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A REVIEW ON NANOEMULSION

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ABSTRACT

The terms sub-micron emulsion (SME) and mini-emulsion are used as synonyms. Emulsions which match this definition have been used in parenteral nutrition for a long time. The existence of an optimum oil-to-surfactant ratio (Ros) in the BC or Wm region indicates that both the phase behavior and the composition of the concentrate are important factors in nano emulsion formation. The second section deals with the mechanism of emulsification and the dynamic light scattering technique for measurement of the droplet size of nano-emulsions. The applications of nano emulsion are limited by the instability. Stability of formulation may be enhanced by controlling factors such as type and concentration of surfactant anco surfactant, type of oil phase, methods used, process variables and addition of additives.

INTRODUCTION

Nanoemulsions can be defined as oil-in-water (o/w) emulsions with mean droplet diameters ranging from 50 to 1000 nm. Usually, the average droplet size is between 100 and 500 nm. The terms sub-micron emulsion (SME) and mini-emulsion are used as synonyms. Emulsions which match this definition have been used in parenteral nutrition for a long time. Usually, SMEs contain 10 to 20 per cent oil stabilized with 0.5 to 2 per cent egg or soybean lecithin Due to their lipohilic interior, nanoemulsions is more suitable for the transport of lipophilic compounds than liposomes. Similar to liposomes, they support the skin penetration of active ingredients and thus increase their concentration in the skin. Furthermore, nanoemulsions gain increasing interest due to their own bioactive effects. Nanoemulsions are able to favor the transport of suitable lipids into the skin. This may reduce the transepidermal water loss (TEWL), indicating that the barrier function of the skin is strengthened.

METHOD OF PREPARATION OF NANOEMULSIONS

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Oil-in-water nanoemulsions for pesticide formulations [2]

A two-step process for formation of nanoemulsions in the system water/poly (oxyethylene) nonionic surfactant/methyl decanoate at 25 °C is described. First, all the components were mixed at a certain composition to prepare a microemulsion concentrate, which was rapidly subjected into a large dilution into water to generate an emulsion. Bluish transparent oil-in-water (O/W) nanoemulsions were formed only when the concentrate was located in the bi continuous microemulsion (BC) or oil-in-water microemulsion (Wm) region. The existence of an optimum oil-to-surfactant ratio (Ros) in the BC or Wm region indicates that both the phase behavior and the composition of the concentrate are important factors in nanoemulsion formation. To demonstrate potential applications of these systems, they were employed to formulate a water-insoluble pesticide, β-cypermethrin (β-CP). The nanoemulsion was compared with a commercial β-CP microemulsion in terms of the stability of sprayed formulations.

Formation of water-in-oil (W/O) nano-emulsions in a water/mixed non-ionic surfactant/oil systems prepared by a low-energy emulsification method [3]

W/O nano-emulsion formation by a low-energy emulsification method is described for the first time. The nano-emulsions have been formed in water/mixed

Cremophor EL: Cremophor WO7 surfactant/isopropyl myristate systems at Cremophor EL: Cremophor WO7 ratios between 1:2 and 1:9, by slow addition of isopropyl myristate to surfactant/water mixtures. Phase behaviour studies have showed that the compositions giving rise to W/O nano-emulsions belong to multiphase regions, one of the phases being a lamellar liquid crystalline phase. The droplet size of the nano-emulsions at a fixed oil concentration of 85% and mixed surfactants/water ratio of 70/30 ranged from 60 to 160 nm as Cremophor EL: Cremophor WO7 ratio increased from 1:8 to 1:2. These nano-emulsions showed high kinetic stability. No phase separation was observed during 5 months in nano-emulsions of the water/Cremophor EL: Cremophor WO7 1:8/isopropyl myristate system with 85% oil concentration, although droplet size experienced an increase with time.

Formation of Nano-emulsions by Low-Energy Emulsification Methods at Constant Temperature [4]

Formation of nano-emulsions has been studied in the system water/Brij 30/decane at 25 °C by three low-energy emulsification methods: (A) stepwise addition of oil to a water−surfactant mixture, (B) stepwise addition of water to a solution of the surfactant in oil, and (C) mixing all the components in the final composition. Nano-emulsions with average droplet size of 50 nm and high kinetic stability have been obtained only at oil weight fractions, R, lower than 0.3 by emulsification method B. Independent of the oil weight fraction, R, emulsions obtained by method B have lower polydispersity than those obtained by methods A and C. Phase behavior studies have revealed that compositions giving rise to nano-emulsions consist of Wm, (O/W microemulsion), Lα (lamellar liquid crystalline), and O (oil) phases, at equilibrium. It has been shown that equilibrium properties cannot fully explain nano-emulsion formation. Low values of equilibrium interfacial tensions and phase equilibrium involving a lamellar liquid crystalline phase are probably required but not sufficient to obtain nano-emulsions in this system

Formation and stability of nano-emulsions

This review describes the principles of formation and stability of nano-emulsions. It starts with an introduction highlighting the main advantages of nano-emulsions over macroemulsions for personal care and cosmetic formulations. It also describes the main problems with lack of progress on nano-emulsions. The second section deals with the mechanism of emulsification and the dynamic light scattering technique for measurement of the droplet size of nano-emulsions. This is followed by a section on methods of emulsification and the role of surfactants. Three methods are described for nano-emulsion preparation, namely high energy emulsification (using homogenisers), low energy emulsification whereby water is added to an oil solution of the surfactant and the principle of the phase inversion temperature (PIT). A section is devoted to steric stabilisation and the role of the adsorbed layer thickness.

Development of low-energy methods for preparing food Nano-emulsions

The aim of this work was to investigate the effect of sucrose on the phase behavior of vegetable oil/poly oxyethylene sorbitanmonooleate (MOPS, Tween 80) and deca glycerol monolaurilester (DGML)/aqueous solution systems to establish low-energy emulsification methods for preparing nano-emulsions suitable for food uses. Phase diagrams were constructed to elucidate the optimal process for preparing the nano-emulsions. It was found that nano-emulsions were obtained when the composition was altered to either cross the sponge phase (L(3)) or lamellar phase (La) in the vegetable oil/MOPS/aqueous solution system or vegetable oil/DGML/aqueous solution system, respectively.

The average droplet sizes in the former and latter emulsions were 0.203 μm and 0.165 μm, respectively. The addition of sucrose changed the hexagonal phase in the vegetable oil/MOPS/aqueous solution system into the sponge phase. As a result, the sponge region in the vegetable oil/MOPS/sucrose aqueous solution system occupied a larger area than that in the vegetable oil/MOPS/water system. In contrast, sucrose had no effect on the area of the La region in the vegetable oil/DGML/aqueous solution system. However the addition of nano-emulsions in both systems.

High pressure homogenizer

This method is performed by applying a high pressure over the system having oil phase, aqueous phase and sur-factant or co-surfactant. The pressure is applied with the help of a special equipment know as homogenizer. There are some problems which are associated with homogenizer such as poor productivity, component deterioration due to difficult mass production and generation of much heat. With this method only oil in water (o/w) liquid nanoemulsion of less than 20% oil phase can be prepared and cream nanoemulsion of high viscosity or hardness with a mean droplet diameter lower than 200 nm cannot be prepared.

Limittions of nanoemusions [5]

Although this formulation provide great advantages as a delivery system for the consumers but sometimes the re-duced size of droplets are responsible for the limited use of nanoemulsion formulation. Some limitations of nanoemulsion are as follows. The manufacturing of nanoemulsion formulation is an expensive process because size reduction of droplets is very difficult as it required a special kind of instru-ments and process methods. For example, homogenizer (instrument required for the nanoemulsion formulation)

arrangement is an expensive process. Again micro-fludization and ultrasonication (manufacturing process) require high amount of financial support. Stability of nanoemulsion is quite unacceptable and creates a big problem during the storage of formulation for the longer time unacceptability of nanoemulsion formulations. This is due to the high rate of curvature of small droplet show greater solubility as compared to large drop with a low radius of curvature period. Ostwald ripening is the main factor associated with Less availability of surfactant and cosurfactant required for the manufacturing of nanoemulsion is another factor which marks as a limitation to nanoemulsion manufac-turing.

ADVANTAGES OF NANOEMULSION [6, 7]

1. Increase the rate of absorption.
2. Eliminates variability in absorption
3. Helps solubilize lipophilic drug
4. Increases bioavailability
5. Various routes like topical, oral and intravenous can be used to deliver the product.
6. Helpful in taste masking
7. Rapid and efficient penetration of the drug moiety.
8. Liquid dosage form increases patient compliance.
9. Nanoemulsions are thermodynamically stable system and the stability allows self emulsification of thesystem.1.4.

Drugs targeting using nanoemulsions [8]

The central nervous system (CNS) is an immunological privileged sanctuary site-providing reservoir for HIV-1 virus. Current anti-HIV drugs, although effective in reducing plasma viral levels, cannot eradicate the virus completely from the body. The low permeability of anti-HIV drugs across the blood–brain barrier (BBB) leads to insufficient delivery. Therefore, developing a novel approaches enhancing the CNS delivery of anti-HIV drugs are required for the treatment of neuro-AIDS. The aim of this study was to develop intranasal nanoemulsion (NE) for enhanced bioavailability and CNS targeting of saquinavirmesylate (SQVM). SQVM is a protease inhibitor which is a poorly soluble drug widely used as antiretroviral drug, with oral bioavailability is about 4%. The spontaneous emulsification method was used to prepare drug-loaded o/w nanoemulsion, which was characterized by droplet size, zeta potential, pH, drug content. Moreover, ex-vivo permeation studies were performed using sheep nasal mucosa. The optimized NE showed a significant increase in drug permeation rate compared to the plain drug suspension (PDS). Cilia toxicity study on sheep nasal mucosa showed no significant adverse effect of SQVM-loaded NE. Results of in vivo biodistribution studies show higher drug concentration in brain after intranasal administration of NE than intravenous delivered PDS.

Nanoemulsions for Skin Targeting: Present Status and Future Prospects [9]

The use of nanoemulsions as a carrier system for skin targeting has attracted increased attention over recent years. Nanoemulsions can be intended for both topical and systemic delivery of the biologically active agents for controlled and targeted delivery. Nano emulsion droplets fall within the size range of 20-200nm, typically below 100nm. Nanoemulsions have high surface area and ability to solubilize poorly soluble drugs. They are reported to have higher skin permeation and retention potential than other novel drug delivery systems like nanoparticles, liposomes, microemulsions etc. Use of nanoemulsions for skin targeting of drug is a current research scenario in the field of Pharmaceutics. This research area has generated immense interest from the Pharmaceutical industry and a number of nanoemulsion based cosmetics formulations like anti-aging creams, skin cleansing lotions etc. are available in the market. Recently, Zydus Cadilla launched the Oxalgin NanoGel™ diclofenac sodium nanoemulsion gel showing the importance of nanoemulsion as carrier system for skin targeting of drugs. This review embodies an in-depth discussion on composition, application, its mechanism of skin permeation and commercial aspects of nanoemulsions for skin targeting.

CONCLUSION

For nanoemulsion preparation of high energy emulsification method is traditionally used for the preparation of nanoemulsion formulation but low emulsion emulsification method now create an attraction due to their wide application and advantages as a formulation and stability aspects. The applications of nanoemulsion are limited by the instability. Stability of formulation may be enhanced by controlling factors such as type and concentration of surfactant an cosurfactant, type of oil phase, methods used, process variables and addition of additives. Overall nanoemulsion formulation may be considered as effective, safe and patient compliance formulation for the delivery of pharmaceuticals.

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