

## Nanoemulsions of Essential Oil Constituents

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### Antimicrobial Nanoemulsions

Essential oils (EOs) are hydrophobic liquids which are derived from aromatic plants. These concentrated liquids are known for their varied biological applications and are therefore widely commercialised across the world. Various methods such as solvent extraction, distillation, expression and florasol extraction are employed to extract essential oils. Apart from its popularity in the fragrance and flavouring industry, EOs are known for their applications in pharmaceuticals. Phenolic constituents, amongst many other functional compounds, lend these natural extracts antimicrobial properties [1,2] by having a destructive impact on the cell membrane of target microorganisms. These constituents include, but are not limited to, carvacrol, eugenol, camphor, cinnamaldehyde, linalool, geraniols, thymol, citral, and terpineol. The efficacies of EOs as medicines are, however, constrained by their poor aqueous solubility, high reactivity and volatility, which are attributable to the lipophilic nature of these essential oils [3]. Nanoemulsification technique is used to overcome these drawbacks, as it leverages the ability of nanoemulsions to deliver the oils which are otherwise insoluble in water. This, along with enhanced surface area for interaction (because of the smaller droplet size), greater thermodynamic stability, improved bioavailability and ease of formation, makes nano emulsification an ideal augmentation to the pharmaceutical applications of EOs [4].

Essential oils, being a combination of 60 or more compounds [5], are not an exclusive collection of beneficial chemical compounds and comprise of undesirable components. Also, studies on oregano essential oil suggest that its antibacterial properties are largely dominated by constituent compounds carvacrol and thymol, with both contributing additively to that of oregano essential oil (OEO) in their inhibition of *Pseudomonas aeruginosa* and *Staphylococcus aureus*. Separate formulations of carvacrol and thymol stand to provide the same efficacy of using OEO, while at the same time addressing flavour constraints that the Essential Oil is known for [6]. This suggests that a further breakdown of EOs into their useful constituents and consequent emulsification of the same will enhance their scope for application. There are published reports on the antimicrobial efficacy of nanoemulsified constituents of essential oils. Two food-grade nanoemulsions, loaded with geraniol and linalool, were studied to exhibit promising results against *E. coli* and *L. innocua* in a meat simulation system [7]. Optimized formulations of nanoemulsions of carvacrol made using spontaneous emulsion were observed to inhibit yeast strains, *Zygosaccharomyces bailii* (ZB), *Saccharomyces cerevisiae* (SC), *Brettanomyces bruxellensis* (BB) and *Brettanomyces naardensis* (BN) [8]. Eugenol nanoemulsions prepared using food-grade emulsifiers gum arabic and lecithin showed similar results to pure eugenol in inhibiting *Listeria monocytogenes* and *Salmonella enteritidis*, while exhibiting better stability [9]. Eugenol nanoemulsions have also been observed to exhibit antibacterial activity against *S. aureus* [10] and antifungal activity against *Fusarium oxysporum f. sp. vasinfectum* and phytotoxicity on cotton seeds [11]. Citral is another constituent whose use, although efficient against microorganisms, is constrained because of its instability and hydrophobicity in normal condition. Ultrasonication method was used to nanoemulsify this component and the resultant nanoemulsion were observed to exhibit strong antibacterial properties against *L. monocytogenes* and *S. aureus* [12]. These studies suggest that individual

constituents of essential oils are equally effective in their antimicrobial properties and can help overcome specific constraints that are generally faced in using essential oils for pharmaceutical purposes.

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