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ROLE OF MICROEMULSION IN ADVANCED DRUG DELIVERY SYSTEM

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ABSTRACT

Microemulsions are transparent, solid, isotropic blends of oil, water, and surfactant, often mixed with a co-surfactant. It serves as potential drug carrier systems for administering orally, topically, and parenterally. This has gained a lot of coverage not only for extended release but also for targeting drugs to a particular site. They are susceptible to sustained and targeted delivery, in addition to oral and intravenous delivery, through ophthalmic, dental, pulmonary, vaginal, and topical routes. Specific poorly water soluble delivered by oral route also found increased bioavailability. We show effective topical delivery mechanisms for various active pharmaceutical ingredients for both the therapeutic and cosmetic applications. The topical it shows very quick penetration of the active molecules which is mainly due to the wide surface area of the internal process, their contents also reduce the stratum corneum's barrier property. They have “great applications and uses in pharmaceuticals, agrochemicals, cutting oils, biotechnology, food, cosmetics, analytical applications, detoxification” of the environment etc. The main aim of this review paper is to describe microemulsions with other possible applications as a drug carrier system.

KEYWORDS: Microemulsions, Characterization, Drug Delivery, Application

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INTRODUCTION

“An ongoing process in pharmaceutical research is the formulation and development of a novel drug delivery system with the nature of enhancing the effectiveness of drug existing”. As it has developed many forms of drug delivery systems. In the 1940s Hoar and Schulman introduced the concept of microemulsion, which produced a simple single-phase solution by shredding a milky emulsion with hexanol [1]. They prepared the first micro emulsion by dispersing oil in a solution of aqueous surfactants and adding an alcohol as a co-surfactant, resulting in a transparent stable formulation. The term microemulsion was later coined by Schulman and co-workers (1959) [2]. Microemulsions, often in conjunction with a “co-surfactant, are clear, solid, isotropic liquid mixtures of oil, water, and surfactant”. The aqueous phase may contain salt(s) and/or other ingredients, and the "oil" may actually be a complex mixture of different hydrocarbons and olefins.

Unlike ordinary emulsions, microemulsion forms when the components are simply combined, and does not require the high shear conditions commonly used in the creation of ordinary emulsions. The two main forms of microemulsion are direct (oil scattered through gas, o / w) and reversed (gas scattered through oil, w/o) [3-5]. Microemulsion is thus described as the “Water, Oil & Amphiphile System that is a single optically

isotropic and thermodynamically stable liquid solution". For topical applications, the microemulsion-based gels are stronger than the microemulsion used as the vehicles for drug delivery purposes [6-7]. So certain gelling agents can be used to increase the microemulsion viscosity and to shape microemulsion-based gels (MBG) [8]. Microemulsion systems serve as a promising tool for distributing orally the poorly water-soluble drugs because the micro emulsion systems will significantly improve drug solubilization. When the drug's thermodynamic activity is increasing in the body, its absorption rate is also rising [9]. The thermodynamic activity can be expressed roughly in terms of the relative solubility which is the ratio of the drug's current concentration to the saturated vehicle concentration) [10].

Difference between Emulsions and Microemulsions

The emulsions and microemulsions vary in many ways, but some of the key distinctions between the emulsions and the microemulsion are as follows: the main difference between the emulsions and the microemulsion is that their particles are of varying sizes and shapes that are further distributed into the continuous phase.

Table 1: Comparison between Emulsion and Microemulsion [11]

S. No.	Emulsion	Microemulsion
1.	Emulsion is thermodynamically unstable	Microemulsion are thermodynamically stable.
2.	They may remain stable for long periods of time, will ultimately undergo phase separation on standing to attain a minimum in free energy.	It can have basically infinite lifetime assuming no change in composition, temperature and pressure, and do not tend to separate.
3.	They are lyophobic.	They are on the borderline between lyophobic and lipophilic colloids.
4.	Most emulsions are opaque (white) because bulk of their droplets is greater than wavelength of light and most oils have higher refractive indices than water.	Microemulsion are transparent or translucent as their droplet diameter are less than ¼ of the wavelength of light, they scatter little light.
5.	Droplet diameter 1–20mm.	Droplet diameter 10–100nm.
6.	Emulsions consist of roughly spherical droplets of one phase dispersed into the other.	They constantly evolve between various structures ranging from droplet like swollen micelles to bi-continuous structure.
7.	Inefficient molecular packing.	Efficient molecular packing.
8.	Direct oil/water contact at the interface.	No direct oil/water contact at the interface.

Advantages of Microemulsion Based Systems

Microemulsion exhibit several advantages as a drug delivery system: -

- Microemulsions are thermodynamically stable and allow the system to self-emulsify.
- Both "hydrophilic and lipophilic drugs, including drugs that are relatively insoluble in both aqueous and hydrophobic solvents, can be solubilized as super solvents" by microemulsion.
- The dispersed phase, either lipophilic or hydrophilic (oil-in - water, O / W, or water-in - oil, W / O microemulsions) may act as a potential reservoir of lipophilic or hydrophilic drugs. Drug release with pseudo-zero-order kinetics may be obtained depending on the volume of the dispersed phase, the drug partition, and the drug's rate of transport.
- The mean micro emulsion droplet diameter is less than 0.22 mm. This yields a large interfacial region from which, as absorption (in vitro or in vivo) occurs, the drug is released rapidly into the external process, retaining the concentration close to the initial levels.
- Ability to handle lipophilic drugs as well as hydrophilic drugs.
- Because of better thermodynamic stability, microemulsions are simple to prepare and require no major energy input during preparation.
- Compared to main and multiple emulsions, microemulsions have low viscosity.
- The use of microemulsion as delivery mechanisms will increase the efficacy of the medication, thereby reducing the total dosage and mitigating side effects.
- Microemulsion formation is reversible. They can become unstable at low or high temperatures but the microemulsion reforms once the temperature returns to the stability range.

Disadvantages of Microemulsion Based Systems

- ❖ Require significant amounts of S/Cs for droplet stabilization.
- ❖ Limited ability to solubilize high fusion substances used in the device.
- ❖ The surfactant for use in pharmaceutical applications should be non-toxic.
- ❖ Physical factors such as temperature and pH affect microemulsion stability. These parameters change as microemulsion is administered to patients.

Limitations

- ❖ For toxicological purposes, the concentration of surfactants and co-surfactants used must be kept low.
- ❖ Microemulsion also suffers from limitations of phase separation.
- ❖ The need for drug toxicity is robust for intravenous use and very few studies have been published to date.
- ❖ The use of surfactants included in the category "Generally Safe" (GRAS) can reduce toxicity [12, 13, 14].

Structure of Microemulsion

Micellar emulsions or microemulsions are the active formulation systems where the interface tends to change rapidly and continuously [15].

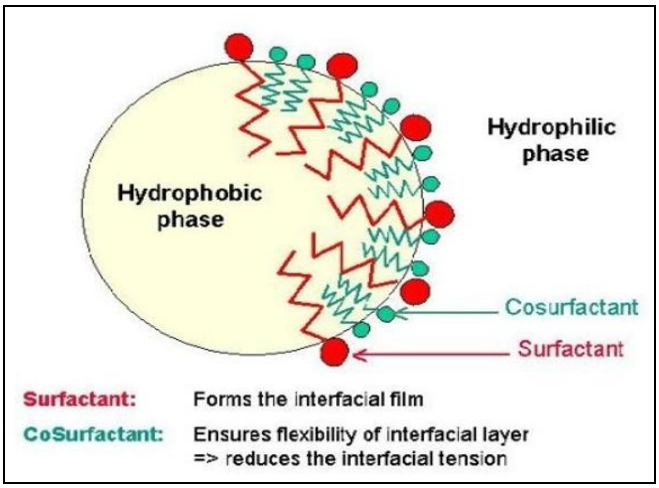

Figure 1: Microemulsion Structure

These may be water in oil (W / O) microemulsion systems, oil in water (O / W) microemulsion systems, and may even be bi-continuous microemulsions, depending on their composition. In the case of water in oil microemulsions, the water droplets are dispersed in the continuous oil phase where they are shaped as in the oil in water microemulsions, leading to the dispersion of the oil droplets into the continuous aqueous phase. But in the case of the systems where the amounts of both oil and water are the same, the formation of the bi-continuous microemulsion takes place[16].

Types of Microemulsion Systems [13, 17-19]

Winsor Classification of Microemulsions

Four different types of situations may arise by mixing oil, water, amphiphiles as shown by Winsor.

Type–I

It consists of equilibrated O/W micro-emulsion with excess oil process. The surfactant is ideally soluble in the form of microemulsion water and oil -in- water (O/W) (Winsor I). The surfactant-rich water phase coexists with the oil phase, in which surfactant is present in small amounts only as monomers.

Type–II

It consists of equilibrated W/O micro-emulsion with excess water step. The surfactant is often in the microemulsion process of the oil system and water-in- oil (W/O). The surfactant-rich oil process coexists with the weak aqueous phase of the surfactant (Winsor II).

Type–III

It consists of the equilibrium micro-emulsion process of both the excess water and the process of excess oil. A three-phase system in which a middle phase rich in surfactants coexists with weak phases of both excess water and surfactant oil (Winsor III or middle phase microemulsion).

Type–IV

A single-phase (isotropic) micellar solution, that forms upon addition of a sufficient quantity of amphiphile (surfactant plus alcohol).

Components of Microemulsion System

The availability of oils and surfactants is abundant, but their use is limited due to their toxicity, potential for irritation, and uncertain mechanism of action. Biocompatible, non-toxic, and clinically safe oils and surfactant that will be used for microemulsion formulation. The focus is on selecting the part that falls under "generally considered secure" (GRAS) [19].

- Oil phase
- Aqueous phase

- Primary surfactant
- Secondary surfactant (co-surfactant)
- Co-Solvent

Methods of Preparation

Phase Inversion Method

The phase inversion of the microemulsion occurs due to the addition of excess of dispersed phase or in the temperature response. Severe physical changes occur at the time of phase inversion and often involves changes in particle size which can also impact both *in-vitro* and *in-vivo* release of the drug. This method utilizes the changing in the spontaneous curvature of the surfactant.

In the case of Non-Ionic surfactants, which forces the transition from an O/w microemulsion at low temperatures to a w/o microemulsion at higher temperatures at cooling, this can be achieved by changing the system temperature, the system crosses the point of zero spontaneous curvature and minimal surface tension, promoting the formation of finely dispersed oil droplets. This approach is also called the Temperature Inversion Phase (PIT) process. Yet certain parameters, including the pH value or the salt concentration, can also be considered only instead of the temperature itself, instead of the temperature.

On top of this, a transition can be accomplished in the random radius of curvature by changing the fraction of the water volume. Initially water droplets are produced in a continuous oil process by successively inserting water into the liquid. Through simply increasing the fraction of the water volume, the surfactant's spontaneous curvature switches from stabilizing a w/o microemulsion initially to an o/w microemulsion at the locus of the inversion. The short-chained surfactants form flexible mono layers at the o/w interface resulting in a bi-continuous microemulsion at the inversion point.

Phase Titration Method

The microemulsion can be prepared using the process of phase titration (a spontaneous emulsification process which can be represented using phase diagrams). The design of the phase diagrams is very useful in researching the complex set of interactions that that occur when various components are mixed. They are formed together with different association structures (including miscelles, lamellar, emulsion, hexagonal, cubic, and various gels, and oily dispersions), depending on the chemical composition and the concentration of and component. The study's basic parameters are its interpretation of their phase equilibrium and demarcation of phase boundaries. Since the quaternary phase diagram (four component system) is very time-consuming and very difficult to interpret, the pseudo ternary phase diagram is also designed to evaluate the different zones, including the micro emulsion region, in which each corner of the diagram represents 100% of the component [20, 21].

Construction of Pseudoternary Phase Diagram

Pseudo ternary phase diagrams consisting of oil, mixture and water were formed using aqueous titration process, different mixing ratio, oil was taken in vial and vortexed for five minutes followed by adding water with micropipette, adding water continued until adding one more drop of turbidity created. Their phase visibility and flowability were also visually observed. The volume of the aqueous phase was noted, and then phase diagrams were constructed using the software Tri plot v1-4.

These values were then used to evaluate the microemulsion domain boundaries corresponding to the value of the oils selected, as well as the mixing ratio of the surfactant or co-surfactant. To evaluate the effect of drug addition on the microemulsion boundary, phase diagrams were also constructed using drug-enriched oil as the hydrophobic portion in the presence of drug [22].

Factor Affecting Phase Behaviour

Salinity

The droplet size of the o/w microemulsion grows at low salinity. That corresponds to an increase in oil solubilization. When salinity increases further the mechanism becomes bi-continuous across an intermediate range of salinity. Increased salinity results in the development of continuous micro-emulsion with reduced globular thickness. Further increase in salinity ultimately results in complete phase transition.

Alcohol Concentration

Increasing the concentration of low molecular weight alcohol as a co-surfactant leads to a continuous phase change from w/o to bi, and eventually to microemulsion type o/w. In the case

of high molecular weight alcohol, exactly the opposite phase transition is observed.

Surfactant Hydrophobic Chain Length

The increase in the length of the surfactant's hydrophobic chain shows the shift in o/w micro-emulsion to w/o via bi-continuous phase.

pH

Changes in pH affect microemulsion that includes pH-sensitive surfactants. For the case of acidic or alkaline surfactants this effect is more pronounced. Carboxylic acids and amines alter phase actions by increasing the pH from w/o to o/w.

Nature of Oil

Increasing the aromaticity of oil results in a phase transition from o/w to w/o and is contrary to the increase in the number of oil alkane carbon.

Ionic Strength

When the ionic pressure increases the device goes from o/w microemulsion in balance with excess oil to the middle phase and eventually to w/o micro emulsion in balance with excess water [23, 24].

Evaluation Parameters of Microemulsion System

Physical Appearance

For Physical appearance microemulsion can be inspect visually for homogeneity, fluidity and optical clarity [25].

Scattering Techniques

Scattering techniques such as small angle neutron scattering, small angle X-ray scattering and light scattering have found applications in microemulsion structure studies , especially in dilute mono dispersion spheres, where poly dispersion or condensed systems such as those often seen in microemulsion [26].

Limpidity Test (Percent Transmittance)

The limpidity of the micro emulsion can be measured spectrophotometrically using spectrophotometer [26].

Drug Stability

The optimized microemulsion was kept in cold (4-8 °C), room temperature and elevated temperature (50 ± 2 °C) condition. The micro emulsion can be analyzed after every 2 months for phase separation, transmission percentage, globule size and percent assay [26].

Globule Size and Zeta Potential Measurements

The globule size and zeta potential of the microemulsion can be determined by dynamic light scattering, using a Zeta-sizer HSA 3000 [27].

Assessment of the Rheological Properties (Viscosity Measurement)

The rheological characteristics play an important part in stability. This can be measured by a wireless viscometer from Brookfield. Changes in the rheological characteristics help to determine the area of micro emulsions and their separation from other regions. Discontinuous microemulsion are dynamic structures with continuous fluctuations occurring between the discontinuous structure, swollen reverse micelle, and swollen micelles [27].

Electrical Conductivity

A mixture of gasoline, surfactant and co-surfactant has been applied to the water process and the electrical conductivity of formulated samples can be measured at ambient temperature and at a constant frequency of 1 Hz using a conduct meter [27].

Drug Solubility

The optimized formulation of microemulsion and each individual component of the formulation were added to the product in excess of. Samples were removed and centrifuged at 6000 rpm for 10 min after continuous stirring for 24 h at room temperature. The quantity of soluble drug in optimized formulation as well as each individual formulating component was determined by subtracting the drug present in the sediment from the total quantity of drug added. The solubility of microemulsion product with respect to its individual ingredients was compared[28].

***In-vitro* Drug Release**

The study of diffusion can be performed on a modified Franz diffusion cell, within 20mL range. The receptor compartment had buffer filled in. The donor compartment was fixed separately with cellophane membrane, containing the formulas for micro emulsions and the solution for simple drugs. At predetermined time intervals samples were withdrawn from the receptor compartment and analyzed for drug content, using

a UV spectrophotometer at specific wavelength[28].

Application of Microemulsion in Delivery of Drug

During the last two decades, microemulsion has been promisingly used as drug delivery system for its advantages include their thermodynamic stability, optical clarity, and ease of penetration. The role of microemulsion as drug delivery system shall be discussed below.

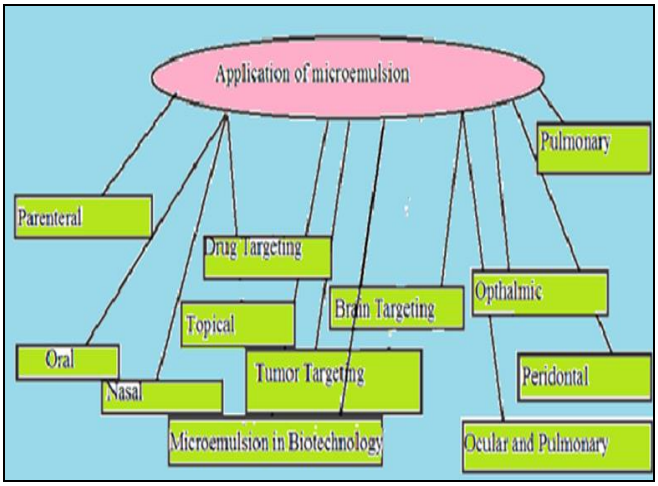

Figure 2: Applications of Microemulsion

Oral Delivery

Researchers have also been challenged to establish successful oral delivery systems, as drug effectiveness can be limited by instability or low solubility in gastrointestinal fluid. They have the potential to enhance the solubilization of poorly soluble drugs (especially BCS class II or class IV) and to resolve the bioavailability issues related to the dissolution.

Hydrophilic drugs including macromolecules can be encapsulated with varying solubility due to the presence of polar, non-polar and interfacial domains. These systems protect the integrated drugs against oxidation, enzymatic degradation and increase the permeability of the membrane. Sandimmune Neoral(R) (Cyclosporine A), Fortovase(R) (Saquinavir), Norvir(R) (Ritonavir), and so forth. Microemulsion formulations can be useful in enhancing the oral bioavailability of poorly water-soluble drugs by increasing their solubility in gastrointestinal fluid [29].

Parenteral Delivery

The formulation of lipophilic and hydrophilic drugs in parenteral dosage form has proved to be difficult. O/w microemulsions are beneficial in the delivery of sparingly soluble drugs in parenteral cases where suspension administration is not required. These offer a way of achieving fairly high concentration of such medications, which typically involves regular dosing. Some advantages are that they show higher plasma physical stability than liposome or other vehicles and the internal oil process is more resistant to drug leaching.

Some sparingly soluble drugs were developed for parenteral delivery into the o/w microemulsion. Von Corsewant and Thoren followed an alternative approach in which C3-C4 alcohols were replaced by parenterally suitable co-surfactants, polyethylene glycol (400)/ polyethylene glycol (660) 12-hydroxystearate / ethanol, thus retaining a versatile surfactant film and a spontaneous curvature close to zero to achieve and almost balanced microemulsion in the middle process [30].

Topical Delivery

For many purposes, topical drug administration may have advantages over other methods, one of which is to prevent first-pass hepatic metabolism, salivary and stomach degradation of the drug, and associated toxicity effects. Another is the drug's targeted delivery and targeting capability to compromised areas of the skin or eyes. There have already been a variety of reports on drug penetration into the skin within a day.

These are capable of absorbing both hydrophilic (5-flurouracil, apomorphine hydrochloride, diphenhydramine hydrochloride, tetracaine hydrochloride, methotrexate) and lipophilic (estradiol, finasteride, ketoprofen, meloxicam, felodipine, triptolide) drugs and their permeation is increased. Since formation of microemulsion formation requires high surfactant concentration, the skin irritation aspect must be considered especially when they are intended to be applied for a longer period [31].

Ophthalmic Delivery

Water soluble drugs are administered in aqueous solution in traditional ophthalmic dosage types whereas water-insoluble drugs are formulated as suspension or ointments. Low corneal bioavailability and lack of productivity in the posterior eye tissue section are some of these systems' severe problems. Recent research has focussed on designing innovative and more

effective delivery system. Microemulsions have emerged as a promising, ocular dosage type. Chloramphenicol, an antibiotic used to treat trachoma and keratitis, quickly hydrolyzes in the typical eye drops. As possible drug delivery mechanisms for eye drops, Lv *et al*., studied the micro emulsion composed of Span 20, Tween 20, isopropylmyristate, and water. Chlroamphenicol was clogged in the alcohol-free o/w microemulsion.

The authors revealed that at the end of the accelerated experiments, the content of microemulsion formulations was much lower than that of glycol (main hydrolysis product) in commercial eye drops. Therefore, the micro-emulsion formulations observed a surprising improvement in the stability of Chloramphenicol. Fialho *et al*., studied dexamethasone eye drops based on microemulsion which showed improved tolerability and increased bioavailability. The formulation showed greater eye penetration which made it possible to decrease the dosing frequency and thus improve patient compliance [32-33].

Nasal Delivery

Microemulsions are recently being investigated as a delivery mechanism for enhancing drug absorption through nasal mucosa. Furthermore, mucoadhesive polymer helps to extend the time of residence on the mucosa. The effect of diazepam on the emergency treatment of epileptic condition was investigated by Lianly *et al.* They found diazepam's nasal absorption to be relatively fast at 2 mg kg-1 dose with maximum concentration of drug plasma reached within 2-3 min [34].

Drug Targeting

Drug targeted at the various tissues has evolved as the most desirable drug delivery objective. It is possible to achieve greater drug efficacy with concomitant reduction of their toxic effects by altering pharmacokinetics and bio-distribution of drugs and by limiting their action to the targeted tissue. Shiokawa *et al.* reported novel microemulsion formulations for lipophilic antitumor antibiotic aclainomycin A (ACM) targeting of tumors. They reported that a folate-linked microemulsion is feasible for delivering targeted ACM to tumour. They also reported that folate modification on emulsions with a sufficiently long PEG chain is an effective way of targeting emulsion into tumor cells [35].

Periodontal Delivery

Periodontal disorder is a common term used to describe a variety of progressive oral pathological disorders such as inflammation and gum degeneration, periodontal ligaments, cement and supporting tissue. It is a significant cause of damage to the tooth. Brodin *et al*., innovation included a novel pharmaceutical composition that contained local anaesthetic in the form of oil, surfactant, water, and optionally a taste masking agent.

The formulation was in the form of an emulsion or microemulsion, which had thermo-reversible gelling properties, i.e. at room temperature it was less viscous than when a patient's mucous membrane was applied. The surfactant in the formulation imparted the thermo reversible gelling properties. Preferred surfactants were Poloxamer 188®, Poloxamer 407® and Arlatone 289®. The formulation may be used in combination with periodontal scaling and root preparation as a local anesthetic for pain relief inside the oral cavity and resolved the problem with current topical products (jelly, ointment or spray) such as lack of effectiveness due to inadequate penetration range, too limited duration and difficulties in administration due to distribution, taste etc. [36]

Cellular Targeting

Cell transmitted nucleic acids are potential therapeutics. Monahan's *et al*., requires the injection of nucleic acid for cell delivery into a reverse micelle. W/o microemulsion is referred to as reverse micelles. For easier distribution the reverse micelle had the property to compress the nucleic acid. Additional molecules such as a surfactant with a bisulfide bond or a poly-ion can be added to the nucleic acid-micelle complex to further improve the delivery. Another advantage of the discovery has been the use of reverse micelles to transfer genes to the cells. The micelle containing the compacted polynucleotide could be used as a reaction vesicle in which additional compounds could be added to the DNA, such as poly cation. In addition, the polynucleotide / reverse micelle method was used as a tool for DNA template polymerization or DNA caging, in which the polycation was interconnected.

Another benefit was that the micelle through be cleaved along the transfection pathway (the method of transmitting a polynucleotide to a cell) under physiological conditions. Better recovery

and purification of the biomolecules could be accomplished by the use of earlier difficult cleavable reverse micelles. Wheeler et al., discovery was related to the delivery of hydrophobic compounds to cells in microemulsion carriers. This consisted of a blend of oil, a hydrophobic compound, and a lipid connected to polyethylene glycol. Polyethylene glycol-linked lipid was intended to increase the stability of the micro emulsion compositions.

The hydrophobic compound existed in an oil system that was encircled by a polar lipid monolayer. The lipid 's polar head faced outward to compatibly with the external aqueous environment, and the non-polar tail faced the internal oil environment. The lipid monolayer may be attached covalently or non-covalently to a targeting moiety such as biotin, avidin, streptavidin or anticorps. The composition may also be used for the diagnosis and therapy [37, 38].

Tumour Targeting

Maranhao indicated that microemulsions would be used as vehicles to deliver chemotherapy or diagnostic agents to neoplastic cells while avoiding normal cells. We reported a mechanism for treating neoplasms where cells with neoplasms have an elevated number of LDL receptors (low density, lipoprotein) relative to normal cells. The microemulsion consisted of a cholesterol ester nucleus and no more than 20 percent triglycerides surrounded by a core of phospholipids and free cholesterol and contained a chemotherapeutic drug. We have the lipid part of low-density lipoprotein (LDL) similar in chemical composition but did not include the protein component.

Such artificial microemulsion particles, when injected into the bloodstream or incubated with water, incorporated water apolipoprotein E (apo E) onto their surfaces. The apolipoprotein E acted as a connecting factor between the microemulsion particles and the LDL receptors. They could then be inserted into cells through LDL receptors and delivered the built-in molecules. Shiokawa and colleagues published a novel microemulsion formulation for lipophilic antitumor antibiotic aclacinomycin A (ACM) drug carrier intended for tumour. Their findings indicate a folate-linked microemulsion is feasible for delivering targeted ACM to the tumour. The study demonstrated that folate modification on emulsions with a sufficiently long PEG chain is an effective way to target emulsion to tumour cells [39, 35].

Brain Targeting

Intranasal administration offers a easy, efficient, cost-effective, safe and non-invasive route for rapid delivery of drugs to the brain. This enables medicines to be delivered directly to the brain, circumventing the brain barriers. Vyas et al., prepared the mucoadhesive microemulsion for clonazepam, an antiepileptic medication. The goal was to provide the rat brain with swift delivery. Brain / blood ratio at all sampling points up to 8h after clonazepam mucoadhesive microemulsion is given intranasally compared with i.v. It was observed that the distribution of the drug in the brain was 2-fold higher [40, 41, 42, 43, 44].

Ocular and Pulmonary Delivery

Drugs are basically administered topically for the treatment of eye diseases. O/W microemulsion was investigated for ocular administration, to remove drugs that are poorly soluble, to improve absorption and to achieve a sustained release profile. They containing pilocarpine have been formulated using lecithin, propylene glycol, and PEG 200 as co-surfactant and IPM as phase oil. The formulations were of low viscosity and provided a refractive index for ophthalmological applications. The formation of a water-in-HFA propulsive microemulsion, stabilized by non-ionic fluorocarbon surfactant and intended for pulmonary delivery, was described [18].

Microemulsions in Biotechnology

Numerous enzymatic and biocatalytic reactions occur in pure organic or aqua-organic media. For these forms of reactions even biphasic media are used. Using pure a polar media allows biocatalysts to denaturate. The use of water-proof media is fairly helpful. Enzymes show and have low water content:

1. Increased solubility in non-polar reactants

2. Possibility of shifting thermodynamic equilibrium in favour of condensations

3. Improvement of thermal stability of the enzymes, enabling reactions to be carried out at higher temperatures. Many enzymes, including lipases, esterases, dehydrogenases and oxidases often function in the cells in micro-environments that are hydrophobic in nature [45].

Other Applications

- Microemulsion in enhanced oil recovery.
- Microemulsions as fuels.
- Microemulsions as lubricants, cutting oils and corrosion inhibitors.
- Microemulsions as coatings and textile finishing.
- Microemulsions in detergency.
- Microemulsions in cosmetics.
- Microemulsions in agrochemicals.
- Microemulsions in food.
- Microemulsions in environmental remediation and detoxification.
- Microporous media synthesis (microemulsion gel technique).
- Microemulsions in analytical applications.
- Microemulsions as liquid membranes.
- Novel crystalline colloidal arrays as chemical sensor materials [46].

CONCLUSION

It can be used to optimize drug targeting without increasing systemic absorption by one fellow. Microemulsion's position in bringing new approaches to the problems of poor aqueous solubility of compounds of highly lipophilic drugs and providing fast, more stable and reproducible bioavailability. The value of microemulsion as vehicles for the delivery of drugs is an exciting and enticing field of study, expiation not only of many difficulties but also of many potentially extraordinary benefits to be gained.

Currently, microemulsion has been shown to be capable of protecting stable drugs, managed drug release, increased drug solubility, increased bioavailability, reduced patient variability, increased absorption rate, allows lipophilic drugs to be solubilised, various routes such as topical, oral and intravenous can be used to deliver the products, helpful in taste masking, supplying and improving the patient compliance. It has proved possible to devise the planning that fits most administration routes. In fact, plans suitable for most routes of administration have been shown to be formulated. The microemulsion is recognized as full of potential for advance drug delivery systems in today's world. There is a lack of toxicological evaluation of the formulate microemulsion, which can be a broad research area in future.

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CONFLICT OF INTEREST

None

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