaturated (for instance, oleic acid and linoleic acid, and linolenic acid) fatty acids have their distinct penetration-enhancing properties, which have been studied for a long time. The oil phase has also included ethyl and methyl esters of lauric acid, myristic, and oleic acid. Lipophilic medications should be dissolved in microemulsions o/w. The drug's solubility in the phase of oil is currently underway, the most important consideration for choosing it. This will reduce the total size of the formulation while still delivering the drug's therapeutic dose in an encapsulated form. The tail group is penetrated by short-chain oils region more deeply than long chain alkanes, causing more negative curvature (and lower effective HLB). The oil phase has also included ethyl and methyl esters of lauric acid, myristic, and oleic acid. Lipophilic medications should be dissolved in o/w microemulsions. The drug's solubility in a period of oil is the most important consideration for choosing it. This will reduce the total size of the formulation while still delivering the drug's therapeutic dose in an encapsulated form.

2. Aqueous phase

In general, hydrophilic active substances and preservatives are found in the aqueous phase. Buffer solutions are sometimes employed as an aqueous phase.

3. Surfactants

The surfactant chosen must be capable of reducing interfacial tension to a very low level low value,allowingforeasierdispersionduringthemicroemulsionpreparationprocess.Surfactants with a low HLB (less than 12) are well-suited to the growth of w/o microemulsions, while surfactants with a high HLB (greater than 12) are preferred for the formation of o/w microemulsions. Surfactants with an HLB of more than 20frequently require the addition of cosurfactants to bring their effective HLB into the range necessary for microemulsion production. Surfactants of various types are used to aid in the creation of microemulsion systems.

a. Cationic
b. Anionic
c. Non-ionic
d. Zwitterionic surfactants

a. Cationic surfactants

When cationic surfactants come into contact with water, they create amphiphilic cations and anion forms, which are usually of the kind halogen. Nitrogen compounds containing atleast one longchains of the alkyl type, such as quaternary ammoniums and fatty amine salts, account for a substantial portion of this family, which is commonly derived from natural fatty acids. Hexadecyltrimethyl ammonium bromide and didodcecyl ammonium bromide are two of the most well-known cationic surfactants. In general, these surfactants are more expensive than anionics**.**

b. Anionic Surfactants

When anionic substances are present, In water, surfactants form an amphiphilic anion as well as a cation, that is usually an alkaline metal(Na,K)or a quaternary ammonium.These are the surfactants that are most regularly utilised. The ionised carboxyl group in these surfactants gives them their anionic charge. Anionic surfactants account for roughly half of global output. The most prevalent anionic surfactants are alkali alkanoates, generally known as soaps. When it comes to structure and function, this is the most well-known variety of surfactant. The carboxylate, sulfonate, and sulphate groups are the three most important anionic groups in all of these surfactants.

c. Non-ionic surfactant

Dipole Its interactions with the hydration layer of water on the surface non-ionic surfactant's

hydrophilic surface stabilise it. Because their hydrophilic group is non-dissociable, such as phenol, alcohol, ester, oramide, they donot ionize in aqueous solution. The presence of a polyethylene glycol chain makes a high majority of these nonionic surfactants hydrophilic.

d. Cosurfactants

Surfactants with only one chain are ineffective usually insufficient to lower interfacial tension o/w tothepointwhereamicroemulsioncandevelop.Theinclusionofco-surfactantsgivestheinterfacial layer enough flexibility to take on the various curvatures needed to produce microemulsions in a variety of compositions. As Co-surfactants, alcohols with short to medium chain lengths (C3-C8) are widely used to further lower interfacial tension and promote interface fluidity.

Method of Preparation [16]

1. Phase Titration Method

Microemulsions are created using the spontaneous emulsification (phase titration) method, Phase diagrams can be used to show this. The use diagram of a phase to explore the complicated series of interactions that can occur when different components are blended is a good idea. Depending on each component's chemical composition and concentration, microemulsions and various association structures (such as hexagonal, emulsion, micelles, lamellar, cubic, as well as different gels and oily dispersion) are generated. The study requires an understanding of their phase equilibria and the delineation of phase borders. Because constructing a quaternary phase diagram (four component system) takes time and is difficult to comprehend, pseudo ternary phase diagrams are diagrams that show the phases of a system in three dimensions frequently used to locate different zones, such as the microemulsion zone, in which each corner of the diagram represents 100% of the component Fig. The area may be classified as w/o or o/w microemulsion based on its composition, which is whether it is oily or watery. It is important to make thorough observations so that metastable systems are not included.

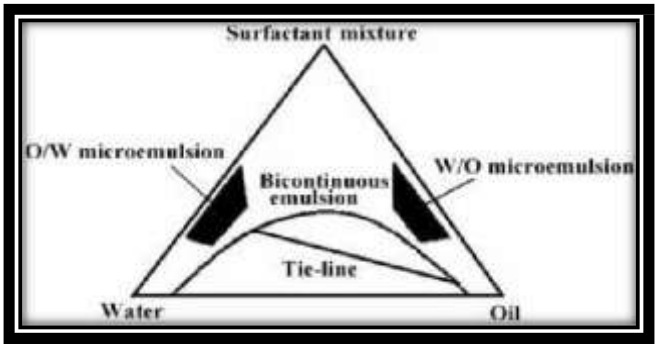

Figure : Microemulsion zone of a pseudoternary phase diagram containing oil, water, and surfactant.

2. Phase Inversion Method

Microemulsions undergo phase inversion when an excess of the dispersed phase is added or when the temperature is raised. During phase inversion, significant physical changes occur, including particle size alterations, which can affect medication release in vivo and in vitro. These approaches work by altering the surfactant's spontaneous curvature. During the cooling process, the procedure passes through a point

with minimum surface tension and negligible spontaneous curvature, allowing oil droplets that are finely scattered to form. The temperature for phase inversion (PIT)method is the name given to this procedure. Other characteristics, such as salt content or pH value, may be evaluated instead of the temperature.

Water droplets are created in a continuous oil phase by gradually adding water to the oil. The surfactant's spontaneous curvature changes from initially stabilising at the inversion, a w/o microemulsion becomes an o/w microemulsion locus when the volume portion of water is increased. At the o/w interface, short-chain surfactants create flexible monolayers at the inversion point, this produces a bicontinuous microemulsion.

Hypothetical Phase Diagram

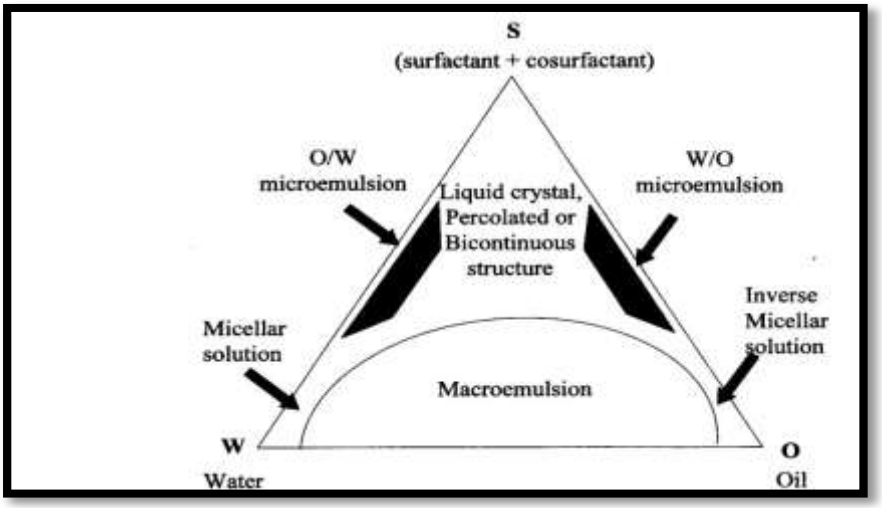

Figure: Hypothetical phase regions of microemulsion System of oil (O), water (W), and surfactant + cosurfactant (S)

Surfactant generates reverse micelles when oil concentrations are high, allowing them to solubilize more water molecules in their hydrophilic interior. The addition of water to this system may result in the creation of a W/O microemulsion, where the water is enveloped and stabilised by the surfactant / co-surfactant mixture's interfacial layer. The isotropic clear area transforms into a turbid, birefringent one in a constrained environment content. Finally, when the volume of water in the system grows, the lamellar structure will deteriorate, resulting in a continuous phase of water. O/W microemulsions contain oil droplets stabilised by a surfactant /co-surfactant.

Evaluation / Characterization of microemulsion [16]

The microemulsions are evaluated by the following techniques. They are

(I) Phase behavior studies: Microemulsions and coarse emulsions can be distinguished using optical observations, phase contrast microscopy, and Transmission electron freeze fracture microscopy. Microemulsions are clear isotropic one-phase systems, whereas liquid crystalline systems are opaque systems that show bifringence when seen with cross polarised light microscopy.

(II) Scattering Techniques: Small angle neutron scattering techniques are examples of scattering techniques. scattering, small angle X-ray scattering, and light scattering have been used to study microemulsion structure, particularly in the case of dilute monodisperese spheres, when polydisperse and/or concentrated systems such as those found in microemulsions are present.

(III) Transmittance test : The stability of the optimised microemulsion formulation in terms of dilution was tested using a UV spectrophotometer to measure transmittance at a specified wavelength.

(IV) Measurements of globule size and zeta potential: Viaa Zetasizer HSA 3000, the measurements of globule size and zeta potential of the microemulsion may be measured using dynamic light scattering.

(V) Viscosity measurements: Using a Brookfield LVDV I+ cone and plate (CP) viscometer (Mfg: Brookfield, USA) and rheocal software at a temperature, the rheological behavior of the formulation can be examined. The microemulsion area and its separation from other areas may be possible determined using changes in rheological properties.

(VI) Electricalconductivity: Drop by drop, the water phase was introduced .by drop to a combination of oil, surfactant, and co-surfactant, and a conductometer was used to evaluate the electrical conductivity of formed samples at room temperature and at a constant frequency of 1 Hz. (Conductivity CM 180 metre, Elico,India).

(VII) Drug stability : The optimised microemulsion was stored at four temperatures: cold (4-8 oC), room temperature, and high (50 2 o C). The microemulsion can be tested for phase separation, percent transmittance, globule size, and percent assay every two months.

(VIII) Drug solubility: The drug, as well as each individual constituent in the optimised microemulsion formulation, was added in excess. After 24 hours of continuous stirring at room temperature, samples were extracted and centrifuged for 10 minutes at 6000 rpm. By subtracting the drug contained in the residue left behind after subtracting the whole amount of medication added, the amount of soluble drug in the improved formulation, as well as each individual ingredient of the formulation, was estimated. The drug's solubility it was compared in microemulsion. to the solubility of the constituent ingredients.

(IX) Drug release studies:

(A) In-vitro drug release: A Diffusion cell modified by Franz with a volume of 20 mL can be applied to the diffusion investigation. The buffer was poured into the receptor compartment. The microemulsion formulation and the simple drug solution were kept separate in the container for donors, which was sealed with cellophane membrane. A UV spectrophotometer set to a certain wavelength was used to collect samples from the receptor compartment at regular intervals and analyse them for drug content.

(B) Ex-vivo drug release: Within a Franz diffusion cell, the intestinal membrane was used to study drug delivery into the body ex vivo buffer. The donor compartments of two different diffusion cells were filled with microemulsion formulation and plain drug solution, as well as each cell's temperature kept at 37.2°C. At predetermined time intervals, samples are removed from the receptor compartment., the amount of medication released from the microemulsion formulation may be measured spectrophotometrically at certain wavelengths.

Applications of Microemulsions :

Microemulsions play a variety of roles in numerous fields (Figure).

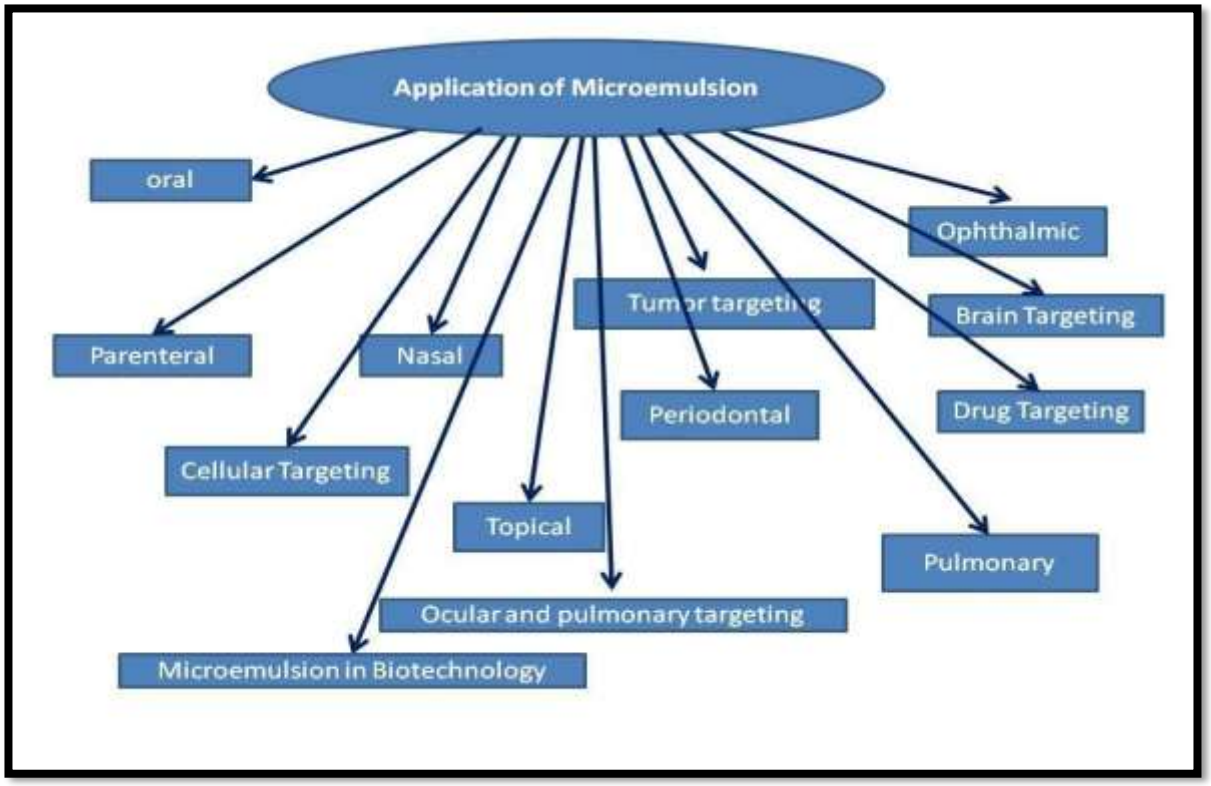

Fig: Represent applications of microemulsion

Table : The BCS claims that, Classification of drug substances .

Sr . No.	Class	Permeability	Solubility
1	I	High	High
2	II	High	Low
3	III	Low	High
4	IV	Low	Low

Microemulsion in pharmaceuticals

***Parenteral administration*:** Because of the extremely little amount of medicine actually reaching a targeted site, parenteral administration (particularly via the intravenous route) of pharmaceuticals with restricted solubility is a major Pharmaceutical companies are concerned. When supplied parenterally, microemulsion formulations have significant compared to macroemulsion systems because microemulsions clear more slowly than coarse particle emulsions and so occupy the body for a longer period of time. For parenteral distribution, O/W and W/O are both acceptable microemulsions can be employed.

***Oral administration*:** Microemulsion formulations have various advantages over traditional oral formulations, include higher clinical potency and better absorption, and reduced drug toxicity[17]. As a result, Microemulsion has been observed to be a good vehicle for transporting drugs like steroids, hormones, diuretics, and antibiotics. However, the majority of them are difficult to take orally. They are rarely therapeutically active when taken orally since their oral bioavailability in conventional (non-microemulsion based) formulations is less than 10%. Most protein medicines are only available as parenteral formulations due to their low oral bioavailability. Peptide medicines, on the contrary, have a very short biological half life when taken by parenteral route, necessitating frequent dosage[18].

***Topical administration*:** Topical medication delivery has various advantages over other approaches, one of which being the avoidance of the drug's hepatic first-pass metabolism and associated adverse consequences. Another is the drug's direct distribution and targetability to the damaged skin or eye area[19].

***Ocular and pulmonary delivery*:** Drugs are mostly given topically through ocular and pulmonary administration for the treatment of eye ailments. O/W microemulsions have been studied for ocular delivery, as well as for dissolving poorly soluble medicines, increasing absorption, and achieving a longer release profile. For example, lecithin, propyleneglycol, and PEG 200 were used as co-surfactants, while iso-propyl myristate (IPM) was used as the oil phase in microemulsions containing pilocarpine. The formulations had a low viscosity and a refractive index that made them suitable for ophthalmologic use.

Microemulsions in biotechnology: Several enzymatic and biocatalytic activities occur in pure organic or aqua-organic systems. Biphasic media are also used for these types of reactions. The use of a pure polar medium leads biocatalysts to denaturate. The usage of water- resistant media has a number of advantages. Enzymes with a low water content show the following characteristics:

1. Non-polar reactants have a higher solubility.

2. It is possible to change thermodynamic equilibrium in favour of condensations.

3. Thermal stability of enzymes is improved, allowing reactions to be carried out at greater temperatures. Many enzymes, such as lipases, esterases, dehydrogenases and oxidases, work in hydrophobic microenvironments. Many enzymes in biological systems work at the interface of hydrophobic and hydrophilic domains, which are normally stabilised by polar lipids and other natural amphiphiles. Enzymatic catalysis in microemulsions has been employed for a number of processes, including ester synthesis, peptide and sugar acetal transesterification, hydrolysis reactions, and steroid transformation. In microemulsion-based operations, lipases are the most widely used enzymes.[20].

Drug solubilization in microemulsion:

Microemulsions have physicochemical characteristics such as transparency, low viscosity, thermodynamic stability, and high solubilization power. Microemulsions are a type of emulsion that can be employed in a variety of as a medicine delivery device because of their unique features. For improved therapeutic efficacy, several types of medicines can be solubilized in microemulsion systems[21].

Coatings and textile finishing using microemulsions:

Because microemulsified resins eliminate many of the drawbacks of more typical water-based systems while avoiding the health and pollution risks associated with solvent-based coatings, microemulsified resins are becoming increasingly popular, Microemulsion technology's coating application area is a very promising and fast increasing field. Microemulsions are ideal when stability and uniformity of the end product are sought due to their stability and small droplet size. Microemulsion-based paint formulations have proved to have superior scrub resistance, colour intensity, and stain resistance than emulsion-based paint formulations. In theory, Microemulsions can be utilized for a variety of purposes, three different coating applications:

(1) Creating microdispersions with microemulsified monomers, (2) transferring non-water- soluble polymers into water, and (3) getting specific effects using polymerization in a w/o system. Acrylate lattices stabilised by isothiouronium groups, which have been successfully polymerized to generate particle sizes of 0.08mm, are an example of such a system. Particle sizes range from 0.02 to 0.14mm, depending on the system.[22,23].

A microemulsion as fuels : One of the benefits of a stable microemulsion is that it can be reused, it may be utilized as in the presence of fuel, water, and it has been effectively employed to reduce soot production. When water is evaporated during cobustion, the amount of heat emitted is lowered, as is the temperature of the combustion. As a result of this, the rate of gas emissions such as nitrogen oxides (NOx) and carbon monoxide (CO) would decrease. The inclusion of water is also thought to increase fuel atomization, reduce particle emissions and sooting, and improve fuel economy in terms of price and miles per gallon. Another intriguing aspect of microemulsion-based fuel is its ability to raise the octane number of gasoline and the comparable octane number of diesel oils. Formamide, glycols, urea, and other octane number enhancers are examples. Due to the high combustion temperatures (160 325°C) in diesel fuels, several issues are solved.Water soluble cetane number improvers are commonly found in diesel microemulsions[24].

Lubricants, cutting oils, and corrosion inhibitors made from microemulsions:

Microemulsions, also known as reverse micellar solutions, have long been used as lubricants, cutting oils, and corrosion inhibitors. Corrosion is inhibited by the presence of surfactant in microemulsions, and the increased water content compared to pure oil results in a larger heat capacity. However, because solubilization is selective, other mechanisms may play a role in corrosion prevention in some instances. In microemulsions, water with a significantly higher thermal conductivity imparts a higher heat capacity to the system. Cutting oil can be made with such compositions; the oil lubricates the cutting surface while the water serves to eliminate the frictional heat generated during the cutting operation.

Microemulsions in cosmetics

Water-based emulsions the continuous phase are widely utilised in various cosmetic applications, such as skin care products. Microemulsion formulation is thought to result in a quicker uptake into the skin. In the formulation of microemulsions, cost, safety (When applied in high quantities, several surfactants irritate the skin.), and suitable constituent selection (surfactants, cosurfactants, oils) are all important considerations [25]. Hair care products based on unique microemulsions have been developed. They contain an acid and/or a metal salt, as well as an amino-functional polyorganosiloxane (anonionic surfactant). Microemulsions can be employed in a variety of applications solubilize aroma and flavoured oils. Cosmetic microemulsions (transparent and translucent) of silicone oils have been created via emulsion polymerization. However, due to silicone oil's low solubility in surfactants, they are not thermodynamically stable products .Condensed ultrafine emulsions have various advantages in cosmetic and therapeutic applications, including high stability and safety, in addition to the ability to adjust droplet size. Because they are O/W emulsions with droplet sizes similar to microemulsions, ultrafine emulsions can be considered thermodynamically unstable microemulsions. Commercial nonionic surfactants and oils often used in cosmetics are also researched in cosmetic formulations for skin care goods[26].

Microemulsions in food

Natural microemulsions can be found in a variety of foods. As a result, As a functional state of lipids, microemulsions have been exploited in the manufacturing of meals. When fat is digested and absorbed, microemulsions occur in the intestine. However, A field of food technology that has been disregarded is the ability to generate microemulsions on purpose and use them as instruments in the food industry, Component solubilization is excellent, and reaction efficiency is increased, and extraction processes offer a lot of potential in the realm of food technology.

Because antioxidants that are both hydrophilic and lipophilic may have a synergistic effect, The ability of microemulsion to increase antioxidation effectiveness is one of its most important uses. When compared to standard methods of dissolving or distributing antioxidants in oils, this method is more effective, Tocopherol at 200 ppm in the oil and 5% ascorbic acid in the reverse micelles have a substantial antioxidant impact. Fish oils have used a similar microemulsion- based technique to achieve an antioxidant protective effect. To boost the protectivity even more, glycerol was employed instead of water[27].

Some research work on Microemulsions

Drug	Category	Route	Purpose/ Result
Acyclovir[28]	Antiviral	Oral	Improved bioavailability
Flurbiprofen[29]	Analgesic	Parenteral	Increased the solubility
Apormorphine[30] HCL	Antiparkinson	Transdermal	Increased the permeability
Ketoprofen[30]	Analgesic	Transdermal	Enhancement of permeability
Prilocainne HCL[31]	Local anesthetics	Transdermal	Increased the solubility
Estradiol[32]	Anticholestermic	Transdermal	Improvement of solubilisation
Aceclofenac[33]	NSAID	Dermatological	Increased the solubility
Piroxicam[34]	NSAID	Oral	Increased the solubility
Diclofenac[35]	NSAID	Transdermal	Permeability enhancement
Dexamethasone[36]	Glucocorticoids	Topical ocular	Enhance the Bioavailability
Carbamazepine[37]	Anticonvulsants	Intranasal	Enhance bioavailability
Chloramphenicol[38]	Antibacterial	Ocular	Increase the solubility
Ibuprofen[39]	Analgesic	Parenteral	Increased the solubility
Ramipril[40]	Antihypertensive	Oral	Improve bioavailability
Ibuprofen[41]	Analgesic	Topical	Increase the solubility
Clonixic acid[42]	NSAID	Transdermal	For better absorption
Itraconazole[43]	Antifungal	Parenteral	For better absorption
Timolol[44]	Antihypertensive	Opthalmic	For better absorption
Terbinafine[45]	Antifungal	Transdermal	Permeability enhancement
Fenofibrate[46]	Antihyperlipidemic	Self micro emulsifying	Increasing the solubility
Progesterone[47]	Hormones	Dermal	Increased the chemical stability
Clopidogrel[48]	Antiplatelet	Oral	Solubility enhancement
Ketoconazole[49]	Antifungal	Topical	Increase the solubility
Itraconazole[50]	Antifungal	Topical	Improve Permeability

Conclusion :

Microemulsions have received a lot of attention in recent years, not only because of their usefulness in industrial applications, but also because of their inherent enchantment. Microemulsions are a popular technology platform among pharmaceutical formulators because of their superior solubilization capabilities, transparency, and ease of formation. Before microemulsions can live up to their potential as a versatile drug delivery vehicle, there is still a lot of fundamental work to be done to characterize their physicochemical characteristics. Despite the fact that there are a significant number of microemulsions for aesthetic applications that are highly biocompatible for transdermal distribution.

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