PREPARATION AND CHARACTERIZATION OF INTELLIGENT PACKAGING BASED ON TORCH GINGER EXTRACT AND SAGO STARCH

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by

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A dissertation submitted in partial fulfillment of the requirements for the degree of
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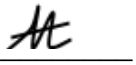
DECLARATION BY AUTHOR

This dissertation is composed of my original work and contains no material previously published or written by another person except where due reference has been made in the text. The content of my dissertation is the result of work I have carried out since the commencement of my research project and does not include a substantial part of work that has been submitted to qualify for the award of any other degree or diploma in any university or other tertiary institution.



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LIST OF ABBREVIATIONS

Abbreviation	Caption
µm	Micrometre
^{o}C	Degree celcius
cm	Centimetre
DPPH	2,2-diphenyl-1-picrylhydrazyl
E	Elongation at break
FTIR-ATR	Fourier transform infrared - attenuated total reflectance
FVs	Flavylium salts
g	Gram
GAB	Guggenheim-Anderson-Boer
GAE	Gallic acid equivalent
h	Hours
kg	Kilogram
kV	Kilovolt
L	Litre
mg	Milligram
min	Minute
mL	Millilitre
mm	Millimetre
MPa	Megapascal
N	Newton
nm	Nanometre
PVA	Polyvinyl alcohol

RFID	Radio frequency identification
RH	Relative humidity
rpm	Revolutions per minute
s	Seconds
SEM	Scanning electrostatic microscope
T	Toughness
T_g	Glass transition
TGE	Torch ginger extract
TGE0	Sago starch-based film without torch ginger extract
TGE1	Sago starch-based film with 10% of torch ginger extract
TGE2	Sago starch-based film with 20% of torch ginger extract
TGE3	Sago starch-based film with 30% of torch ginger extract
TS	Tensile strength
TTI	Time-temperature indicator
TVB-N	Total Volatile Basic Nitrogen
UV	Ultraviolet
UV-Vis	Ultraviolet-visible
v/v	Volume /volume
w/v	Weight/volume
w/w	Weight/weight
WVP	Water vapour permeability
YM	Young's modulus

LIST OF SYMBOLS

Symbol	Caption
%	Percentage
=	Equal to
<	Smaller than
±	Plus-minus sign
ΔE	Total colour difference
a*	Red to green
ANOVA	Analysis of variance
b*	Yellow to blue
cm^{-1}	Wavenumber
L*	Lightness
M	Molarity

PENYEDIAAN DAN PENCIRIAN PEMBUNGKUSAN PINTAR BERDASARKAN EKSTRAK BUNGA KANTAN DAN KANJI SAGU

ABSTRAK

Oleh sebab timbulnya kebimbangan mengenai kegunaan dan pembuangan plastik yang tidak terbiodegradasi yang semakin meningkat, ramai penyelidik memfokuskan penyelidikan pada penggantian bahan-bahan ini dengan sumber semula jadi dan biodegradasi pada tahun baru-baru ini. Satu lagi kategori penting iaitu pembungkusan pintas juga menarik perhatian. Kajian ini bertujuan untuk menghasilkan dan mencirikan filem sensitif terhadap pH berdasarkan kanji sagu dan digabungkan dengan antosianin dari bunga kantan untuk menunjukkan perubahan kualiti makanan melalui pengesanan perubahan pH produk makanan. Antosianin dari bunga kantan diekstrak dengan menggunakan pelarut termasuk etanol dan air. Filem sensitif terhadap pH dihasilkan dengan kaedah pemutus dan digabungkan dengan kepekatan ekstrak bunga kantan (TGE) yang berbeza (0%, 10%, 20%, 30%). Ketebalan, kandungan kelembapan, isotherm penyerapan kelembapan, sifat mekanikal, kebolehtelapan wap air, kelarutan air, warna, spektroskopi Fourier Transform Infrared (FT-IR) dan morfologi filem dianalisis dan diselidiki. Kekuatan tegangan, kekuatan, modulus muda dan kebolehtelapan wap air menurun setelah menambahkan TGE sementara pemanjanganpada waktu rehat, ketebalan, kandungan kelembapan dan kelarutan air meningkat. Variasi warna bagi filem sensitif terhadap pH diukur dengan menggunakan colorimeter setelah merendam filem dalam pH buffer yang berbeza (pH 4, pH 7, pH 9). Filem yang mengandungi 30% TGE adalah lebih sesuai digunakan dalam aplikasi kerana filem ini dapat dikesan oleh mata manusia dalam julat pH yang luas. Justeru, filem sensitif terhadap pH yang dihasilkan dengan penggabungan ekstrak bunga

kantan berpotensi untuk memainkan peranan sebagai pembungkusan pintar untuk mengesan kerosakan makanan dengan kelebihannya, iaitu proses pembuatan yang mudah, biodegradasi dan penggunaan sebatian semula jadi.

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ABSTRACT

As the concern about the irresponsible usage and disposal of non-biodegradable plastic are arising, researchers are focusing on the substitution of these materials with natural and biodegradable sources. Thus, intelligent packaging has focused on its development as it can exhibit or provide the function of pH changes which can help to detect the freshness of food product. This study was to develop and characterize pH-sensitive films based on sago starch and incorporated with anthocyanin from torch ginger to detect the quality of food products though pH changes. The anthocyanins were extracted with solvent including ethanol and water. The pH-sensitive films were fabricated by casting method with incorporation of different torch ginger extract (TGE) concentration (0%, 10%, 20%, 30%). Thickness, moisture content, moisture sorption isotherm, mechanical properties, water vapour permeability, water solubility, colour, UV-Vis spectroscopy, Fourier Transform Infrared (FT-IR) spectroscopy and morphology of the films were analyzed and investigated. The tensile strength, toughness, young modulus and water vapour permeability decreased after adding TGE, while elongation at break, thickness, moisture content and water solubility increased. The colour variations of pH-sensitive films were measured by a colorimeter after immersion in different pH buffer (pH 4, pH 7, pH 9). The films containing 30% TGE were more suitable for application because it is detectable by human eye over a wide pH range. Thus, the developed pH-sensitive film with torch ginger extract has potential as intelligent packaging for the detection of food spoilage as natural dye was used and the films produced were biodegradable.