Comparative Analysis of Alginate/Clove Essential Oil Nanoemulsion Process for Enhanced Antibacterial and Antifungal Activation of Textile Surfaces

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Abstract: Superficial cutaneous mycoses are among the most common dermatological infections. They affect both the skin (epidermis) and its appendages (hair, nails) and are mostly caused by the invasion of large groups of fungi: dermatophytes, yeasts of the Candida genus, and molds. The advantage of using clove essential oil to treat mycoses is that there are no strains of yeast or dermatophytes resistant, unlike treatments based on fluconazole or amphotericin B [1].

This study contributes to the development of nanoemulsion process involving Alginate/ clove essential oil (AL/clove), aimed at enhancing a textile for paramedical applications having antifungal and antibacterial function. Our main purpose is comparative study of emulation synthesis process to develop the best antifungal and antibacterial emulsion for textile activation. The synthesis of AL/clove emulsion was carried out using two process. First one is conducted by mixing alginate, clove essential oil, and non-ionic emulsifier using an Ultraturrax Homogenizer and the second one is conducted by using ultrasonic emulsification. In order to maximize the amount of CH/LEO emulsion activity , the effect of manufacturing conditions has been studied. The prepared emulsion was applied on weave sutures by pad-dry technique.

Droplet size distribution were used to characterize the physical structure of the emulsion. In-vitro antibacterial and antifungal activity was tested against gram-positive and gram-negative microorganisms. Drop size analysis revealed that alginate-clove-based emulsion obtained by ultrasonic technique had a more uniform size distribution compared to those prepared by Ultraturrax Homogenizer technique, indicating improved encapsulation control. The obtained nanoemulsions showed a homogeneous distribution depending on process conditions from 200 to 400nm.

The results also demonstrated significant antibacterial efficacy of the emulsion prepared with Ultraturrax Homogenizer against Bacillus Subtilis (BS), Staphylococcus aureus (Sau), Enterococcus faecalis (EF), Pseudomonas Aeruginosa (PS), and Salmonella enterica (SE), with inhibition zones measuring 7 mm, 11 mm, 13 mm, 10 mm, and 10 mm respectively. Additionally, it exhibited antifungal activity against Candida albicans (Ca) with a 10 mm inhibition zone. Conversely, nanoemulsion solutions produced through ultrasonic emulsification displayed enhanced inhibition zones against all tested strains, particularly against Candida albicans (Ca), with a 30 mm inhibition zone. Thus, emulsions prepared via ultrasonic emulsification showcased improved stability and uniform droplet distribution at nanoscale size, enhancing the diffusion of antibacterial agents. This funding is supported by the outstanding performance of the treated textile, as evidenced in Figure 1.

Keywords: *nanoemulsion, Alginate, clove oil, antibacterial activity, antifuangal activity component.*

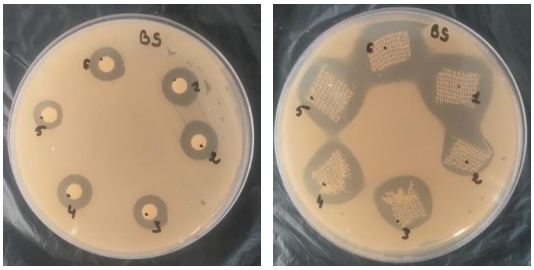

Figure 1 Example of Antibacterial activity against Bacillus Subtilis(BS) (process 2) of prepared emulsion and activated textile

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