



University of Zabol  
Graduate School  
Faculty of Agriculture  
Department of Plant Protection

The Thesis Submitted for the Degree of M.Sc  
(in the field of Plant Pathology)

**Title:**

Antifungal activity of microcapsules containing rosmarinus essential oil against  
early blight of tomato

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## Abstract :

The antimicrobial and antioxidant properties of rosemary essential oil have been proven. The present study sought to evaluate the antifungal properties of rosemary essential oil microcapsules on fungus *Alternaria alternata*, the cause of tomato early blight disease in laboratory conditions. First, rosemary essential oil was extracted, and acetic acid solution and zein (the major storage protein of corn) were prepared. Then, the rosemary essential oil microcapsules were provided by electrospraying technique. The microcapsules were assessed by scanning electron microscope (SEM), X-ray diffraction (XRD), fourier transform infrared spectrometry (FTIR), differential scanning calorimetry (DSC), and gas chromatography–mass spectrometry. The microcapsules' antifungal activity was determined by agar well diffusion method. The SEM test and the measurement of the particles' diameter by Image j software revealed that most microcapsules' morphology is uniform, smooth surface, and homogeneous, looking like red blood cells. It was demonstrated that as the essential oil concentration increased, the particles' diameter also increased. Gas chromatography and spectrometry of rosemary essential oil exhibited that alpha-Pinene and *P-caiman* are the primary constituents of essential oil. The antifungal properties of thyme essential oil can be attributed to alpha-Pinene and P-caiman. The XRD analysis revealed that phenolic acids, diterpenes, and flavones are the major constituents of rosemary. The DSC data analysis and FTIR approved the bonds in the rosemary essential oil and pure zein compounds. Moreover, increases in the peaks' magnitude with regard to rosemary compounds and the hydrogen bond between zein and these compounds were confirmed through increase in the rosemary percentage in the composite produced. SPSS 19 was employed for statistical analysis; Duncan's multiple-range test compared the data means. The microcapsules with different concentrations of rosemary essential oil were significantly effective in hindering the growth of pathogen. Also, a positive correlation was observed between the essential oil concentration and its inhibitory ability in pathogen growth.