Nanoemulsion Based Delivery Systems to Enhance the Antimicrobial Activity of Essential Oils

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Abstract

The rise of antimicrobial resistance poses a significant global health challenge, driving the urgent need for novel and effective antimicrobial agents. Essential oils (EOs) have emerged as promising natural alternatives due to their broad-spectrum antimicrobial properties; however, their clinical application is limited by high volatility, low water solubility, and chemical instability. This study explores the potential of nanoemulsions (NE) to enhance the antimicrobial efficacy and stability of Thymus capitatus essential oil (TEO) and Origanum vulgare essential oil (OEO), both native to northern Albania and the Mediterranean region.

Oil-in-water nanoemulsions (TEO-NE and OEO-NE) were prepared using medium-chain triglyceride (MCT) oil and Tween 80 via high-pressure homogenization. The resulting formulations were tested against several microbial strains. Both NE systems demonstrated improved antimicrobial activity compared to the free EOs, particularly against Escherichia coli ATCC 25922, Staphylococcus aureus ATCC 29213, and Candida albicans ATCC 10231. No inhibitory effects were observed against Pseudomonas aeruginosa ATCC 27853. Among the two, OEO-NE showed superior antimicrobial performance.

These findings suggest that nanoemulsification can significantly improve the bioavailability and antimicrobial potential of essential oils. While in vitro results are promising, further in vivo studies are essential to confirm their safety and therapeutic value. Encapsulated EOs may represent a promising strategy in the development of alternative antimicrobial treatments aimed at overcoming resistance, reducing side effects, and improving cost-effectiveness in clinical applications.

Keywords: nanoemulsions based delivery systems, essential oils, antimicrobial activity, stability

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