# Nanoemulsions: versatile formulations for active substance delivery and targeting

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Innovative drug delivery systems have been developed to overcome the major drawbacks associated with conventional drug delivery systems. Among these systems, nanoemulsions have been developed as a potential system of drug administration due to their good intracellular penetration and tolerability.

Nanoemulsions (NEs) are very fine dispersions, formed by the conjunction of two liquid immiscible phases, water and oil, whose globule size ranging from 20–500 nm. They can be either oil in water (O/W) or water in oil (W/O). Thanks to the wide range of droplet sizes, it is possible to obtain nanoemulsions useful in different fields: as versatile nanocarriers in drug delivery, as preservatives in the food industry, in the cosmetic industry in skin hydration products, and finally in the restoration sector. In particular, nanoemulsions can be formulated in many forms for different applications in pharmaceutical field, such as topical, ocular, intravenous, intranasal and oral delivery.

They appear transparent or milky, depending on droplet; droplets smaller than 200 nm lead to a quite transparent NE. They are kinetically more stable than microemulsions, in fact reducing the size of the drops it possible to avoid phenomena of instability, such as flocculation or separation of the two phases.

Taking into account the above-mentioned elements, the present research is based on the formulation and characterization of O/W nanoemulsions by several essential oils stabilized by different nonionic surfactants, useful to deliver hydrophobic drugs.

Essential oils are known as naturally occurring substances with many interesting properties such as antioxidant, antifungal, anti-inflammatory and many other biological roles. In these studies, Neem, Almond and Satureja Oil are selected.

Non-ionic surfactants play a key role in stabilizing nanoemulsions. In particular, Tween® 20, Tween® 80 and Brij® 72 are selected in order to evaluate their ability to form nanoemulsions with different features.

In the nanoemulsion formulation, it is also important to control some parameters, such as pH and turbidity of the samples, especially in ocular or intravenous application.

The obtained nanoemulsions have been characterized in terms of size, ζ-potential, microviscosity and polarity. Stability studies were carried out over a period of 90 days at two different storage temperatures (room temperature and 4°C). The shape and the surface morphology of all samples are also investigated using Atomic Force Microscopy (AFM) and Small-Angle X-ray Scattering (SAXS). NEs were loaded with lipophilic drugs, such as Resveratrol, Curcumin and Vitamin E and the entrapment efficiency (EE %) and the release rate were evaluated. Finally, cytotoxicity studies were carried out using specific cell lines.

Obtained results allow confirming the versatility of nanoemulsions and the most promising formulations will be selected for in vivo studies.