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AN INTEGRATED REVIEW ON ADVANTAGES, CLASSIFICATION AND TECHNIQUES OF PREPARATION OF MICROEMULSION: A FUTURISTIC DRUG DELIVERY

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ABSTRACT

The improvement of bio-availability of drugs is one of the greatest challenges in drug formulations. Among various approach microemulsion, which is a clear, stable, isotropic mixtures of oil, water and surfactant, has gained more attention due to enhanced oral bio-availability, protect labile drug, control drug release, increase drug solubility, and reduce patient variability. Microemulsions are commercially simple and convenient vehicle for delivery of medicaments which can enhance drug absorption with reduced systemic side effect. They can be used to optimize drug targeting without a concomitant increase in systemic absorption. Appropriate excipients selection and safety evaluation especially of the cosurfactants is crucial in the formulation of microemulsions. this review gives an overview of the formation, characterization of microemulsions, methods of preparation, advantages, disadvantages, classification and their application in different routes of drug delivery.

KEYWORDS: Microemulsion, drug delivery system, emulsion.

1. INTRODUCTION

The formulation and development of novel drug delivery system with the nature of enhancing the effectiveness of existing of drug is an ongoing process in pharmaceutical research. Since there are many types of drug delivery systems that have been developed.

1.1 Microemulsion

The microemulsion concept was introduced in 1940s by Hoar and Schulman who generated a clear single-phase solution by triturating a milky emulsion with hexanol.[1] They prepared the first microemulsion by dispersing oil in an aqueous surfactants solution and adding an alcohol as a co-surfactant, leading to transparent stable formulation. Microemulsion is defined as clear, transparent, thermodynamically stable dispersions of oil and water, stabilized by an interfacial film of surfactant frequently in combination with a co-surfactant.[2] Alternative names for these systems are often used, such as swollen micelle, transparent emulsion, solubilized oil and micellar solution. Microemulsions are bicontinuous systems that are essentially composed of bulk phases of water and oil separated by a surfactant /cosurfactant rich interfacial region.[3]

These systems have advantages over conventional emulsions in that they are thermodynamically stable liquid systems and are spontaneously formed.[4] Microemulsions are currently the subject of many investigations because of their wide range of potential and actual utilizations. The high capacity of microemulsions for drugs makes them attractive formulations for pharmaceuticals. These systems also offer several benefits for oral administration, including increased absorption, improved clinical potency and decreased toxicity.[5]

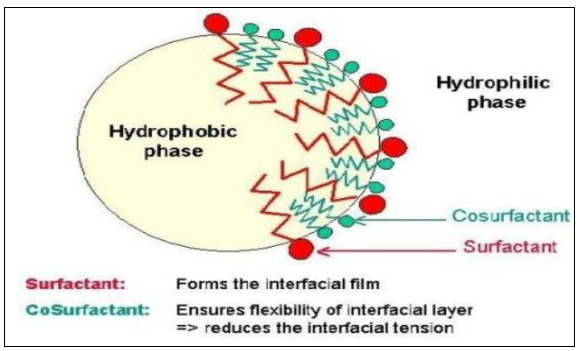


Figure 1: Structure of Microemulsion.

1.1.1 Advantages of Microemulsion system[6-11]

1. Microemulsions are easily prepared and require no energy contribution during preparation this is due to better thermodynamic stability.
2. The formation of microemulsion is reversible. They may become unstable at low or high temperature but when the temperature returns to the stability range, the microemulsion reforms.
3. Microemulsions are thermodynamically stable system and allows self-emulsification of the system.
4. Microemulsions have low viscosity compared to emulsions.
5. Microemulsions act as super solvents for drug, can solubilize both hydrophilic and lipophilic drugs including drugs that are insoluble in both aqueous and hydrophobic solvents.
6. Having the ability to carry both lipophilic and hydrophilic drugs.
7. The dispersed phase, lipophilic or hydrophilic (O/W, or W/O microemulsions) can act as a potential reservoir of lipophilic or hydrophilic drugs, respectively.
8. The use of microemulsion as delivery systems can improve the efficacy of a drug, allowing the total dose to be reduced and thus minimizing side effects.

1.1.2 Disadvantages of Microemulsion Systems[6-8]

1. Having limited solubilizing capacity for high-melting substances.
2. Require large number of Surfactants for stabilizing droplets.
3. Microemulsion stability is influenced by environmental parameters such as temperature and pH.

1.1.3 Classification of Micro Emulsion

According to Winsor, there are four types of micro emulsion phases exists in equilibrium, these phases are referred as Winsor phases. they are

- Winsor I (two phase system): upper oil layer exists in equilibrium with lower (o/w) micro emulsion phase
- Winsor II (two phase system): the upper (w/o) micro emulsion exists in equilibrium with lower excess water.
- Winsor III (three phase system): middle bi-continuous phase of o/w and w/o called) exists in equilibrium with upper phase oil and lower phase water.
- Winsor IV (single phase system): it forms homogenous mixture of oil, water and surfactant
- The ratio is among the characteristics that Winsor initially presented to describe the impact on interface curvature of amphiphiles and solvents. R-ratio relates an amphiphile's affinity in the oil to its affinity in the water.

1.1.4 Cosurfactant

Table 1: Cosurfactant.

S. No.	Solubilizing, surfactants, emulsifying agents adsorption enhancers
1.	Capryol 90
2.	Gelucire 44/14, 50/13
3.	Cremophor RH 40
4.	Imwitor 191, 308(1), 380, 742, 780 K, 928, 988
5.	Labrafil M 1944 CS, M 2125 CS
6.	Lauroglycol 90
7.	PEG MW > 4000
8.	Plurol Oleique CC 497
9.	Poloxamer 124 and 188
10.	Softigen 701, 767
11.	Tagat TO
12.	Tween 80.

1.1.5 Method of preparation of microemulsion

There are two primary methods to prepare a microemulsion

1. Persuasion and;
2. Brute force

1. by Persuasion

(1) Phase Transition from Near-Optimum State via Change in Single Variable: This method involves change in one formulation variable such as salinity or temperature for a system near optimal (HLD (hydrophilic lipophilic deviation) near 0), such as applying a higher temperature to a micro emulsion.

(2) Phase Transition from Near-Optimum State via Change in Multiple Variables: This method involves change in more than one formulation variable, such as applying higher temperature and inclusion of additional salt in a micro emulsion.

(3) Catastrophic Inversion: This method involves causing a low internal phase emulsion to invert such that the internal phase becomes the external phase. (4) Phase Transition Stabilized by Liquid Crystal Formation: This method involves stabilization of Nano droplets by liquid crystal formation from a state near HLD=0.

2. by Brute Force

This method may involve the use of a high speed mixer, a high pressure homogenizer, a high frequency ultra-sonic device, a small pore membrane, etc. Formation of O/W and W/O microemulsion by dispersion or high-energy emulsification methods is apparently fairly common, while microemulsion formation by condensation or "low-energy" emulsification methods, take advantage of the physicochemical properties of these systems based on the phase transition that takes place during the emulsification process. It can be carried out by operating in particular areas of the phase diagram with a very low interfacial tension, which are areas of liquid crystals and microemulsions; at the end of the emulsification process, microemulsion formed. Properties of microemulsion, such as small droplet size, relative high kinetic stability and optical transparency seem to depend not only on composition variables but also on preparation variables such as emulsifying path, degree of mixing energy input and emulsification time.

1.1.6 Techniques of preparation of microemulsion

Microemulsion have very small particle size range; they can be most effectively produced using high-pressure equipment. The most commonly used methods for producing microemulsion are 'High-pressure homogenization' and 'Micro fluidization' used at both laboratory and industrial scale. Other methods like 'Ultrasonification' and 'In-situ emulsification' are also suitable for preparation of microemulsion.

i. High-Pressure Homogenization

The preparation of microemulsion requires high-pressure homo- genization. This technique makes use of high-pressure homogenizer/piston homogenizer to produce microemulsion of extremely low particle size (up to 1nm). The dispersion of two liquids (oily phase and aqueous phase) is achieved by forcing their mixture through a small inlet orifice at very high pressure (500 to 5000 psi), which subjects the product to intense turbulence and hydraulic shear resulting in extremely fine particles of emulsion. The particles which are formed exhibit a liquid, lipophilic core separated from the surrounding aqueous phase by a monomolecular layer of phospholipids. This technique has great efficiency, the only disadvantage being high energy consumption and increase in temperature of emulsion during processing.

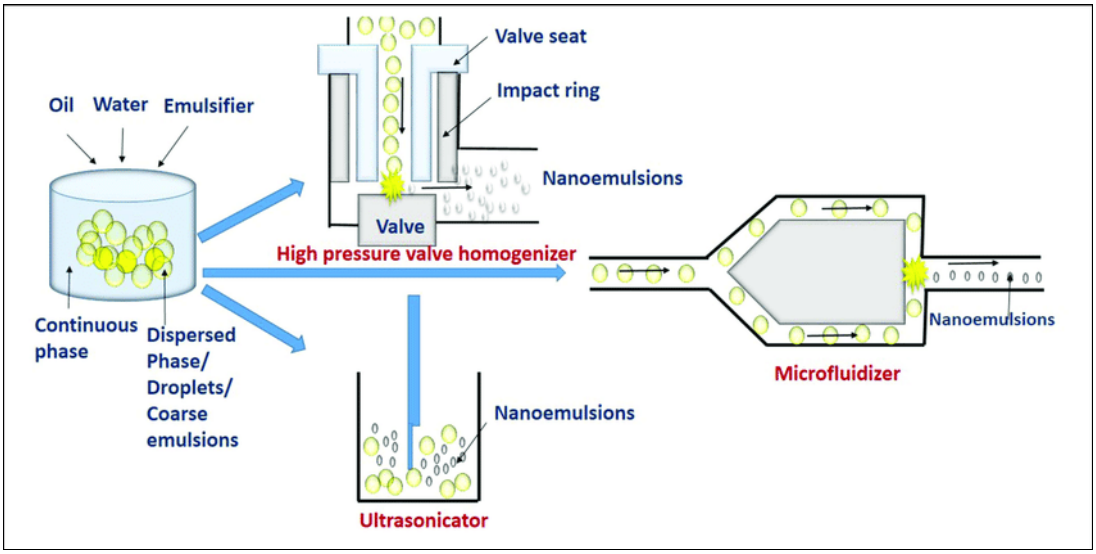


Figure 2: High-Pressure Homogenization.

To obtain the optimized formulation following process variables should be investigated

a. Effect of Homogenization Pressure: It is optimized the process parameter ranging from 100 to 150 bars. The higher is the size the lower is the particle size obtained e.g., RMRP 22.

b. No. of Homogenization cycles: The higher the homogenization cycles the smaller is the particle size obtained. The cycles are carried out in 3, 4 or 10 cycles. The number of cycles is analyzed by polydispersity index of drug after each cycle.

Advantages

- Ease of scale-up and little batch-to-batch variation
- Narrow size distribution of the nanoparticulate drug.
- Flexibility in handling the drug quality.
- Effectively used for thermolabile substances.

ii. Microfluidization

Microfluidization is a mixing technique, which makes use of a device called microfluidizer. This device uses a high-pressure positive displacement pump (500 to 20000psi), which forces the product through the interaction chamber, which consists of small channels called microchannels. The product flows through the microchannels on to an impingement area resulting in very fine particles of sub- micron range.

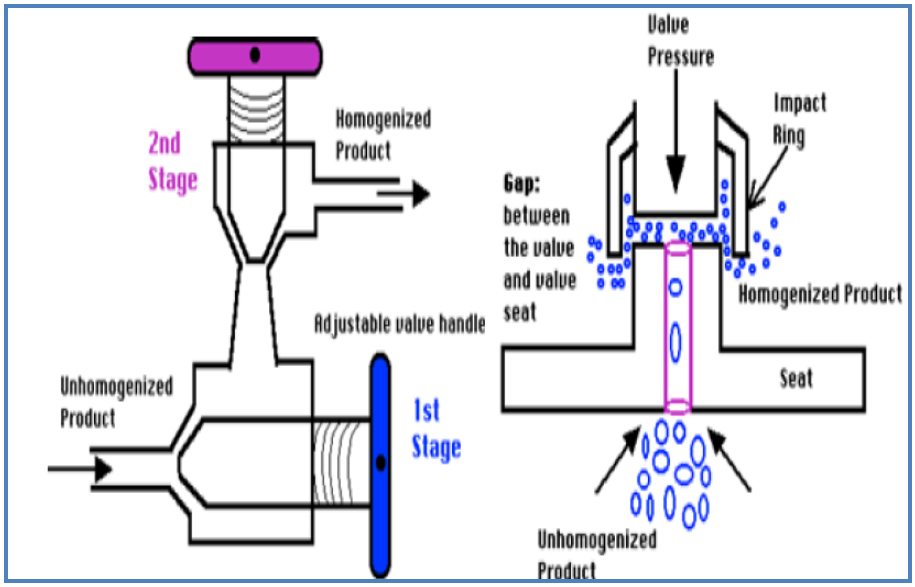


Figure 3: Microfluidization.

The two solutions (aqueous phase and oily phase) are combined together and processed in an inline homogenizer to yield a coarse emulsion. The coarse emulsion is into a microfluidizer where it is further processed to obtain a stable microemulsion. The coarse emulsion is passed through the interaction chamber microfluidizer repeatedly until desired particle size is obtained. The bulk emulsion is then filtered through a filter under nitrogen to remove large droplets resulting in a uniform microemulsion.

iii. Ultrasonication

The preparation of microemulsion is reported in various research papers which aim to use the ultrasonic sound frequency for the reduction of the droplet size. Another approach is the use of a constant amplitude sonotrode at system pressures in excess of the ambient value. It is well known that increasing the external pressure increases the cavitations threshold within an ultrasonic field and thus fewer bubbles form. However, increasing the external pressure also increases the collapse pressure of cavitations bubbles.

This means that the collapse of thebubbles when cavitation occurs becomes stronger and more violent than when the pressure is at atmospheric conditions. As cavitation is the most important mechanism of power dissipation in a low frequency ultrasonic system, these changes in navigational intensity can be related directly to changes in the power density. The system also uses a water jacket to control the temperature to optimum level.

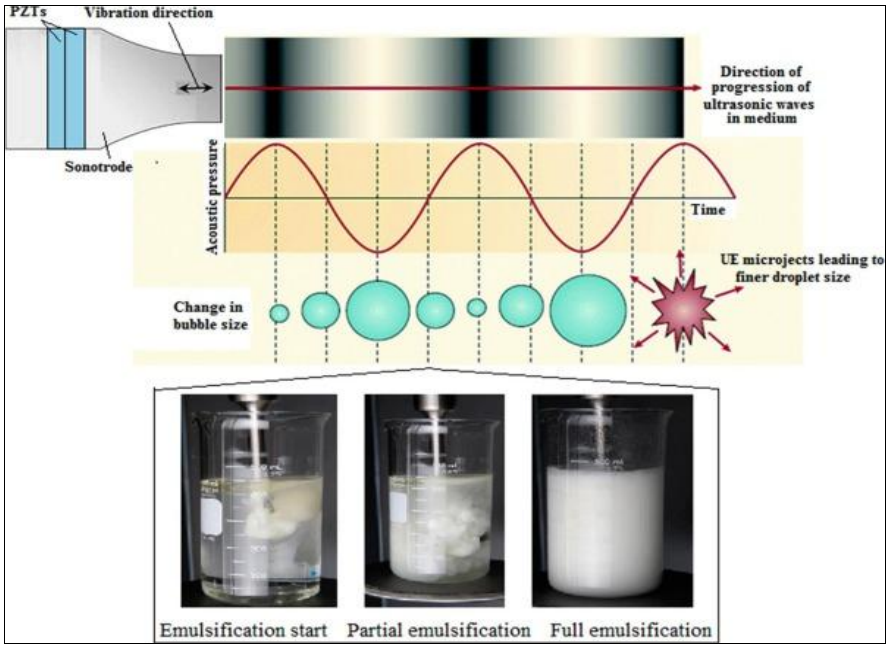


Figure 4: Ultrasonication.

iv. Phase inversion method

In this method, fine dispersion is obtained by chemical energy resulting of phase transitions produced by emulsification pathway. The phase transition is produced by varying the composition of the emulsion and keeping temperature constant or vice versa. The phase inversion temperature was first done by Shinoda et al. it was concluded that increase in temperature results in the chemical changes of polyoxyethelene surfactants by degradation of the polymer chain with the temperature.

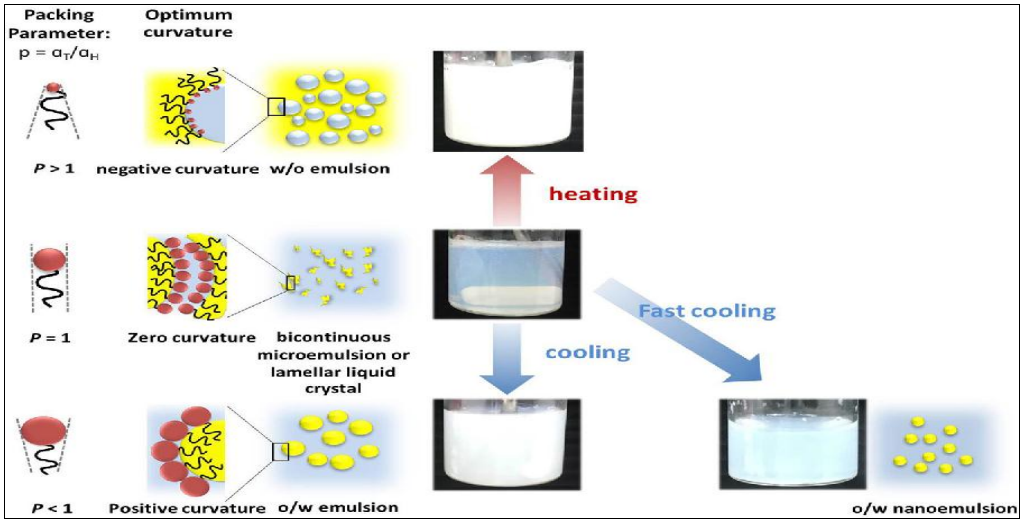


Figure 5: Phase inversion method.

v. Spontaneous emulsification

It involves three main steps

i. Preparation of homogeneous organic solution composed of oil and lipophilic surfactant in water miscible solvent and hydrophilic surfactant.

ii. The organic phase was injected in the aqueous phase under magnetic stirring the o/w emulsion was formed.

iii. The water-miscible solvent was removed by evaporation under reduced pressure.

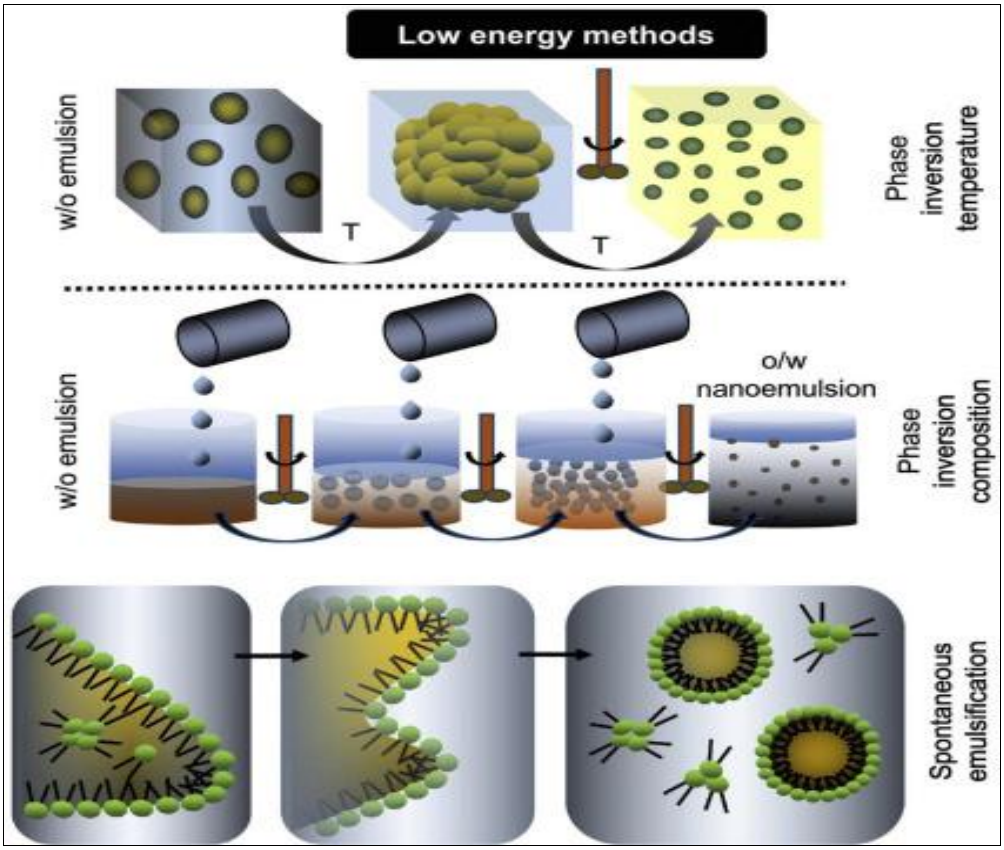
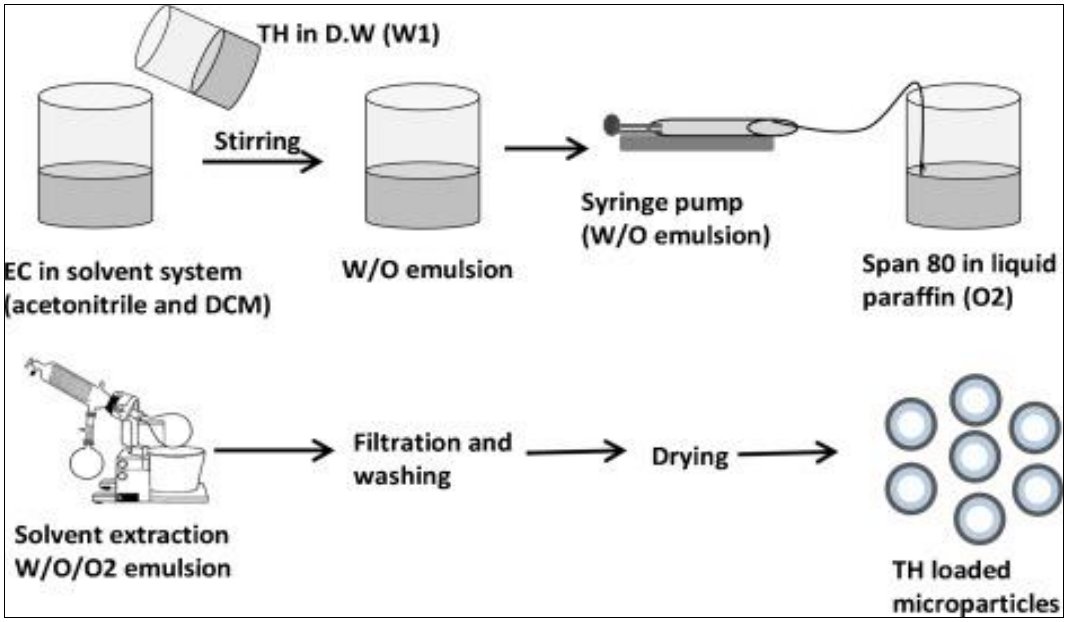


Figure 6: Spontaneous emulsification.

vi. Solvent evaporation technique

This technique involves preparing a solution of drug followed by its emulsification in another liquid that is non-solvent for the drug. Evaporation of the solvent leads to precipitation of the drug. Crystal growth and particle aggregation can be controlled by creating high shear forces using a high-speed stirrer.



1.1.7 Factor affecting Microemulsion

Factor affecting the microemulsion are as follows

Packing ratio

HLB of surfactant influences the kind of microemulsion by affecting the packaging and the curvature of the film.

Property of surfactant

Two lipophilic group and hydrophilic group include surfactants. Hydropyl single chain surfactants, such cetyl ammonium bromide, are totally dissociated into a diluted solution and tend to produce o/w microemulsion.

Property of oil phase

By its capacity to enter and swell the tail group area of a surfactant monolayer, the oil phase influences a curvature, swelling the tail resulting in an enhanced negative curvature to w/o microemulsion.

Temperature

The efficient head group size of nonionic surfactants is very essential to determine the temperature. The hydrophilic and the typical O/W system are formed at low temperatures. They are lipophilic and w/o systems at higher temperatures.

1.1.8 Characterization Techniques of microemulsion

1. **pH:** The apparent pH of the formulation was measured by pH meter.
2. **Zeta Potential:** Zeta potential measures the surface charge of microemulsion with the help of a mini electrode.
3. **Transmission Electron Microscopy (TEM):** It is a very simple method to determine the size, number, weight and structure (morphology characteristic). O/w microemulsion is stain with uranyl acetate and placed on a grid, coated with monolayer polymer, then water is evaporated and observation is done using TEM.
4. **Drug Content:** Western Blot method is used to measured amount of drug present.
5. **Viscosity Measurement:** Viscosity of microemulsion should be measured by using the rotary viscometer at different rate and temperature. microemulsions have very low viscosity.
6. **Centrifugation:** Microemulsion formulations were centrifuged at 3500 rpm and those that did not show any phase separation were taken for the freeze thaw stress test.
7. **Conductivity:** Electrical conductivity of formulated samples was measured using a digital conductometer at ambient temperature. Results were taken in triplicate and the average was taken in to consideration.
8. **Dilution test:** If the continuous phase is added in microemulsion, it will not crack or separate into phases. Maximum amount of water and oil were added to o/w and w/o formulations respectively and then inspected visually for clarity and phase separation. Here 50 and 100 times aqueous dilution of the formulation was visually checked for phase separation and clarity. Results were taken in triplicate and the average was taken in to consideration.
9. **Refractive index:** Refractive index of placebo formulations, drug-loaded formulations and one year old formulations was determined using an Abbes type refractometer.

10. **Stability of drug microemulsion:** Samples of Drug microemulsion formulations was sealed in ampoules and then placed in Stability chambers at different temperature conditions i.e., room temperature (25^0C) and accelerated temperature (40 ± 2^0C) for 2 months. Duplicate samples were withdrawn at 0, 1 and 2 months to evaluate their physical and chemical stabilities. The physical stability was evaluated by visual inspection for physical changes (such as phase separation and drug precipitation).

1.1.9 Factors affecting formulation of microemulsion

1. Appropriate composition is required to avoid Oswald ripening the dispersed phase should be highly insoluble in the dispersed medium.
2. The surfactant is an essential part of the microemulsion. They should not form lyotropic liquid crystalline "microemulsion" phases. Systems containing short chain alkanes, alcohols, water, and surfactants form the phases which are generally used with the co surfactant.
3. The presence of excess surfactants enables new surface area of nano scale to be rapidly coated during emulsification there by inhibiting induced coalescence.
4. Extreme share must be applied to rupture microscale droplets to nanoscale by providing the stress level to reach above the Laplace pressure of the droplets with a pressure of 10-100 atm.

1.1.10 Applications of microemulsion[12]

i. Parenteral Delivery: Microemulsion is advantages for intravenous administration, due to the strict requirement of this route of administration, particularly the necessity for the formulation droplet size lower than 1 micrometer. Parenteral (or Injectable) administration of microemulsion is employed for a variety of purposes, namely nutrition eg. Fats, Carbohydrates, Vitamins etc. Microemulsion of natural oils (soyabean, sesame and olive) with the non toxic surfactant Pluronic F-68 via ultrasound for parentral feeding. Lipid microemulsion has been widely explored for parentral delivery of drugs. Microemulsion formulations have distinct advantages over macroemulsion systems when delivered parenterally because of the fine particle microemulsion is cleared more slowly than the coarse particle emulsion and, therefore, have a longer residence time in the body. Both O/W and W/O microemulsion can be used for parenteral delivery.

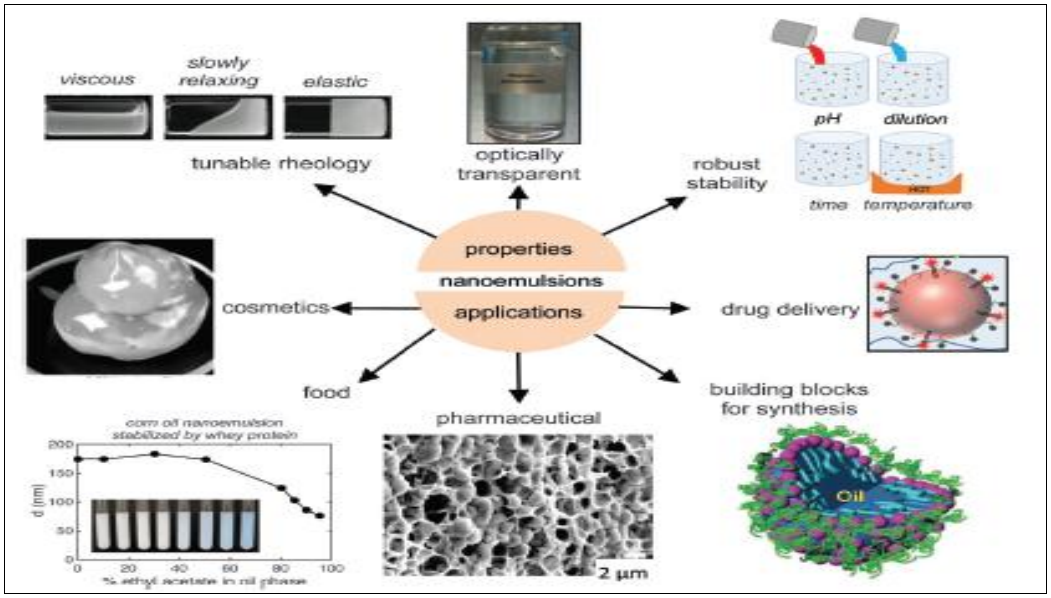


Figure 8: Schematic of various properties and applications of Nanoemulsions.

ii. Oral Delivery: Microemulsion formulations offer the several benefits over conventional oral formulation for oral administration including increased absorption, improved clinical potency and decreased drug toxicity. Therefore, microemulsion have been reported to be ideal delivery of drugs such as steroids, hormones, diuretic and antibiotics. Pharmaceutical drugs of peptides and proteins are highly potent and specific in their physiological functions.

Primaquine when incorporated into oral lipid microemulsion showed effective antimalarial activity against Plasmodium bergheii infection in mice at a 25% lower dose level as compared to conventional oral dose. Lipid microemulsion of primaquine improved oral bioavailability by the liver with drug concentration higher at least by 45% as compared with the plain drug.

iii. Topical Delivery: Topical administration of drugs can have advantages over other methods for several reasons, one of which is the avoidance of hepatic first pass metabolism of the drug and related toxicity effects. Another is the direct delivery and targetability of the drug to affected area of the skin or eyes. The microemulsion can achieve a level of topical antimicrobial activity that has only been previously

achieved by systemic antibiotics. The microemulsion has broad spectrum activity against bacteria (e.g. *E. coli, S. aureus*) fungi (e.g. Candida, Dermatophytes).

iv. Ocular Delivery: For the treatment of eye diseases, drugs are essentially delivered topically.[13]

O/W microemulsion have been investigated for ocular administration, to dissolve poorly soluble drugs, to increase absorption and to attain prolong release profile.

v. In Cosmetic: The aesthetic properties, i.e. low viscosity and transparent visual aspects of microemulsion with droplet sizes below 200nm, its high surface area allowing effective transport of the active ingredient to the skin make them especially attractive for their application in cosmetics. microemulsion are acceptable in cosmetics because there is no inherent creaming, sedimentation, flocculation or coalescence that are observed with macro emulsion. The incorporation of potentially irritating surfactants can be avoided by using high energy equipment during manufacturing. Nanogel technology to create miniemulsion from oil-in water concentrate suited to minimizing transepidermal water loss, enhanced skin protection and penetration of active ingredient. It would be useful for sun care products, moisturing and antiageing creams. It helps to give skin care formulations a good skin feels.

vi. Transdermal: Indomethacin a potent NSAID, the anti-inflammatory effects of true optimized microemulsion formulation were compared with marketed gel in carragenan induced paw edema in rats. The %inhibition value was significant for developed microemulsion, so great potential for transdermal application of indomethacin. Microemulsion for transdermal delivery of celecoxib. Formulation which consisted of 2% celecoxib 10% oil phase (Sefsol 218 and Triacetin) 50% surfactant mixture (Tween 80 and Transcutol –P) and 40% water.[14]

The anti-inflammatory effect and percent inhibition value after 24h administration was found to be high for microemulsion formulation (81.2%) as compared to celecoxib gel (43.7%) and microemulsion gel (64.5%). The *in vitro- in vivo* studies revealed a significant increase in the anti-inflammatory effects of aceclofenac microemulsion (82.2%) as compared to microemulsion gel formulation (71.4%) and conventional gel (41.8%).

vii. In Biotechnology: Many enzymatic and biocatalytic reactions are conducted in pure organic or aqua-organic media. Biphasic media are also used for these types of reactions. The use of pure apolar media causes the denaturation of biocatalysts. The use of water-proof media is relatively advantageous.

Enzymes in low water content display and have

- Increased solubility in non-polar reactants.
- Possibility of shifting thermodynamic equilibria in favour of condensations.
- Improvement of thermal stability of the enzymes, enabling reactions to be carried out at higher temperatures.

viii. Microemulsion in food industry

Microemulsion can be used in the food industry to design smart foods with ingredients that are otherwise difficult to incorporate due to low-water solubility; an example is b-carotene, a pigment responsible for color in vegetables like carrots possessing important health benefits. Yuan *et al.*[15-16] studied the size and stability of microemulsion with b-carotene against temperature, pH and surfactant type. Qian *et al.*[17-18] prepared microemulsion with b-carotene and stabilized them with b-lactoglobulin, a biocompatible emulsifier. Researchers also reported the bioaccessibility of these microemulsion by simulating the oral, gastric and small intestine environments. b-Carotene nanoemulsions have been prepared with different methods (like high pressure homogenization, microfluidization and evaporative ripening) and different emulsifiers.

ix. Microemulsion As building blocks

Microemulsion can be used as building blocks for the preparation of more complex materials through exploitation of their small size and high surface area which enable easy decoration of a liquid–liquid surface with functional moieties such as designer macromolecules.

Emulsion polymerization is perhaps the best-known example in polymer synthesis where hydrophobic monomers contained in droplets are polymerized to create polymeric particles. Microemulsion (also known as miniemulsions) have been utilized extensively in polymer synthesis.

x. Microemulsion in crystallization/pharmaceuticals industry

This procedure eliminates the need for high energy grinding methods and avoids undesired polymorphic transitions, a major disadvantage of traditional schemes. The researchers dissolved the active pharmaceutical ingredient (API) in nanosized droplets of anisole in an aqueous medium containing alginate (a biopolymer) and F68 (a biocompatible polymeric surfactant); and cross-linked the continuous phase leaving a droplet trapped in a hydrogel. The resulting soft material is a composite hydrogel. Through evaporation of the composite hydrogel, authors showed that crystals of controlled size (330 nm–420 mm) and loading (up to 85% w/w) can be produced. Eral *et al.*[19-20] also demonstrated that dissolution rates comparable to commercially available formulations of fenofibrate can be achieved. Furthermore, dried composite hydrogels can be produced with a continuous process and the final formulation containing the API and biocompatible polymer alginate can be compressed into tablets.[21-25]

1.1.11 Excipient used for formulation of microemulsion

i. Tween 80

Tween 80 is a nonionic surfactant and emulsifier often used in foods and cosmetics. This synthetic compound is a viscous, water-soluble yellow liquid.

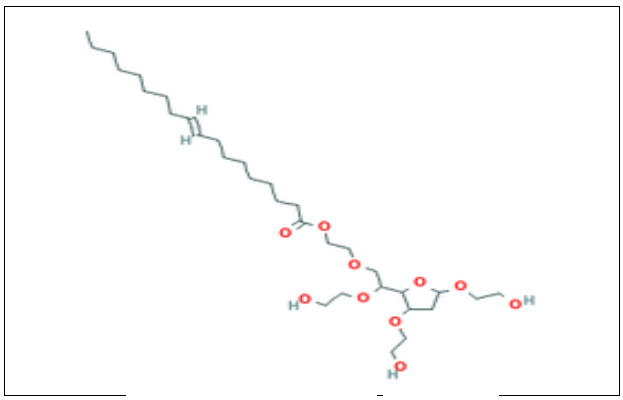


Figure 9: Structure of Tween 80.

Chemistry

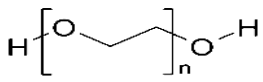
Tween 80 is derived from polyethoxylated sorbitan and oleic acid. The hydrophilic groups in this compound are polyethers also known as polyoxyethylene groups, which are polymers of ethylene oxide. In the nomenclature of polysorbates, the numeric designation following polysorbate refers to the lipophilic group, in this case, the oleic acid.

IUPAC name: Polyoxyethylene (20) sorbitan monooleate
Chemical formula: $C_{64}H_{124}O_{26}$
Molar mass: 1310 g/mol

Uses

Tween 80 is an excipient that is used to stabilize aqueous formulations of medications for parenteral administration, and used as an emulsifier in the making of the popular antiarrhythmic amiodarone. It is also used as an excipient in some European and Canadian influenza vaccines. Influenza vaccines contain 2.5 µg of Tween 80 per dose. Tween 80 is found in many vaccines used in the United States. It is also used in the culture of *Mycobacterium tuberculosis* in Middlebrook 7H9 broth. It is also used as an emulsifier in the estrogen-regulating drug Estrasorb. Also used in granulation for stabilization of drug and excipients while doing IPA binding.

ii. Polyethyleneglycol 600

Name	**Polyethylene glycol 600**
Structure	
IUPAC Name	Poly(oxyethylene), poly(ethylene oxide
Other Name	Carbowax, Golytely, GlycoLax, Fortrans, TriLyte, Colyte, Halflytely, Macrogol, Miralax, Movis
Properties 1) Formula 2) Molecular mass 3) Flash point 4) Solubility	 $C_{2n}H_{4n+2}O_{n+1}$ Variable 182 to 287°C In water, methanol, ethanol, acetonitrile, benzene
Uses	• Clinical uses • Chemical uses • Biological uses • Commercial uses • Industrial uses

iii. Castor oil

Castor oil has long been used commercially as a highly renewable resource for the chemical industry. It is a vegetable oil obtained by pressing the seeds of the castor oil plant (*Ricinus communis* L.) that is mainly cultivated in Africa, South America, and India.

Castor is one of the oldest cultivated crops; however, it contributes to only 0.15% of the vegetable oil produced in the world. The oil produced from this crop is considered to be of importance to the global specialty chemical industry because it is the only commercial source of a hydroxylated fatty acid.

Structure of castor oil

The structure of castor oil is made up of triglycerides that lack glycerin. The triglyceride molecule has a long 18-carbon chain with a double bond. Its chemistry is based mainly on the ricinoleic acid structure, carboxyl group, hydroxyl group, and a single point of unsaturation Figure 5. The carboxylic group in castor oil molecule allows production of a wide range of esterification products. The hydroxyl (-OH) group on the 12th carbon can be acetylated or eliminated through a dehydration process to upsurge the unsaturation to give a semi-drying oil. Through caustic fusion and high-temperature pyrolysis, the reactive site of the hydroxyl group can be splited to generate useful products with shorter chains. In addition, the hydroxyl group provides more strength to the structure to prevent the formation of hydroperoxides. The double bond in the structure can be modified through the process of carboxylation, epoxidation or hydrogenation. Lastly, the single point of unsaturation can be altered through the process of epoxidation and hydrogenation. Hydrogenated castor oil, which is a wax-like substance, can be obtained from the oil via hydrogen reduction.

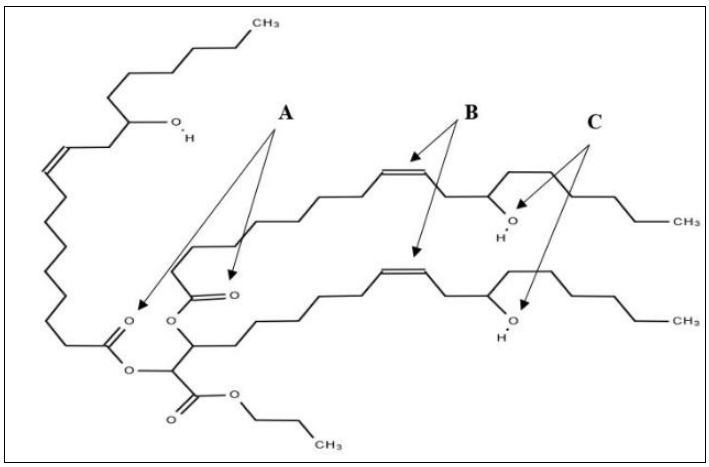


Figure 10: Structure of castor oil molecule. (A) indicates carboxylic groups; (B) indicates double bonds; (C) indicates hydroxyl groups.

Composition of castor oil seed

The composition of castor oil is mainly composed of fatty acids and neutral lipids (triglycerides). Other minor biological active compounds that consist of unsaponifiable fractions such as carotenoids, phenolics, phospholipids, phytochemicals, phytosterols, tocopherols, and tocotrienols are also present in the oil.

Medicinal use

Castor oil is well known as a powerful laxative, the medicinal use of the oil is relatively minor (1%). Beyond this infamous application of castor oil, it is considered to be an important feedstock utilized by the chemical industry, particularly in producing a wide array of materials, many of which are superior to equivalent products derived from petroleum. The high percent composition of ricinoleic acid in proximity to the double bond makes this oil poised for various physical, chemical, and even physiological activities, as described in the aforementioned paragraphs.

2. Recent Trends & Future Developments

During the last two decades lot of research work has been carried out on microemulsion system for providing novel solutions to overcome the problems of poor aqueous solubility of highly lipophilic drug compounds and these are providing reproducible bioavailability[26-29]. Industrial point of view, it can be easily scaled up with considering relative cost of commercial production. Cosmetic purpose and drug targeting, microemulsion are used. Now a day, researcher work is focused on the production of safe, efficient and more compatible microemulsion constituents which will further enhance the utility of this novel delivery system. One hopes that our society will be able to muster the collective financial and moral courage to allow such extraordinarily powerful drug delivery carrier to be deployed for human betterment, with due regard to essential ethical considerations.[30-31]

3. CONCLUSION

Over the last decades, microemulsions have been, and still are, very important and promising areas of study for a wide range of applications, from food science, detergents, and cosmetics, to drug delivery, nanoparticle synthesis, biotechnology, etc. This report summarizes the possible microstructures and phase behavior found in μEs, including the customary techniques and theoretical models used to describe and formulate them. Additionally, some examples of the recent progress in the applications in diverse fields have been presented. Both for the medication delivery system and for the industrial process, microemulsions are of critical relevance. They can be utilized to maximize medication targeting without increasing systemic absorption at the same time. Micro-involvement emulsion's in giving new methods for addressing the challenges of poor water solubility and high bioavailability in highly lipophilic

substances. However, problems persist, largely due to the layers of barriers these systems must overcome to reach the target, microemulsions may also be employed to reach the drug target. The ability to safeguard labile drugs, regulate the discharge of pharmaceutical drugs and reduce patient variability. Microemulsions are commercially simple and convenient vehicle for delivery of medicaments which can enhance drug absorption with reduced systemic side effect. They can be used to optimise drug targeting without a concomitant increase in systemic absorption. Appropriate excipients selection and safety evaluation especially of the cosurfactants is crucial in the formulation of microemulsions. They can be potential drug delivery systems for the delivery of more than one medicament simultaneously.

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