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Review Article

A Review On Nano-Emulsion

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ABSTRACT

Nanoemulsions are kinetically stable, liquid-in-liquid dispersions with droplet sizes typically around 100 nm. Due to their small size, they exhibit unique properties such as a high surface area per unit volume, robust stability, and an optically transparent appearance. These characteristics make nanoemulsions highly versatile, finding applications across various fields including drug delivery, food technology, cosmetics, pharmaceuticals, and materials science. The preparation of nanoemulsions can be achieved through both high and low energy methods, such as high-pressure homogenization, ultrasonication, phase inversion temperature, and emulsion inversion point techniques. Recent advancements have introduced novel approaches like the bubble bursting method to further optimize the process.

INTRODUCTION

Nano-emulsion are characterized as isotropic, thermodynamically stable transparent or semi-transparent systems of oil and water which stabilize by surfactant with a droplet size usually in the range of 5 to 200 nm. The following are some of the advantages that nanoemulsion has over macroemulsion: i.e., nano emulsions are an efficient transport system because they have a significantly larger surface area and free energy than macroemulsions. The inherent issues with creaming, flocculation, coalescence, and sedimentation that are frequently linked to macroemulsions are not present in this system. The spontaneous emulsification approach can be used to create nano-emulsions that improve the solubility and bioavailability of medications that are not very water soluble. These are easily applied to skin and mucous membranes because they are non-toxic and non-irritating. By enabling the reduction of the overall dosage and thus the mitigation of adverse effects, the use of nano-emulsion delivery methods can enhance a drug's effectiveness. A thermodynamically stable or

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isotropically transparent dispersion of two immiscible liquids is referred to as a nano-emulsion. A nano-emulsion is a liquid dispersion containing an oil phase, a water phase, and a surfactant that is stable either thermodynamically or kinetically. The following three kinds of nano-emulsions are most likely to form.

- Oil in water nano-emulsions: these consist of continuously dispersed oil droplets in an aqueous phase.
- Water in oil nano-emulsions: water droplets scattered throughout an oil phase that is continuous.
- Bi-continuous nano-emulsions: in these systems, water and oil microdomains are spread throughout. [1,2]

Advantages of nano-emulsion

- It can be utilized as an alternative to liposomes and vesicles.
- to enhances the drug's bioavailability.
- By nature, it is non-toxic and non-irritating.
- The physical stability has increased.
- To improve nutritional oils' palatability.
- To disguise the unpleasant taste and odor of medications.
- To improve topical absorption of drugs.

Disadvantage of Nano-emulsion

- Not as constant as various kinds of dose
- Has a brief shelf life
- Using a high concentration of surfactant and cosurfactant, which is required to stabilize the nanodroplets,
- causing them to cream and crack (break).
- Limited ability to dissolve highly soluble compounds;
- Needs to be nontoxic for use in pharmaceutical applications.[3,4]

Composition

The major components of micro emulsion system are:

1. Oil phase
2. Surfactant (Primary surfactant)
3. Co-surfactant (Secondary surfactant)
4. Co-Solvent.[5]

Oil phase

Since oil phase has the ability to solubilize lipophilic drug molecules and enhance absorption through the body's lipid barrier, it is the second most important vehicle after water. Oil is particularly helpful for lipophilic active medication delivery because of its special ability to penetrate cell walls. The oil phase has an impact on the surfactant's tail group area swelling. Compared to long chain alkanes, short chain alkanes exhibit a higher degree of penetration.

Surfactants

In order to allow the dispersion of every component during the microemulsion preparation process, the surfactant needs to be able to decrease the interfacial tension as close to zero as possible. Among these surfactants are: Anionic, Cationic, Zwitterionic, Non-ionic, The surfactant's nature has a role in determining the microemulsion's stability. Ionic surfactants are stabilized by an electrical double layer, while non-ionic surfactants are stabilized by dipole and hydrogen bond interactions. The concentration of salt also has an impact on ionic surfactants. [6,7]

Co-surfactants

It is High concentrations of single-chain surfactants are needed to lower the O/W interfacial tension to a point where a microemulsion can form spontaneously, according to research. Co-surfactants, on the other hand, can be added to produce a stable microemulsion composition by forming distinct interfacial film curvatures at the minimum surfactant concentration. 11–16 Co surfactants cause the interface to become more fluid due to the presence of fluidizing groups like as unsaturated bonds. This, in turn, breaks down the structure of liquid crystals or gels and modifies the HLB value, resulting in the spontaneous creation of micro emulsions.

Co-solvents

Complementary solvents are organic solvents such as ethanol, polyethylene glycol (PEG), and propylene glycol (PG), which aid in the dissolution of lipid-soluble medications and surfactants at relatively high concentrations. As a result, co-solvents and co-surfactants are synonymous terms. The nano-emulsion While micro-emulsions occur spontaneously, nano-emulsions are obtained by mechanical force, similar to micro-emulsions, which are dispersions of nanoscale particles. [8,9,10]

Preparation methods

High energy emulsification method:

Ultra sonication and high pres¬sure homogenization

Low energy emulsification:

Phase inversion temperature method, solvent displacement method and phase inversion composition meth¬od

High-Pressure Homogenization:

To create nanoscale particles, a high-pressure homogenization apparatus with a unique design is employed. Phase separation occurs between the oil and water at very high pressures (500–5000 psi) when they push through a tiny input aperture.34 As a result, hydraulic shear and severe turbulence produce incredibly minute particles. However, this technique needs a lot of energy and heat. The direct causes of particle size are homogenization cycles and pressure.35 Particle size decreases as pressure and homogenization cycles increase. Scaling up this strategy is simple. [11,12]

Microfluidization:

In This technique uses a micro fluidizer, a specially made instrument, to produce high pressure (500–20,000 psi). Make a coarse emulsion first by combining the water phase and oil. This apparatus is made up of an interaction chamber with tiny microchannels that drive coarse emulsion into an impingement area to create nanoscale fine particles. Filtration is then used to create uniform particles. [13,14]

Ultrasonication:

This technique is predicated on the idea that when an ultrasonic field is applied to a coarse emulsion and external pressure is raised, the cavitation threshold—which sets the boundary where fine nanoparticles form—also rises. [15]

Phase inversion method:

The phase transition temperature, or the temperature at which a phase change takes place, is the basis for this procedure. O/W emulsions do better in colder temperatures, whereas W/O emulsions do better in warmer temperatures. Fine particles are produced by quick cycles of heating and cooling. Due to the polymer chain's dehydration, non-ionic surfactants like poly-oxyethylene become hydrophilic at low temperatures and lipophilic at high ones.36. [16]

Spontaneous Emulsification:

This is a straightforward approach that employs a volatile organic solvent composed of water, oil, and surfactants that are both hydrophilic and lipophilic. Through magnetic stirring, this mixture is made uniformly. Next, under vacuum, evaporate the water-miscible solvent to produce the nano-emulsion.39.[17]

Solvent Evaporation Technique:

In this Using an appropriate surfactant, first mix the medication with the organic solvent in this procedure. Then, combine the continuous phase to form the O/W emulsion. After that, use a vacuum, heat, or atmospheric conditions to evaporate the organic solvent to create drug-loaded microspheres, which may then be filtered or centrifuged. [18]

Hydrogel Method:

There are similarities between this procedure and the solvent evaporation method. To create a drug-solvent nano-emulsion that is miscible with the drug anti-solvent, high shear pressures are applied. [19]

Characterization of nano-emulsion

Centrifugation

The A centrifuge is used to centrifuge the produced formulations that have been passed for centrifugation for 30 minutes at 5000 rpm. The formulations that showed no phase separation were sent for further analysis.

Measurement of pH

The pH of several nanoemulsion formulations is measured using a digital pH meter. After dissolving 1 gm of nanoemulsion in 100 ml of pure water, the pH was determined. To prevent mistake, the formulation is measured three times.

Viscosity:

The viscosity of the formulations was tested to ascertain their rheological characteristics. This was accomplished by using a Brookfield Rheometer viscometer at 30°C and a CPE 61 spindle spinning at 30 rpm. Three copies of the results were collected, and the average was taken into account. [20,21,22]

Zeta potential

Zeta PALS is the equipment used to measure zeta potential. It helps to gauge the charge on a droplet's surface in a nanoemulsion. Emulsifiers function as both a mechanical barrier and a surface charge generator. Coalescence can be hampered by zeta potential, which can create repellent electrical forces between approaching oil droplets. The higher the net charge of droplets and the more stable the emulsion, the higher the International Journal of Research in Pharmacy and Pharmaceutical Sciences 38 negative zeta potential. In general, a high level of physical stability is indicated by zeta potential levels less than -30 mV. Zeta potential is measured with the Malvern Zeta sizer, which is based on dynamic light scattering.[23,24]

Polydispersity

The ratio of the standard deviation to the mean droplet size, or polydispersity, shows how consistent the droplet size is throughout the formulation. The formulation's droplet size homogeneity decreases with increasing polydispersity. Polydispersity is measured using the Malvern Zetasizer, which is based on dynamic light scattering.

Particle size analysis

Generally, For the purpose of measuring the size and distribution of particles in a nanoemulsion, the dynamic light scattering (DLS) method is typically employed.

Percent of drug loading

A suitable 25 ml solvent is used to dissolve the pre-weighed nano-emulsion, and the resulting extract is then subjected to spectrophotometric and HPLC analysis. contrary to the drug's usual solution. Using several columns with the right porosity, the reverse phase HPLC method is used to determine the drug content.

Transmission electron microscopy (TEM)

Transmission electron microscopy (TEM) can be used to study the morphology and structure of the nano-emulsion. [25]

In vitro drug release

The in Semipermeable membranes can be employed in a dissolving device to study the in vitro release of drugs containing nano-emulsions. In place of the basket, a glass cylindrical tube measuring 2.5 cm in diameter and 6 cm in length is attached. The semi-permeable membrane should be tightly covered over the tube. At the surface of the semi-permeable membrane, the drug-loaded nano-emulsion is inserted into the cylindrical tube. In order to generate sink conditions and maintain permanent solubilization, the cylindrical tube should be dipped in a 100 ml buffer that maintains pH. At 32∨C, the release research can be conducted for a full day At 100 revolutions per minute, the stirring shaft should spin. A milliliter of the release medium is taken in aliquots and diluted before being filtered for analysis at predefined intervals of time (1, 2, 4, 6, 8, 12, 20, and 24 hours). To maintain a constant volume, the

aliquots are then replaced with an equal volume of the buffer solution. Utilizing a UV spectrometer, the absorbance of the gathered samples may be determined. [26]

APPLICATION

- Since the droplet size of nano-emulsion is so small, it never exhibits issues with creaming or sedimentation. With traditional emulsion and even microemulsion, these issues are highly prevalent. The gravitational force acting on the emulsion droplet is essentially the cause of both issues. However, the droplet size of a nanoemulsion is extremely small, which reduces the effect of gravity over the droplets and allows for emulsion creaming and sedimentation.
- Again, the nano-emulsion's small droplet size inhibits the droplets' coalescence. The instability of the emulsion is caused by the coalescence process, in which small droplets fuse together to produce a larger, more massive droplet. However the nano-emulsion's small droplet size inhibits surface fluctuation by preventing deformation and coalescence between them.
- Nano-dispersibility is much higher than micro-dispersibility due of the tiny droplet size, which inhibits droplet flocculation, a process that disperses the system without separating it..
- Because the droplets in a nano-emulsion formulation have a wide surface area, the active chemicals penetrate the skin quickly. It has also been shown that tough skin may be easily penetrated by nano-emulsion. This characteristic of the nano-emulsion reduces the need for extra particular penetration enhancer use, which is what causes formulation incompatibility.
- The preparation of nanoemulsion requires less surfactant than that of microemulsion. For instance, 5–10% surfactant is adequate for the manufacture of nano-emulsion, whereas roughly 20–25% surfactant is needed for micro-emulsion. Once more, surfactant consumption may be reduced with the aid of nano-emulsion technology.
- The lack of colloidal particles and thickening agent in nano-emulsion gives it a clear and fluidity quality that enhances patient compliance and makes it safe for administration. Furthermore, target delivery of an active component, particularly in cancer therapy, may be accomplished by the use of nano-emulsions.[27,28]

CONCLUSION:

Nano-emulsion offer a number of benefits for medication delivery. Since they may be used with nearly any delivery method, they have a prospective impact on a variety of industries, including biotechnology, cosmetics, and medicines. This innovative technique was created to address some medications' low miscibility with the lipid components of cell membranes and their poor absorption. The increasing number of medications that are insoluble presents obstacles that are almost impossible for the traditional methods of enhancing bioavailability to overcome. The literature provides ample evidence of the efficacy of nano-emulsion-based medication delivery in addressing contemporary bioavailability issues with the hopes of laying the groundwork for many more successes in the sector, the contemporary approaches and factors for effective nano-emulsion-based drug delivery have been reviewed in this study. The instability of nano-emulsion limits its uses. Controlling a number of variables, including the kind and concentration of surfactant and co-surfactant, the type of oil phase, the procedures employed, process variables, and the addition of additives across the nano-emulsion formulation's interphases, can improve the stability of the formulation.

REFERENCES:

1. Shaikh Neha M., Vijayendra Swamy S. M.*, Nagoba Shivappa N., Kulkarni K. B. "Formulation and Evaluation of Nanoemulsion for Topical Application" Journal of drug delivery and therapeutics, 15 august 2019.
2. Dasari Prasad, G P Mohanta, M Sudhakar, "A Review on Preparation and Evaluation of Nanoemulsions" International Journal of Pharma Research and Health Sciences, 26 Feb 2019.
3. Santosh Nemichand Kale, Sharada Laxman Deore, "Emulsion Micro Emulsion and Nano Emulsion: A Review" Sys Rev Pharm. 2017;8(1):39-47.
4. Tiwari SB, Shenoy DB, Amiji. MM, NanoemulsionFormulations for Improved Oral Delivery of Poorlysoluble drugs, anotech, 2006; (1): 475-478.
5. Bouchemal K, Briancon S, Fessi H, Perrier E. Nanoemulsion formulation using spontaneous emulsification:solvent, oil and surfactant optimization. Int J Pharm2004; 280:242
6. Bouchemal K, Briancon S, Fessi H, Perrier E. Nanoemulsion formulation using spontaneous emulsification:solvent, oil and surfactant optimization. Int J Pharm 2004; 280:243
7. Nurul Amin Biswajit Das "A Review On Formulation And Characterization Of Nanoemulsion",International Journal of Current Pharmaceutical, Vol 11,Issue 4, 2019.
8. Patel H C, Parmar G, Seth A K, Patel J D and Patel S R, "Formulation and evaluation of o/w nanoemulsion of ketoconazole", International Journal of Pharmaceutical Sciences, 2013, 4(4): 338-351.
9. Yukuyama MN, Ghisleni DD, Pinto TJ, Bou-Chacra NA. Nano emulsion: processselection and application in cosmetics - a review. Int J Cosmet Sci.2016;38(1):13-24.http://dx.doi.org/10.1111/ics.12260;PMid:26171789.
10. Thukral DK, Dumoga S, Mishra AK. Solid lipid nano particles: promising therapeuticnano carriers for drug delivery. Curr Drug Deliv. 2014;11(6):771-91.http://dx.doi.org/10.2174/1567201811061412021223 35;PMid:25469779.
11. Pawar KR, Babu RJ. Lipid materials for topical and transdermal delivery of nano emulsions. Crit Rev Ther Drug Carrier Syst. 2014;31(5):429-58.http://dx.doi.org/10.1615/CritRevTherDrugCarrierSyst.2014010663.
12. Ganta S, Talekar M, Singh A, Coleman TP, Amiji MM. Nano emulsions in translationalresearch-opportunities and challenges in targeted cancer therapy. AAPSPharm Sci Tech. 2014;15(3):694-708.http://dx.doi.org/10.1208/s12249-014-0088-9;PMid:24510526PMCid:PMC4037485.
13. Cerpnjak K, Zvonar A, Gašperlin M, Vrečer F. Lipid-based systems as a promising approach for enhancing the bioavailability of poorly water-soluble drugs. Act a Pharm. 2013;63(4):427-45.http://dx.doi.org/10.2478/acph-2013 0040;PMid:24451070.
14. Odriozola-Serrano I, Oms-Oliu G, Martín-Belloso O. Nano emulsion-based delivery systems to improve functionality of lipophilic components. Front Nutr.2014;5(1):24.
15. Mc Clements DJ. Nano emulsion-based oral delivery systems for lipophilic bioactive components: nutraceuticals and pharmaceuticals. Ther Deliv.2013;4(7):841-57.http://dx.doi.org/10.4155/tde.13.46;PMid:23883127.
16. Characterization of nano emulsion

17. Narang AS, Delmarre D, Gao D. Stable drug encapsulation in micelles and microemulsions. Int J Pharm 2007;345:9-25.
18. Pouton CW, Porter CJH. Formation of lipid-based delivery systems for oral administration: materials, methods and strategies. Adv Drug Delivery Rev 2008;60:625-37.
19. Gursoy RN, Benita S. Self-emulsifying drug delivery systems (SEDDS) for improved oral delivery of lipophilic drugs. Biomed Pharmacother 2004;58:173-82.
20. Chime SA, Kenechukwu FC, Attama AA. Nanoemulsions-advances in formulation, characterization and applications in drug delivery; 2014. p. 77-111.
21. Nirmala MJ, Shivashankar M, Mukherjee A, Chandrasekaran N. Fluconazole: a simple nanoemulsion drug delivery system. Int J Pharm Pharm Sci 2013;5:716-7.
22. Application
23. Thakur A, Walia MK, Kumar SLH. Nanoemulsion in the enhancement of bioavailability of poorly soluble drugs: a review. Int Res J 2013;4:15-25.
24. Shah P, Bhalodia D, Shelat P. Nanoemulsion a pharmaceutical review. Systemic Rev Pharm 2010;1:24-32.
25. Singh BP, Kumar B, Jain SK, Shafaat K. Development and characterization of a nanoemulsion gel formulation for transdermal delivery of carvedilol. Int J Drug Dev Res 2012;4:151-61.
26. Heidi MM, Yun Seok R, Xiao W. Nanomedicine in pulmonary delivery. Int J Nanomed 2009;4:299-319.
27. Charles L, Attama AA. Current state of nanoemulsions in drug delivery. J Biomat Nanobiotech 2011;2:626-39.
28. Venkatesan N, Yoshimitsu J, Ito Y, Shibata N, Takada K. Liquid filled nanoparticles as a drug delivery tool for protein therapeutics. Biomaterials 2005;26:7154–63.

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