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Effect of Microwave on Physical, Mechanical and Functional Properties of Chitosan Film Incorporated with Curcumin

Siti Mysarah Saiful Bahari[a], Nafisah Musa[abc*]

Structured Abstract

Background: Plastic pollution is a growing environmental issue that affects nearly every ecosystem on the planet. Currently, bio-based polymers are being used to replace non-renewable synthetic plastics, with chitosan being one of the most common polymers used. However, due to its poor water barrier and mechanical strength, chitosan's use as film packaging is limited in the food industry. Therefore, this study incorporated curcumin into chitosan to improve its water barrier, while also applying microwave treatment to improve the mechanical properties of the chitosan film. The objectives of this study are to determine the physical, mechanical, and functional properties of chitosan film incorporated with curcumin, as well as the duration of microwave that can improve those film's properties.

Methods: The main ingredients used in the development of film were chitosan, beeswax, acetic acid, and curcumin, a natural colourant. The chitosan-curcumin film was successfully created using the solvent casting technique. After drying, the films were microwaved for various periods of time (0, 30, 60, and 120 seconds each).

Results: This study shows that microwave treatment does not influence the film's thickness. In the meantime, the microwave treatment for 120 seconds significantly improved the colour (L*: 30.70, a*: 1.91 and b*: 8.93), making it opaque (2.19) and exhibited the lowest water solubility in both unheated and heated condition (47.51% and 59.96%, respectively) and highest crystallinity (17.35%) when compared to the untreated, 30 and 60-second treated film samples. However, 60 seconds demonstrated the highest tensile strength (1.30 MPa) because strength degradation may occur up to 60 seconds. The FESEM displayed that the surface and the cross-section morphology of CSCur films after microwave treatment were smoother, denser, and had fewer pores. The mechanical and barrier properties of the films were supported by the changes detected in ATR and XRD, which demonstrates the rigidification of hydrophilic domains at the OH/NH moiety and fluidization of hydrophobic domains at the CH moiety, as well as a significant increase in crystallinity index between duration of microwave treatment ($p<0.05$).

Conclusion: In conclusion, 120-seconds microwave of chitosan-curcumin exhibited the most improved properties.

Keywords: Microwave treatment, Chitosan, Curcumin, Edible film

*Correspondence: *nafisahmusa@uitm.edu.my

[a] Faculty of Applied Sciences, Universiti Teknologi MARA, Shah Alam,Selangor, 40450, Malaysia

[b] Food Science Research Group, Faculty of Applied Sciences, Universiti Teknologi MARA, Shah Alam,Selangor, 40450, Malaysia

[c] Non-Destructive Biomedical and Pharmaceutical Research Centre, Smart Manufacturing Research Institute, Universiti Teknologi MARA Selangor, 42300, Puncak Alam, Selangor, Malaysia