

Chapter 2. Formulation and Evaluation Parameters of Nanoemulsion

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Abstract:

Nanoemulsions are kinetically stable, isotropic colloidal dispersions of two immiscible liquids stabilized by suitable surfactants and co-surfactants, with droplet sizes typically ranging from 20 to 200 nm. They have gained significant attention in pharmaceutical formulations due to their ability to enhance the solubility, stability, and bioavailability of poorly water-soluble drugs and herbal extracts. The preparation of nanoemulsions can be achieved through high-energy methods such as high-pressure homogenization, ultrasonication, and microfluidization, or low-energy methods including spontaneous emulsification, phase inversion temperature (PIT), emulsion inversion point (EIP), and membrane emulsification techniques. Each method operates based on the principles of interfacial tension reduction, phase transition, and controlled droplet formation to achieve nanoscale emulsions with uniform particle size and long-term stability. Optimizing formulation variables such as oil phase selection, surfactant-to-co-surfactant ratio, temperature, and mixing conditions plays a critical role in achieving desired characteristics like small droplet size, high stability, and efficient drug loading. Nanoemulsions serve as promising carriers for oral, topical, parenteral, and nasal drug delivery, offering improved absorption and targeted therapeutic effects. In particular, nasal nanoemulsions provide a non-invasive route for rapid drug transport to the brain, making them suitable for the delivery of anti-anxiety herbal extracts with enhanced onset of action and patient compliance.

Keywords: Nanoemulsion, drug delivery, surfactants, stability, characterization, pharmaceutical formulation

Definition :

Nanoemulsion (NE): A nanoemulsion is a colloidal dispersion system consisting of two immiscible liquids (such as oil and water), stabilized by surfactants, where the droplet size of the dispersed phase typically lies in the 20–200 nm range.

Nanoemulsion = oil + water + surfactant (droplet size in nanometer range) used to deliver drugs effectively

Types of nanoemulsion

1. Water-in-oil nanoemulsions: Nanoemulsions in which water droplets are dispersed in continuous oily phase