MICROEMULSION: A POTENTIAL CARRIER TO ENHANCE PATIENT COMPLIANCE

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ABSTRACT

A cosurfactant is routinely added to clear, stable, isotropic solutions of oil, water, and surfactant to create microemulsions. Microemulsions are liquid mixtures of amphiphile, water, and oil that are optically isotropic and thermodynamically stable. To far, it has been demonstrated that microemulsions can control medication release, protect labile drugs, improve their solubility, boost their bioavailability, and lessen patient variability. Additionally, it has been demonstrated that preparations that work well for the majority of administration methods can be created. Since their discovery, microemulsions have grown in importance in both basic and applied research. Microemulsions have many uses and applications because of their special properties, such as ultralow interfacial tension, huge interfacial area, thermodynamic stability, and the capacity to solubilize liquids that would otherwise be incommensurable. Microemulsions are readily distinguished from normal emulsions by their transparency, low viscosity and more fundamentally their thermodynamic stability.

KEYWORDS: Microemulsions, Carrier, thermodynamically stable

INTRODUCTION TO MICROEMULSIONS [1-3]

Microemulsions spontaneously develop, with typical droplet sizes ranging from 10 to 140 nm. Surfactant is present at the precise boundary between the oil and water phases in microemulsions. Traditional surfactant molecules had an apolar tail and a polar head group region. Asymmetrical microemulsions typically take on the prolate ellipsoid shape. Microemulsions can be used as liquid membrane carriers to move hydrophilic materials over a lipoidal medium or to move lipophilic materials through an aqueous medium. Microemulsions are translucent and cannot be seen with an optical microscope because the particle size is substantially smaller than the visible light wavelength. Since they are liquids, microemulsions exhibit Newtonian behaviour. They don't have much viscosity.

Over the years, there has been a lot of interest in microemulsions as prospective drug delivery systems. In addition to improved drug solubilization, microemulsion-based formulations also exhibit strong thermodynamic stability and are simple to manufacture. Microemulsions are flexible delivery systems that can be employed for a variety of drug delivery methods. In-depth research has been done on these systems for topical application. Microemulsions can boost the local or systemic distribution of a medicine through a variety of methods when used as topical carriers. Both water-soluble and oil-soluble molecules can be solubilized since the same single phase solution contains microdomains with various polarities.

The composition of the microemulsion may change the skin's diffusional barrier. Also, an increased thermodynamic activity of the drug may favour its partitioning in the skin.

TYPES OF MICRO-EMULSION [4, 5]

- There square measure four sorts of micro-emulsion segments conferring by Winsor exists in equilibrium, these segments are discussed, they are:
- Two phase system (Winsor I): upper oil layer exists in equilibrium with lower (o/w) micro emulsion phase
- Two phase system (Winsor 2): the upper (w/o) micro emulsion exists within equilibrium with lesser spare water.
- Three phase system (Winsor 3): mid bi-continuous stage of oil/water and water/oil called) exists in equilibrium with greater phase oil and lesser phase water.
- Single phase system (Winsor 4): it forms homogenous mixture of surface-active-agent, oil and water.

ADVANTAGES [6-8]

Thermodynamic consistency and the smallest amount of energy are required for growth.

- To emulsify hydrophobic or oil-soluble medications
- Increased bioavailability and better solubilization of the drug.
- Micro-emulsions are used in combination drug delivery systems to achieve medication targeting and controlled release.
- Drug administration via oral, parenteral, and topical routes is possible using micro-emulsion.
- Micro emulsions can be used to conceal the taste of unpleasant medications.
- To make nutritional oils more palatable.

DISADVANTAGES [9]

Consuming insufficient amounts of solubilizing volume for ingredients with high melting points;

Calling for a significant amount of surface-active agent to be used for all evacuating droplets;

Having the constancy of the micro-emulsion hampered by conservational factors like temperature and hydrogen ion concentration.

LIMITATIONS OF THE MICRO-EMULSION SYSTEM [10]

There are certain reasons which limit the utilization of the micro- emulsion systems within the medicinal submissions:

- The concentrations of the co-surfactants and the surfactants must be kept low for reasons of toxicity, and phase separation is a common issue with micro-emulsions.
- Due to the toxicity of the formulation, micro-emulsion systems are not particularly ideal for intravenous usage, and up to now, very few research have been reported on them.
- "Generally- Regarded-as-Safe" (GRAS) class surfactants must be utilised in order to lessen the toxicity of micro-emulsion systems.

COMPONENTS OF MICRO EMULSION [11-16]

Several components are used in the preparation and expansion of micro-emulsions. Mostly Surface-Active Agent and Oil are used in Micro-emulsion.

Chief components of micro-emulsion are

- **Aqueous stage**

Commonly, the aqueous stage comprises preservatives and hydrophilic active components. Occasionally Buffer solutions are used as aqueous stage.

- **Oil stage**

Oil is one of the most vital components of a microemulsion since it can saturate the Lipophilic Drug's required dosage. Any liquid that consumes squat polarity and squat miscibility with water is well-defined as oil. Additionally, it raises the percentage of lipophilic drugs that are released through the intestinal lymphatic system.

- **Surfactant (surface-active-agent)**

Oil is one of the most vital components of a microemulsion since it can saturate the Lipophilic Drug's required dosage. Any liquid that consumes squat polarity and squat miscibility with water is well-defined as oil. Additionally, it raises the percentage of lipophilic drugs that are released through the intestinal lymphatic system. Several types of surfactants that assistance in the liberal progress of micro-emulsion system are. 30-31

1. Cationic-Surfactant
2. Anionic-Surfactant
3. Non-Ionic-Surfactant
4. Zwitterionic-surfactants.

- **Co-surfactants**

It has been discovered that single-chain surfactants by themselves are unable to adequately lower the o/w interfacial tension to permit the formation of a microemulsion. Co-surfactants give the interfacial film the flexibility it needs to adopt the many curvatures necessary to create microemulsions over a wide range of composition. The lipophilic chains of the surfactant should be suitably short or contain fluidizing groups if a single surfactant film is needed (e.g. unsaturated bonds). Alcohols with short to medium chains (C3–C8) are frequently added as cosurfactants to boost the fluidity of the interface and further lower interfacial tension. Short chain alcohols (from ethanol to butanol), glycols like propylene glycol, middle chain alcohols, amines, and acids are typical co-surfactants. The use of co-surfactant is to destroy liquid crystalline or gel structures that form in place of a microemulsion phase and co-surfactant free microemulsion in most system cannot be made except at high temperature.

The role of a co-surfactant is as following

1) Increase the interface's smoothness.

2) Eliminate any liquid crystalline or gel structures that might hinder the emergence of microemulsions.

3) Modify the surfactant partitioning characteristic to adjust the HLB value and the interface's spontaneous curvature. [43,44]

❖ **Co-solvents**

Surfactant concentrations must be relatively high (usually greater than 30% w/w) in order to produce stable microemulsion. For oral administration, organic solvents like ethanol, propylene glycol (PG), and polyethylene glycol (PEG) are appropriate. These solvents make it possible to dissolve significant amounts of either the hydrophilic surfactant or the medication in the lipid base. In microemulsion systems, these solvents can even function as co-surfactants.

METHOD OF PREPARATION [17-22]

1. Phase Titration Method

Phase diagrams can be used to represent microemulsions, which are created using the spontaneous emulsification technique (also known as the phase titration technique). The creation of phase diagrams is a helpful method for studying the intricate web of interactions that might develop when several components are combined. Depending on the chemical makeup and concentration of each component, microemulsions are created along with a variety of association structures (including emulsion, micelles, lamellar, hexagonal, cubic, and different gels and oily dispersion). The study's key components are the identification of their phase equilibrium and phase boundary demarcation. In order to find the various zones, including the microemulsion zone, where each corner of the diagram represents 100% of the specific component, pseudo ternary phase diagrams, which are quicker to construct and easier to understand, are frequently used instead of quaternary phase diagrams (four component systems). By only taking into account the composition—whether it is oil- or water-rich—the area can be divided into w/o or o/w microemulsion. It is important to make cautious observations to avoid observing the metastable systems.

2. Phase Inversion Method

Microemulsions can undergo phase inversion due to temperature changes or the addition of too much dispersed phase. Significant physical changes, such as changes in particle size, occur during phase inversion and may have an impact on drug release both in vivo and in vitro. These techniques work by altering the surfactant's natural curvature. This can be accomplished for non-ionic surfactants by altering the system's temperature, causing a change from an o/w microemulsion at low temperatures to a w/o microemulsion at higher temperatures (transitional phase inversion). The development of finely distributed oil droplets is encouraged by the system crossing a point of zero spontaneous curvature and negligible surface tension as it cools. The phase inversion temperature (PIT) method is the name of this technique. Other factors, such as salt concentration or pH value, may be taken into account in addition to or instead of temperature. Changing the water volume fraction can also result in a change in the spontaneous radius of curvature. Water droplets are originally created in a continuous oil phase by adding water to it in small amounts at first. The spontaneous curvature of the surfactant shifts from initially stabilising a w/o microemulsion to an o/w microemulsion at the inversion locus as the water volume fraction is increased. At the o/w interface, flexible monolayers formed by short-chain surfactants produce a bicontinuous microemulsion that is present at the inversion point.

Hypothetical Phase Diagram

Surfactant creates reverse micelles, which have a hydrophilic interior and may solubilize more water molecules in high oil concentrations.

The creation of a W/O microemulsion, in which water exists as droplets surrounded and stabilised by the interfacial layer of the surfactant/co-surfactant mixture, may occur in this system if water is added to it repeatedly.

The isotropic clear area transforms into a turbid, birefringent one at a limiting water content.

Upon further dilution with water, a liquid crystalline region that contains water sandwiched between double layers of surfactant may occur.

Finally, when the amount of water grows, this lamellar structure will disintegrate, resulting in the formation of an O/W microemulsion, which is a continuous phase of water containing oil droplets stabilised by a surfactant or co-surfactant.

FACTORS AFFECTING FORMATION AND PHASE BEHAVIOR OF MICROEMULSIONS [22-32]

1. Factor affecting formation of Microemulsion system [22-26]

The packing ratio, oil phase, temperature, chain length, type, and nature of co-surfactant are all factors that affect how an oil or water swelling microemulsion forms.

- **Ratio of packing**

The type of microemulsion is determined by the surfactant's HLB (Hydrophilic Lipophilic Balance), which has an impact on molecular packing and film curvature. In terms of packing ratio, also known as the crucial packing parameter, outlined how the study of film curvature for surfactant connections leading to microemulsion production works.

Critical Packing Parameter (CPP) = v/a * l

Where,

"v" is the partial molar volume of the hydrophobic portion of the surfactant,

"a" is the optimal head group area and l is the length of the surfactant tail.

- ✓ If CPP (0-1) interface curves towards water (positive curvature) and o/w systems are favoured
- ✓ CPP is greater than 1, interface curves spontaneously towards oil (negative curvature) so w/o microemulsions are favoured
- ✓ At zero curvature, when the HLB is balanced (p is equivalent to 1), then either bi continuous or lamellar structures may form according to the rigidity of the film (zero curvature).

- **Property of Surfactant, Oil Phase and Temperature**

The kind of microemulsion that forms is dependent on the surfactant. A surfactant has a lipophilic tail group and a hydrophilic head group. When calculating the surfactant HLB in a specific system, the areas of these groups—which are a measure of the differential tendency of water to swell the head group and oil to swell the tail area—are crucial for specific formulation. The degree of polar group dissociation increases lessened in the presence of salt or when the surfactant is applied in high concentrations, and the resulting system may be typeless. Water dilution can cause more dissociation and an o/w system.

Thermostatically, ionic surfactants are significantly impacted. Increased surfactant counter-ion dissociation is its principal effect. The capacity of the oil component to permeate and subsequently swell the tail group region of the surfactant monolayer affects curvature as well. Short chain oils deeply penetrate the lipophilic group area, increasing the negative curvature. When establishing the effective head group size of nonionic surfactants, temperature is crucial. They are hydrophilic at low temperatures and form a typical o/w system. They create w/o systems at higher temperatures because they are lipophilic. Microemulsion coexists with excessive water and oil phases at a medium temperature and develops a bicontinuous structure.

- **Chain Length, Type and Nature of Co-Surfactant**

Alcohols are frequently utilised as a co-surfactant in the creation of microemulsions. Longer chain co-surfactants favour w/o type w/o type due to alcohol swelling more in the chain region than the head region, whereas adding shorter chain co-surfactants has a positive curvature effect because alcohol swells the head region more than the tail region, making it more hydrophilic and favouring o/w type.

2. Factor Affecting Phase Behaviour [27-32]

- **Salinity**

O/W microemulsion droplet size rises at low salinity. This is consistent with an increase in oil solubilization. The system becomes bi-continuous over an intermediate salinity range as salinity rises more. A continuous microemulsion forms as salinity rises while globule size decreases. A complete phase change eventually ensues from additional salinity increase.

- **Alcohol concentration**

The phase shift from w/o to bi continuous and finally to o/w type microemulsion occurs when the concentration of low molecular weight alcohol as a co surfactant is increased. The phase transition for high molecular weight alcohol is exactly the reverse.

- **Surfactant Hydrophobic Chain Length**

The increase in length of hydrophobic chain length of the surfactant shows the change of o/w microemulsion to w/o via bi continuous phase.

- **pH**

Change in pH influences the microemulsions containing pH sensitive surfactants. This effect is more pronounced in case of acidic or alkaline surfactants. Carboxylic acids and amines change the phase behaviour from w/o to o/w by increasing the pH.

- **Nature of Oil**

Increase in the aromaticity of oil leads to phase transition from o/w to w/o and is opposite to that of increase in the oil alkane carbon number.

- **Ionic Strength**

As the ionic strength increases the system passes from o/w microemulsion in equilibrium with excess oil to the middle phase and finally to w/o microemulsion in equilibrium with excess water.

CHARACTERIZATION OF MICROEMULSION [33-37]

Different methods can be used to describe microemulsions. Due to their complexity, the wide range of structures and components they include, as well as the limitations of each technique, characterising microemulsions is a challenging undertaking, yet this knowledge is necessary for their effective commercial exploitation. To get a complete picture of the physicochemical characteristics and structure of microemulsions, complementary investigations utilising a variety of methodologies are typically needed.

The basic component in a physicochemical characterization of microemulsions systems are

- ✓ Phase stability and phase behaviour.
- ✓ Microstructure, dimension.
- ✓ Shape and surface futures such as specific area, charge and distribution.
- ✓ Local molecular rearrangement.
- ✓ Interaction and dynamics.

Particle size, interactions, and dynamics are among these characteristics, and they are of utmost significance since they govern many of the general characteristics of microemulsions. The distribution of the drug in the phases of the Microemulsions system, the size of the droplets, and the rate of diffusion or absorption in both phases are all factors that affect the drug's release from the microemulsions.

❖ Visual observation

Microemulsions are visually observed for clarity and flowability.

❖ Centrifugation:

ME systems are subjected to centrifugation at 5000 rpm for 30 minutes and then examined for any phase separation.

❖ Interfacial Tension:

The formation and the properties of microemulsion can be studied by measuring the interfacial tension.

In instance, the presence of surfactant phase or middle-phase microemulsions in equilibrium with aqueous and oil phases is connected with extremely low values of interfacial tension. It is possible to quantify the extremely low interfacial tension using a spinning-drop instrument. When a drop of the low-density phase is rotated in a cylinder-shaped capillary that is filled with the high-density phase, the form of the drop is measured to determine the interfacial tensions.

EVALUATION OF THE MICRO-EMULSIONS [38-45]

❖ Visual inspection

By the visual inspection we can check the properties such as fluidity, homo-genicity and optical clarity.

❖ Percent transmittance test (limpidity test)

The Percent Transmittance Test of the micro emulsion can be measured spectrophotometrically using spectrophotometer. 32

❖ Measurements of Droplet Size

Size examination of micro-emulsion can be obtained by Dynamic-Light-Scattering experiments or electron microscopy. The polydispersity can be done by the similar Instrument. 33, 34

❖ **Zeta-Potential Dimensions and Globule-Size**

Zeta-Potential and Globule-Size of the micro-emulsion can be resolute by Dynamic-Light-Scattering, via a ZETASIZERHAS- 3000. 35

❖ **Examination Under cross-polarizing Microscope**

The nonappearance of fringence on the way to eliminate Liquid- Crystalline-Systems, the micro-emulsion must be examined under cross polarizing microscope.

❖ **Constancy studies (Stability studies)**

The microemulsion's physical stability should be confirmed over the course of a year while being stored at various temperatures (4°C, 25°C and 40°C). Droplet Dimensions Delivery Examination was in danger from recent preparations as well as from those that had been held under various stressful conditions for an extended period of time. It is also necessary to determine the surface-active agent's conclusion and their focus on the drop size.

❖ **Ph of the Micro-emulsion**

The sample tubes are used to collect various micro-emulsion samples. The pH scale of the individual samples is then checked using a tiny pH-meter. The pH scale of the preparation is the factor on which the bioavailability of the medication in the microemulsion and its consistency over the microemulsion by the permeation spot depend.

❖ **Scattering methods**

The Scattering techniques, such as small-angle neutron scattering, small-angle X-ray scattering, and small-angle light scattering, have contributed to revisions of micro-emulsion assembly, particularly in the case of diluted mono-disperse spheres, as opposed to poly-disperse or focused systems, like those frequently observed in micro-emulsions.

❖ **Transmittance examination**

Constancy of the adjusted micro-emulsion preparation with relevancy dilution was check by measuring transmission at a particular wavelength with a Ultra Violet Spectrophotometer.

❖ **In-Vitro drug release**

The Franz-Diffusion cell, which typically has a capacity of 20mL, is used to conduct the diffusion investigation. The Buffer portion was located in the Receptor. The basic medication solution and the micro-emulsion preparation were held separately in the donor portion, which was sealed off with a plastic wrap membrane. Trials for the intermission were reserved from the receptor area and tested for drug content using a UV spectrophotometer set to a specific wavelength at a predetermined time.

APPLICATION OF MICROEMULSION IN DELIVERY OF DRUG PHARMACEUTICAL APPLICATIONS [46-52]

During the last two decades, microemulsions have 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 herein.

❖ **Oral delivery**

Researchers have traditionally had a difficult time creating efficient oral delivery methods because gastrointestinal fluid instability or low solubility can limit a drug's potency. Microemulsions have the potential to improve the solubilization of poorly soluble pharmaceuticals (especially BCS class II or class IV medications) and resolve bioavailability issues caused by dissolution. Hydrophilic pharmaceuticals, including macromolecules, can be encapsulated with different solubilities due to the presence of polar, nonpolar, and interfacial domains. These methods have improved membrane permeability and protected the pharmaceuticals included against oxidation and enzymatic degradation. Sandimmune Neoral(R) (Cyclosporine A), among other formulations, are the commercially available microemulsions at the moment. By increasing a drug's solubility in gastrointestinal fluid, microemulsion formulations have the potential to be helpful in increasing the oral bioavailability of weakly water soluble medications.

❖ **Parenteral delivery**

It has proven challenging to create medications that are lipophilic and hydrophilic for parenteral administration. When administering sparingly soluble medications via parenteral administration, O/w microemulsions are advantageous since they eliminate the need for suspension administration. They give a way to achieve reasonably high concentrations of these medications without having to administer them frequently. They are more physically stable in plasma than liposomes or other delivery systems, and their internal oil phase is more resistant to drug leaching. O/W microemulsions containing a number of poorly soluble medications have been created for parenteral administration. Von Corsewant and Thoren used a different strategy in which parenterally acceptable cosurfactants, such as polyethylene glycol (400)/polyethylene glycol (660)/12-hydroxystearate/ethanol, were used in place of C3-C4 alcohols, while maintaining a flexible surfactant film and spontaneous curvature near zero to obtain and almost balanced middle phase microemulsion.

❖ **Topical delivery**

For a number of reasons, topical medication delivery can be superior to other approaches. One of them is the avoidance of hepatic first-pass metabolism, salivary and stomach drug degradation, and associated adverse consequences. Another is the drug's capacity to target and transport itself directly to the skin or eyes that are being affected. Studies on the penetration of drugs into the skin have been conducted recently. Both hydrophilic (5-flurouracil, apomorphine hydrochloride, diphenhydramine hydrochloride, tetracaine hydrochloride, methotrexate) and lipophilic medicines (estradiol, finasteride, ketoprofen, meloxicam, felodipine, triptolide) can be included and their permeability is improved. Because a high surfactant concentration is necessary for microemulsion creation, skin irritation must be taken into consideration, especially when they are meant to be applied for.

❖ **Ophthalmic delivery**

Water soluble medications are administered in aqueous solution in standard ocular dosage forms, whereas water insoluble medications are prepared as suspensions or ointments. Some of the main issues with these systems include low corneal bioavailability and ineffectiveness non the tissue of the posterior region of the eye. The creation of new, more efficient distribution systems has been the subject of recent

research. For ocular usage, microemulsions have become a potential dosage form. In ordinary eye drops, the antibiotic chloramphenicol, which is used to treat trachoma and keratitis, hydrolyzes quickly. Lv et al. looked into possible eye drop drug delivery methods using a microemulsion made of water, Span 20, Tween 20, and isopropylmyristate. Chloamphenicol was contained in the alcohol-free o/w microemulsion. At the conclusion of the accelerated testing, research showed that the glycol (the principal hydrolysis product) level of the microemulsion formulation was significantly lower than that of the commercial eye drops. As a result, a notable improvement in chloramphenicol stability was seen in the formulations of microemulsions.

Dexamethasone eye drops based on microemulsions were examined and demonstrated improved tolerability and increased bioavailability. The formulation had better eye penetration, which made it possible to administer doses less often and increase patient compliance.

- **Nasal delivery**

Recently, microemulsions are being studied as a delivery system to enhance uptake of drug through nasal mucosa. In addition with mucoadhesive polymer helps in prolonging residence time on the mucosa. Lianly et al. investigated the effect of diazepam on the emergency treatment of status epilepticus. They found that the nasal absorption of diazepam fairly rapid at 2 mg kg-1 dose with maximum drug plasma concentration reached within 2-3 min.

- **Drug targeting**

The most desirable aim of medication delivery has evolved to be drug targeting to the various tissues. Drug efficacy can be boosted while simultaneously reducing their adverse effects by changing the pharmacokinetics and biodistribution of the drug and limiting its action to the targeted tissue. A new microemulsion formulation for the lipophilic antitumor antibiotic aclainomycin A was reported. They stated that it is possible to deliver tumor-targeted ACM via a folate-linked microemulsion. They also claimed that targeting tumour cells using emulsions modified with folate and appropriately long PEG chains works well.

- **Periodontal Delivery**

A number of progressive oral pathological conditions, including inflammation and degeneration of the gums, periodontal ligaments, cementum, and its supporting bone, are collectively referred to as periodontal disease. It is a significant factor in tooth loss. A unique pharmaceutical compound made up of local anaesthetic in oil form, surfactant, water, and maybe a taste-masking ingredient was part of discovery. The substance had thermal reversible gelling qualities, meaning it was less viscous at room temperature than it was after being applied to a patient's mucosal membrane. The substance was in the form of an emulsion or microemulsion. The thermoreversible gelling capabilities were a result of the surfactant included in the formulation. Poloxamer 188®, Poloxamer 407®, and Arlatone 289® were the preferred surfactants. The composition was able to address the issues with the existing topical products (jelly, ointment, or spray), such as lack of efficacy due to inadequate depth of penetration, too short of a duration, and difficulties in administration due to spread, taste, etc. in addition to providing pain relief within the oral cavity in conjunction with periodontal scaling and root planning.

❖ **Cellular Targeting**

Delivering nucleic acids to cells is a promising therapeutic approach. Nucleic acid was inserted into a reverse micelle as part of Monahan et alinvention .'s for the purpose of cell transport. Without microemulsions, they were referred to as reverse micelles. The ability to condense the nucleic acid for simpler administration was a feature of the reverse micelle. The nucleic acid-micelle combination may be supplemented with other molecules, such as a surfactant with a disulfide link or a polyion, to further improve the delivery. The usage of reverse micelles for gene transport to the cells was another benefit of the technology. The compacted polynucleotide-containing micelle could be used as a reaction vesicle to incorporate other substances, such polycations, into the DNA. Additionally, a vesicle for template polymerization of the DNA or caging of the DNA in which the polycation was crosslinked was created using the polynucleotide/reverse micelle method. Another benefit was the possibility of micelle cleavage under physiological circumstances related to the transfection route (the process of delivering a polynucleotide to a cell). improved restoration and purification of the biomolecules, which was previously challenging, was made possible by the use of cleavable reverse micelles. The idea of Wheeler and colleagues concerned the delivery of hydrophobic substances into cells via microemulsion carriers. Oil, a hydrophobic substance, and a lipid coupled to polyethylene glycol made up the microemulsion. The polyethylene glycol-linked lipid was added to the microemulsion compositions to increase their stability.

The polar lipid monolayer that enclosed the hydrophobic compound's oil environment in which it lived. In order to be compatible with the exterior water environment, the lipid's polar head faced outward, and its nonpolar tail faced the inside oil environment. Covalent or noncovalent attachments of a targeting moiety, such as biotin, avidin, streptavidin, or antibodies, to the lipid monolayer are both possible. Additionally, the composition might be employed for medicinal and diagnostic purposes.

❖ **Tumour Targeting**

Maranh proposed the use of microemulsions as delivery systems for the delivery of diagnostic or chemotherapeutic chemicals to malignant cells while avoiding normal cells.

They asserted a method for treating neoplasms in which cancer cells have more LDL (low density, lipoprotein) receptors than healthy ones. The microemulsion included a chemotherapeutic medication and had a core of phospholipids and free cholesterol surrounded by a nucleus of cholesterol esters and not more than 20% triglycerides. Microemulsions lacked the protein portion of low density lipoprotein (LDL), but they had a comparable chemical make-up with the lipid fraction. When these synthetic microemulsion particles were delivered into the bloodstream or mixed with plasma, plasma apolipoprotein E (apo E) attached to their surface. The microemulsion's microparticles and the LDL receptors were connected through the apolipoprotein E. Through LDL receptors, the microemulsions might then transfer the integrated chemicals into the cells. As a result, neoplastic cells with enhanced receptor expression might reach larger concentrations of anticancer medications. These medications' harmful effects on healthy tissues and organs could be prevented in this way. They found no difference in the plasma kinetics of the radioactively labelled microemulsion containing cytosine-arabinoside or

carmustine in human test subjects, proving that the presence of these drugs did not affect the microemulsion's ability to incorporate apo E in the plasma and bind to receptors. A new microemulsion formulation for the lipophilic antitumor antibiotic aclacinomycin A was disclosed by Shiokawa and colleagues (ACM). Their results indicated that a folate-linked microemulsion is practical for delivering tumor-specific ACM. The study demonstrated that targeting tumour cells using emulsions that have been modified with folate and have a long enough PEG chain is successful.

- **Brain Targeting**

For quick medication delivery to the brain, intranasal administration offers a straightforward, practical, economical, convenient, and noninvasive mode of administration. It enables direct drug delivery to the brain while avoiding the brain's physical barriers. Mucoadhesive microemulsion for the antiepileptic medication clonazepam was created by Vyas et al. Rapid delivery to the rat brain was the goal. Brain/blood ratio at all sampling points up to 8h following intranasal administration of clonazepam mucoadhesive microemulsion compared to i.v. was found to be 2-fold higher indicating larger extent of distribution of the drug in the brain.

- **Ocular and Pulmonary Delivery**

The majority of drug delivery for the treatment of eye disorders occurs topically. O/W microemulsions have been researched for use in ocular administration, to break down poorly soluble medicines, to boost absorption, and to achieve a prolong release profile.

Lecithin, propylene glycol, and PEG 200 were used to create the pilocarpine-containing microemulsions, with IPM serving as the oil phase. The formulations' low viscosity and favourable refractive indices made them suitable for ophthalmologic uses.

A water-in-HFA propellant microemulsion that is intended for pulmonary distribution and is stabilised by a fluorocarbon non-ionic surfactant has been disclosed.

- **Biotechnology uses microemulsions**

Pure organic or aqua-organic media are used for many enzymatic and biocatalytic processes. These responses also make advantage of biphasic media. Biocatalysts become denaturized when used with pure apolar medium. The use of water-proof media is relatively advantageous. Enzymes in low water content display and have –

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

Numerous enzymes, including lipases, esterases, dehydrogenases, and oxidases frequently work in hydrophobic microenvironments within cells. Numerous enzymes work at the interface between hydrophobic and hydrophilic domains in biological systems, and this interface is typically stabilised by polar lipids and other naturally occurring amphiphiles. Various hydrolysis reactions, steroid transformation, peptide synthesis, sugar acetal transesterification, and other reactions have all been

carried out in microemulsions using enzyme catalysis. Lipases are the category of enzymes that are most frequently used in microemulsion-based processes.

CONCLUSION

Microemulsions are innovative drug delivery systems that are simple, easy to use, and commercially viable. They can improve drug absorption while minimising systemic side effects. Without causing a corresponding rise in systemic absorption, they can be employed to optimise drug targeting. Microemulsion formulation requires careful excipient selection and safety assessment, especially of the cosurfactants. They may be possible drug delivery systems for the simultaneous administration of multiple medications. The capacity of microemulsion to protect labile drugs, regulate drug release, increase drug solubility, boost bioavailability, and decrease patient variability has been demonstrated. Additionally, it has been shown that preparations that are appropriate for the majority of administration routes can be created.

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