Thesis Title	Development of Chitosan Nanoencapsulated Clove Essential Oil and Its Antifungal Efficacy Against *Aspergillus niger*
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ABSTRACT

This study focused on the development and characterization of chitosan nanoencapsulated clove essential oil (CEO-CSNPs) and its antifungal efficacy against *Aspergillus niger*, a common spoilage fungus. A preliminary screening was conducted to evaluate the antifungal activity of three plant essential oils, clove, cinnamon, and lemongrass using the disc diffusion method. Clove essential oil exhibited the highest inhibition zone (50.20 ± 0.51 mm), and was therefore selected for nanoencapsulation using the ionic gelation method with sodium tripolyphosphate (TPP) as the cross-linking agent. The CEO-CSNPs were characterized using Scanning Electron Microscopy (SEM), Fourier Transform Infrared Spectroscopy (FTIR), X-ray Diffraction (XRD), Thermogravimetric Analysis (TGA), and Energy Dispersive X-ray Spectroscopy (EDS). These techniques confirmed the formation of spherical nanoparticles and the successful encapsulation of clove essential oil, as indicated by the presence of its characteristic functional groups within the chitosan matrix. Agar diffusion assays against *Aspergillus niger* demonstrated a concentration-dependent increase in antifungal activity of clove essential oil (CEO), with inhibition zones increasing by approximately 186% as the CEO concentration was raised from 5% to 100%. A similar trend was observed for nanoencapsulated CEO (CEO-CSNPs), where increasing the CEO-to-chitosan (CS) ratio from 1:1 to 1:2 resulted in an approximately 165% increase in the diameter of inhibition zones. These findings indicate that chitosan-based nanoencapsulation not only preserves but also enhances the antifungal efficacy of CEO. This encapsulation strategy offers a potential for the development of bio-based antifungal agents applicable in food preservation and shelf-life extension. supporting

its potential application as a natural antifungal agent for food preservation and shelf-life extension.

Keywords: Antifungal Activity, *Aspergillus niger*, Chitosan, Essential Oils, Clove Oil, Nanoencapsulation