UNIVERSITI TEKNOLOGI MARA

MECHANICAL, MELT FLOW, MORPHOLOGICAL, THERMOSTRUCTURAL AND ANTIBACTERIAL PROPERTIES OF CHITOSAN/ LINEAR LOW-DENSITY POLYETHYLENE BLEND FOR SELECTED FOOD (BANANA) PACKAGING FILM

SITI AISHAH BINTI MOHD ISA

Thesis submitted in fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Science)

Faculty of Applied Science

December 2022

ABSTRACT

The world are facing excessive dumping of plastics wastes especially from packaging food industries. The food industries also need long shelf life as food degradation caused by the growth of microorganism, had reduced the quality of food products. Fresh food product packaging during import and export process especially for fruit product need proper packaging. In this study, an antimicrobial agent and polymer which are in demand for food packaging application had been developed. This research is related to the production of an antibacterial packaging which use chitosan and cinnamaldehyde acting as antibacterial (AM) agent. Different varying compositions 5 to 15wt% of chitosan with fixed 1% cinnamaldehyde were compounded with 85-95wt% of Linear Low- Density Polyethylene (LLDPE) using Twin Screw extruder and Blown film process, to produce two different antibacterial packaging, LLDPE/Chitosan/Cinnamaldehyde and LLDPE/Chitosan. The effects of chitosan incorporation on LLDPE were tested for physical, mechanical, thermal, morphology, antibacterial and rheological behaviour. For first stage blending process, increase percentage of chitosan/LLDPE with cinnamaldehyde had resulted in increased melt flow index (MFI) than Chitosan/LLDPE blend. The MFI value showed two different composites suitable for film blowing process which are in range of 0.34 g/10min to 0.78 g/10min. In general, addition of increase chitosan in LLDPE film blend with and without cinnamaldehyde showed an increase in 21% to 32% of tensile strength and young modulus. 15wt% chitosan/LLDPE with 1% cinnamaldehyde showed highest increase in tensile strength and young modulus, and decrease in elongation at break. From Zone of inhibition test, antibacterial action were found to exhibit Gram-negative bacteria *(E.coli)* with the presence of chitosan in the film blend. The highest zone of inhibition was found for 5% chitosan/LLDPE film without cinnamaldehyde having zone inhibition at 11.25mm compared to 15% chitosan. For thermal properties, chitosan/LLDPE composite with cinnamaldehyde showed good in thermal stability with 15% chitosan composition. Meanwhile, observation from field emission scanning electron microscope (FESEM) revealed that the increase percentage of chitosan with cinnamaldehyde formed rougher surface and numerous small holes. At second stage, the process of modification onto the chitosan/LLDPE film surface were performed via sulfuric acid immersion with various time between 20, 40, 60 and 80 minutes. For both Fourier Transform Infrared Spectroscopy (FTIR) and Atomic Force Microscope (AFM) tests, the treatment time at 40 minutes showed increase in surface roughness with Root Means Square (RMS) value of 41.0 nm, with new formation of bands from sulfonation and carbonyl groups. In the third stage, the shelf life of the banana selected for investigation of fabricated chitosan/LLDPE with cinnamaldehyde film from uncoated and coated chitosan layer with various thicknesses (40, 60, 70, 80 micron). Analysis of the coated and uncoated chitosan of the fabricated chitosan/LLDPE film with Water vapour transmission rate (WVTR) test and Colour Peel test. For WVTR test, it was found that higher chitosan coating thickness of 80 micron resulted in lower WVP and lower total colour difference indicating prolong shelf life of banana until days 15 were analysed compared to uncoated Chitosan/LLDPE film with cinnamaldehyde.

ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious and the Most Merciful

Alhamdulillah

Firstly, all praises to Allah S.W.T for His guidance and blessing for giving me the strength and permission to completing this long and challenging journey successfully.

First and foremost, my special appreciation goes to my superior supervisors Prof. Ts Dr. Rahmah Mohamed and my Co- Supervisors Dr Raja Roslan Bin Mohamed, for their patience, continuous support, encouragement, support, ideas and suggestion during the process in completing this study.

I would like to express my appreciation to the Dean and Deputy Deans, Faculty of Applied Science for their support and help toward my postgraduate affairs. My acknowledgement is also goes to all the academic and non-academic staffs of Faculty of Applied Science, Universiti Teknologi Mara's (UiTM) polymer laboratory assistants who were willing to assist me in completing my sample preparation and testing. Thanks to Kementerian Pelajaran Malaysia for the financial support provided throughout my PhD study (MyPhD scholarship).

My Special appreciation goes to my beloved parents, Mr. Mohd Isa Bin Suradin and Mrs Zainah binti Yahya, my little sister, Ms.Siti Nur Atiqah Binti Mohd Isa, my husband, Mr Norkamaron bin Mohamad Yusak, my daughter Siti Maryam Medina Binti Norkamaron for their tremendous support, prayers and encouragements and helping me to survive all the stress I received from this year and not letting me give up. The most dedicated to the loving memory of my first late daughter Nor Aina Sakinah Binti Norkamaron for inspired the strength to 'ummi' completely the PhD journey. This piece of victory is dedicated to you. Alhamdulillah

Finally, I would also like to extend my sincere thanks to all my friend, especially all members of Postgraduate Room, for their ideas, motivation, help and moral support throughout my PhD journey. Thank you very much for the great memories.

Thank you very much

SITI AISHAH BINTI MOHD ISA, 2022

TABLE OF CONTENTS