

Title: Investigating the effect of cold plasma on physical, mechanical and antimicrobial properties of Persian acorn starch film containing *Trachyspermum ammi* essential oil

Abstract:

This study was conducted to investigate the effect of cold plasma on the physical, mechanical and antimicrobial properties of Persian acorn starch film containing *Trachyspermum ammi* essential oil (TAEO). Analysis of the chemical composition of TAEO using a gas chromatography device connected to a mass spectrometer showed that thymol with 54.62%, para-cymene with 22.6%, and terpinene with 18.27% were the main components of TAEO. The antimicrobial activity of TAEO was investigated using the minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) methods. The results showed that *Staphylococcus aureus* and *E. coli* were the most sensitive bacteria to TAEO with the MIC of 2 mg/ml. The MBC level for all tested bacteria was 4 mg/ml. The antioxidant activity of TAEO using the DPPH and ABTS methods indicated significant and dose-dependent antioxidant properties. In the DPPH test, the results showed that with increasing the concentration of essential oil, the inhibition of free radicals increased significantly ($P \leq 0.05$). In the ABTS test, TAEO was able to eliminate ABTS radicals at much lower concentrations compared to DPPH method. Four types of films were prepared, including acorn starch film, acorn starch film containing TAEO (2%), plasma-treated acorn starch film, and plasma-treated acorn starch film containing TAEO (2%). The films were treated using a DBD plasma device. The antimicrobial properties of the four types of films were investigated using the disk diffusion test. Acorn starch films containing TAEO showed favorable antimicrobial properties compared to acorn starch films. To investigate the physical and mechanical properties of the four types of films, various tests including, Tensile, Water Vapor Permeability, Colorimetry, Hydrophobicity, FTIR, XRD, DSC, and FESEM were performed. The tensile strength of the starch film was significantly lower than the other films. Plasma treatment reduced the water vapor permeability of the starch film. Plasma reduced L^* and increased b^* . Plasma significantly increased the hydrophobicity of the starch film and the starch film containing essential oil. Cold plasma caused the inclusion of TAEO in the starch film. Plasma increased the crystallinity of the starch film but reduced the thermal stability. Cold plasma created a smooth and uniform surface in the film. According to the results, TAEO showed high antimicrobial and antioxidant activity. Cold plasma, as one of

the methods used to modify starch, improved the physical and mechanical properties of the Persian acorn starch film containing TAE0.

keywords: Cold plasma, mechanical properties, film, starch, Persian acorn, essential oil, *Trachyspermum ammi*.