WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.453
Volume 13, Issue 11, 481-489. Review Article ISSN 2277–7105

A REVIEW ON NANOEMULSION: AN EMERGING NOVEL APPROACH WITH DIFFERENT TECHNIQUES

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Article Received on
09 April 2024,

Revised on 30 April 2024,
Accepted on 21 May 2024

DOI: 10.20959/wjpr202411-32577

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ABSTRACT

Nanoemulsion is a stable drug delivery system consisting of oil, water, and surfactant droplets with a size of 100nm. The emulsifier slows interfacial tension and stabilizes the nanoemulsion through electrostatic interaction and steric hindrance. This review mainly gives a brief image of naoemulsion Nanoemulsion can be used in place of conventional dosage form to overcome from its demerits. It contain oils, water and emulsifiers. It is used for to improving the solubility and bioavalability of the drug. The droplets size of nanoemulsion consist of 20-200nm range in the nanometric scale. It is prepared in multiple delivery forms such as gels, creams, aerosols and spray. It should be taken by various ways such as orally, intravenously, intraocularly, intrapulmonary, topically and intranasally. Nanoemulsions are formulations used in various body routes and can be manufactured at low prices in various dosage forms. They require less surfactant than microemulsions, making them suitable for cancer therapy, targeted drug delivery, cosmetics, and improves its solubility and the bioavailability is also increased. This review mainly provide knowledge about the types of nanoemulsion, itsadvantages, disadvantages, formulation of nanoemulsion and application.

KEYWORDS: Nanoemulsion, Emulsifier, Novel Drug delivery.

INTRODUCTION

Nanoemulsion is a advanced form of novel drug delivery. Nanoemulsion is stable in high heat condition. It contains water phase and oil phase which is mixed with surface active agents. Its droplets size is around 100nm. A nanoemulsion mainly consist of water, oil, and

emulsifier. The emulsifier plays an important role as it slow down the interfacial tension The main function of emulsifier is to stabilized the electrostatic interaction between the oil phase/water phase.. Nanoemulsion is known as miniemulsion due to having droplets size 20-600nm and either oil/water is dispersed in the dispersion medium. They are transparent in nature. There are two phases in nanoemulsion.[1]

1. Dispersed phase
2. Dispersion medium.

The Forrmulation of nanoemulsion consist of two types:

1. High energy techniques
2. Low energy techniques.

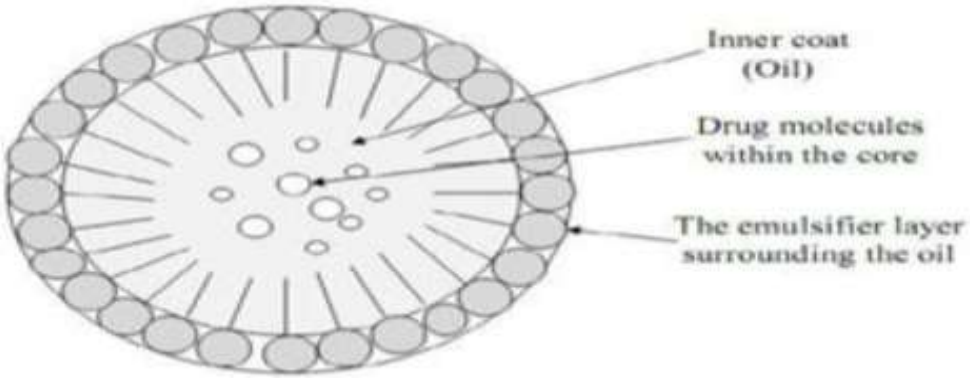

Fig 1: Structure of Nanoemulsion.

There are three classes of Nanoemulsion.[1][2]

1. Water /oil nanoemulsion(W/O):In this, water is disseminate in oil phase.
2. Oil/water nanoemulsion(O/W): In this, oil is disseminate in water phase.
3. Bicontinuous emulsion:In this phase, both oil and water quantity are equally interdispersed.

Merits of Nanoemulsion

- It improves solubility as well as bioavailability of the medication.
- It doesn't cause toxicity or irritation.
- It improves physical stability.
- It can be used in the place of liposomes.
- It provides greater absorption due to small size molecules having larger surface area.
- It could be prepared in different forms like creams, liquids, foams and spray.

- lipophilic drug is solubilizes in it.
- It requires less amount of energy.[1][2]

Disadvantages of Nanoemulsion

- It requires high amount of surface active agent to stabilize it.
- For Thermolabile substances, there are limited solublizing capacity.[1]
- Temperature and pH is directly affects the nanoemulsion stability.[2]

Components of Nanoemulsion

1. Oil: This is a key component, often consist of a lipid or oil. It could be a natural oil or synthetic lipid. The choice of the oil phase affects the characterstics of the nanoemulsion, including its stability and compatibility with specific application. Example: oils of corn, coconut, rose, olive, peanut etc.[12][13]
2. Emulsifier: Emulsifier are crucial for stabilizing the nanoemulsion by decreasing surface tension between oil and water phases. Example:PEG 300, poloxy 60, polysorbate 80, polysorbate 20, span 80, etc.
3. Co-emulsifier: co-emulsifier also known as co-surfactant, work in conjunction with surfactant to stabilize nanoemulsion. Example: Ethanol, glycerine, PEG 400, polyene glycol etc.
4. Solvent: The continuous water phase surrounds the dispersed oil droplets. The selection of water and its properties (pH, ionic strength, etc.) is important for the stability and functionality of the nanoemulsion. Example: glycerol, acetone, sorbitol etc.

Method of preparation of Nanoemulsion

There are mainly two types for preperation of nanoemulsion i.e High – energy Techniquesand low energy Techniques. Then they are further divided into following types.[2][3]

A. High energy methods: It requires high amount of energy and temperature. it is very expensive in order to provide a good solution.

1. High-Pressure Homogenization: This method is used to produce nanoemulsion by introducing the mixture to high pressure, typically using a homogenizer. This process breaks down larger droplets into smaller and forms a uniform nano-sized droplets gives rise to a stable nanoemulsion. The pressure is around 500psi to 5000psi.[3]

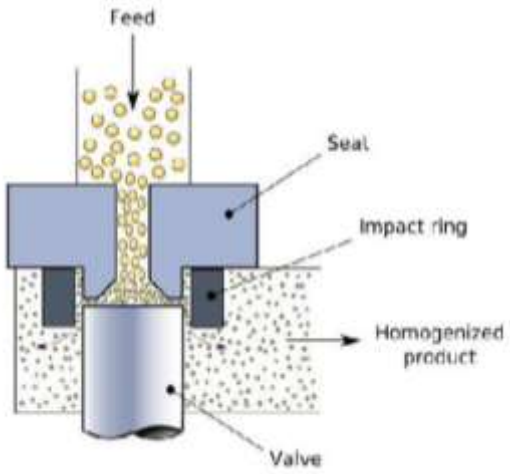

Fig 2: High pressure homogenizer.

2. Micro fludization: It is another type of high energy methods. M icrofludizer is used for the formulation of nanoemulsion. In this the product is passed through micro-channels. The solution of oil and aqueous phase is mixed and forms coarse emulsion then it is transported to a microfludizer where it forms stable nanoemulsion. The desired emulsion is filtered with the help of nitrogen for removing large droplets and forms a uniform emulsion.[3]

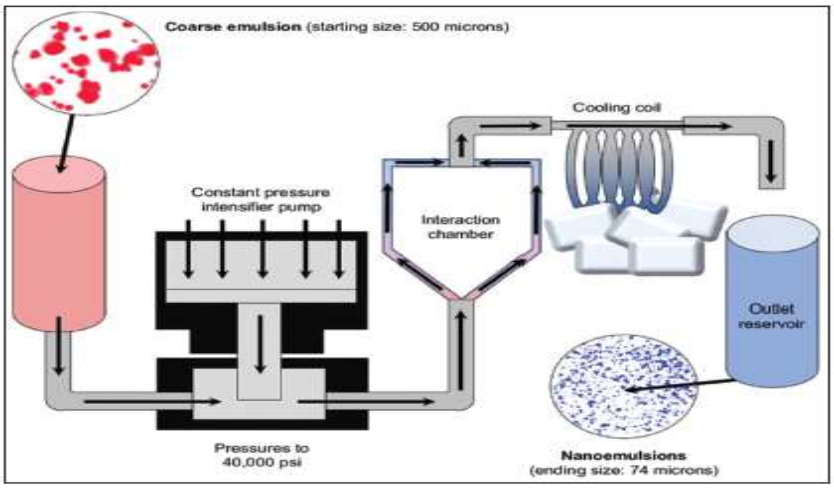

Fig 3: Microfluidizer.

3. Ultrasonic emulsification: Ultra sonic emulsification is mainly for reducing the droplets size. It mainly consists of high frequency sound waves called ultrasound sonicator probe. Mechanical vibration and cavitation is produced when the tip of sonicator touches the liquid.[16]

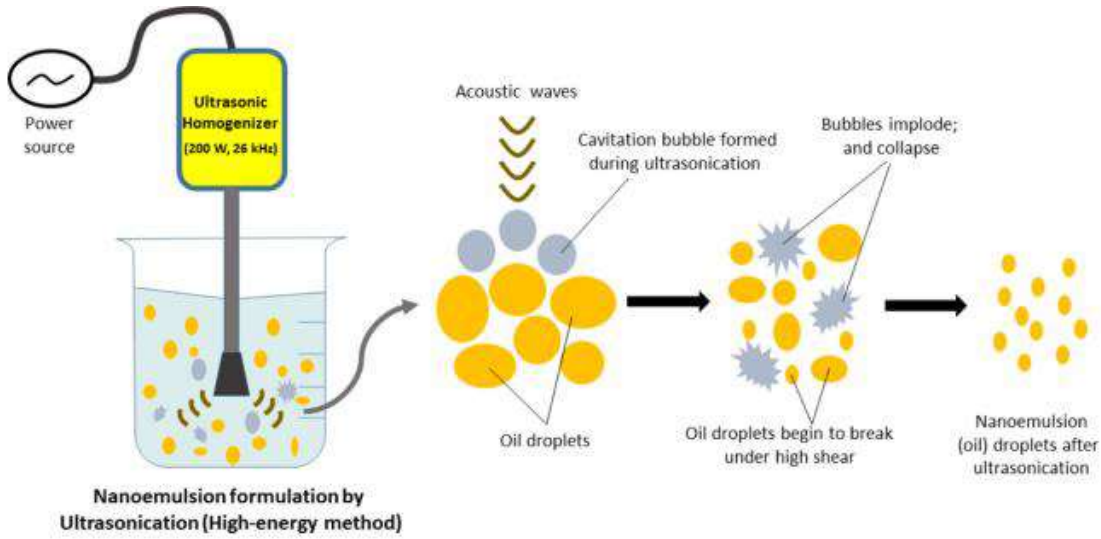

Fig 4: Ultrasonic Emulsifier.

4. Membrane filtration: This technique is used for the production of nanoemulsion by passing the emulsion through a membrane with specific pore sizes. The membrane acts as a barrier which allows small droplets to pass while larger one is remain on the membrane. It is mainly for the control of droplet size and gain the narrow size distribution.[3][4]

B. Low Energy Methods: It requires less amount of energy to produce nanoemulsion and are more energy efficient.

1. Phase inversion technique: Any external force is not required in this technique. In this method water is added slowly in the oil emulsifier solution after that the temperature should be maintained then it produces kinetically stable nanoemulsion consisting droplets size about 50 nm. Phase inversion technique is classified into two types i.e transitional phase inversion and catastrophic phase inversion.

2. Solvent evaporation technique: In this the drug solution is emulsified into another liquid after that the solution is evaporated which give rise to drug precipitation and by the use of high stirrer, it regulates the crystal growth and particle aggregation. Then the nanoemulsion is formed.[4]

3. Spontaneous emulsification: In the spontaneous emulsification, a homogeneous organic solution is formed which conatain oil and lipophilic surfactant which are miscible in water and hydrophilic surfactant. By the use of magnetic stirrer it give rise to o/w nanoemulsion. Then the aqueous phase is removed by evaporation by the reduction of pressure.[14]

Evaluation of Nanoemulsion

- **Visual appearance:** The homogeneity and colour of the appearance at equilibrium can be examined uing a clear or calibrated glass cylinder.[7]
- **Colour, odour, Taste:** Taste variation is typically caused by changes in globule size distribution, especially with regard to active components. Different ingredients may have different tastes, smells, or colours, which could indicate a chemical incompatibility.[7]
- **Density:** Two important characteristics are the density or specific gravity of the nanoemulsion formulation. A drop in the formulations density indicates that air has become trapped in its composition. High Precision hydrometers can be used to determine density at specific temperatures.[11]
- **Viscosity:** The viscosity of various compositions at various temperature and shear rates can be measured using a Brookfield type rotational viscometer. Before testing, the sample needs to be immered in it, and a thermobath need to be accurately calibrated to determine the suspension apparent viscosity at equilibrium.[10]
- **Refractive Index:** The refractive index can be determine using Abbe's refractometer. It shows how isotropic the composition is.[7][1]
- **Particle Size and Polydispersity index(PDI):** The Malvern zetasizer is used to calculate the PDI and particle size of nanoemulsions. The PCS hypothesis states that small particles move faster than large ones. A polydisperse particle dipersion has a PDI of one, whereas a monodispersed system has a PDI of zero.[1]
- **Zeta potential:** The surface charge of the particle or globules can be determined by measuring the zeta potential of the nanoemulsion preperation with a Malvern zetasizer instruement. The zeta potential forcast the stability of the dispersion and the ways in whichthe drugs, emulsifiers, coemulsifiers and the other electrolytes influence its value. In order to create a stable nanoemulsion by preventing the nanodroplets from coalescing and flocculating, the nanoemulsion generally needs to grow to a value greater than thirty.[8][20]

Applications of Nanoemulsion

There are various application of nanoemulsion, some of the applications are.

- Nanoemulsion formulation given by different routes of body such as parenterals, oral, topical, nasal and ocular route.[17]
- Nanoemulsion can be manufacture at very low price in different dosage form such as creams, gels, foams, sprays and aerosols etc.[18]

- If one compared nanoemulsion with microemulsion, nanoemulsion requires less surfactant. For example: for the preparation of microemulsion, 20-30% of surface active agent is needed but for the preparation of nanoemulsion, 5-10% of surface active agent should be required.[15]
- Nanoemulsion can be used in treatment of cancer and targeting drug molecule.[19]
- Nanoemulsion can be used in cosmeceuticals industry.[9]
- By developing water in oil type, nanoemulsion should be used to promote the solubility of low soluble drug.[3][4]

CONCLUSION

Nanoemulsion are a huge part of novel drug delivery system because of their targeting site of action and improving bioavailability. The main thing is that it contain small particle size reduced to the nanometric scale shows various physical properties. Nanoemulsion can be used in various disciplines including cosmetics, biotechnology, and pharmaceuticals. Nanoemulsions are formulations used in various body routes and can be manufactured at low prices in various dosage forms. They require less surfactant than microemulsions, making them suitable for cancer treatment, drug targeting, and cosmeceutical industry. They promote drug solubility by developing water in oil. This review paper mainly focus on the recents development in the field of nanoemulsion formulation which are discovered till date. Nanoemulsion mainly formed due to overcome such as poor solubility, absorption and miscibility with lipids.

ACKNOWLEDGEMENT

All praise to the Almighty God and I would like to give sincere thanks to my guide Assistant Prof. Shweta Ma'am for her support and involvement in this article. Huge thanks to Dean DR. S. K Sharma Sir and all the staff of PDM University Bahadurgarh, Haryana, India.

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