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Effects of Microwave Treatment on Physical, Morphological, Mechanical and Functional Properties of Chitosan Films Incorporated with β-Carotene

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Structured Abstract

Background: Packaging plays a crucial role in safeguarding the quality of food products and extending their shelf life. Despite the benefits, the use of synthetic materials for food packaging that are non-biodegradable such as polyethylene (PE), polypropylene (PP) and polyamide (PA), causes alarming ecological problem and increases number of health risks. This study explores the potential of chitosan biodegradable films, as an eco-friendly alternative to synthetic plastics. Chitosan are favourable materials in developing biodegradable films on an industrial level due to their biodegradable, film-forming and non-toxic attributes. The objective of this study is to determine the impact of microwave treatment on the physical, morphological, mechanical and functional properties of chitosan films with β-carotene.

Methods: In this study, chitosan films were established by dissolving chitosan in 2% acetic acid solution with addition of glycerol and beeswax. The chitosan solution was then homogeneously blended with β-carotene, followed by drying the film solution under 40°C for 24 hours. Microwave treatment for 0, 30, 60 and 120 seconds was subsequently applied to the chitosan-based film to enhance its packaging attributes. The chitosan-based film was analysed for thickness, colour, opacity, solubility, surface morphology, mechanical strength, and crystallinity.

Results: The results revealed that the microwave treatment gave no significant effect on thickness. The microwave treatment for 120 seconds significantly improved the colour (L*: 38.01, a*: 0.32 and b*: 6.41), making it opaque (4.36) and exhibited the lowest water solubility (47.13%) compared to the untreated, 30 and 60-second treated film. Microstructure analysis (FESEM) highlights a more uniform matrix deposition. Mechanical properties, such as tensile strength, elongation at break and Young's modulus significantly improved with extended microwave treatment. The ATR-FTIR spectrum shows that there was an interaction of β-carotene and chitosan in the chitosan-β-carotene films after microwave treatment. The peak intensity of chitosan-β-carotene film microwave treated for 120 seconds was significantly declined (3257.54) indicating more amorphous structure making them more suitable for food packaging applications.

Conclusion: To conclude, 120 seconds microwave treatment were selected as the best treatment condition for developing chitosan film incorporated with β-carotene.

Keywords: Microwave treatment, Chitosan films, β-carotene

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