UNIVERSITI TEKNOLOGI MARA

# DEVELOPMENT OF INTELLIGENT PACKAGING FILM FROM SOFT-GEL CAPSULE WASTE AND SAGO FLOUR INCORPORATED WITH RED CABBAGE (*BRASSICA OLERACEA)* LEAVES WASTE EXTRACT

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MSc

November 2019

# ABSTRACT

Visual pH indicator film is one of intelligent packaging system which had introduced to provide the information on the food product condition based on its colour changes. This study aims to develop a new intelligent packaging film from soft-gel capsule waste and sago flour incorporated with Red cabbage (*Brassica oleracea*) leaves extract. For raw materials characterization, the source of gelatin, starch, glycerol and anthocyanin compound were detected from the purified soft-gel capsule (PSC), sago flour (SF) and red cabbage leaves waste extract (RCE) by using the FTIR analysis. The thermogravimetric analysis was performed to identify the suitable heating temperature for PSC and SF which does not exceed 118.15°C and 193.26°C. During film formulation, the central composite design (CCD) was employed to determine the effect of PSC and SF concentration with a fixed concentration of RCE on the thickness (mm), tensile strength (MPa), elongation at break (%) and Young's modulus (MPa) of the film. The film with 0.263 g/ml of PSC and 0.02 g/ml of SF was chosen as the optimum formulation by considering the maximum tensile strength and elongation at break of the film by using Response Surface Methodology (RSM) software. For characterization of the film, the possible molecular interaction between film components after film development was studied by FTIR analysis. The addition of RCE to the film significantly reduced the water vapour permeability of the film from 12.241 g/m2.day to 9.793 g/m2.day. The film with RCE exhibited colour variation from red to green colour after immersion in different pH buffer and have visually perceptible by having the value of ΔE greater than 1. Other than that, the RCE also improved the antioxidant properties of the film by increasing the phenolic content of the film from 0.496±0.1766 to 2.19±0.5361 μg of GA/g and increased the percentage of DPPH scavenging activity from 8.17±1.1623% to 88.78±0.8271%. The extract from red cabbage leave waste also makes the film performed as an antimicrobial property by exhibit the intermediate response of *E.coli* bacteria towards the film after 24 hours of culture. Therefore, the film based on food-grade by-products from pharmaceutical and agricultural industries has the potential to be used for the development of low-cost intelligent packaging film and applicable for determining the bean sprout spoilage.

# ACKNOWLEDGEMENT

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

Firstly, I wish to thank Allah (S.W.T) for giving me the opportunity to embark on my master and for completing this long and challenging journey successfully. First and foremost, I would like to express my sincere gratitude to my supervisor Dr. Siti Noor Suzila Binti Maqsood-ul-Haque for her supervision and continuous support. Her invaluable help, motivation and immerse knowledge while completing this study are gratefully praised.

My appreciation goes to all the academic staffs and non-academic staffs in the Faculty of Chemical Engineering who provided the facilities and assistance during my study at University Teknologi Mara (UiTM) Shah Alam.

I also wish to thank the Institute of Research Management and Innovation (IRMI) for funding the project through BESTARI fund (Project code: 600-IRMI/DANA5/3/BESTARI (059/2017). Without the fund, the study will not be successfully completed.

Special thank also goes to my best friends, especially Akmal Hafiz, Faridatul Akmal, Azianna Gusniah, Izni Mariah, Zatul Iranati, Fatin Alia and Nurul Shuhada for always given me motivation and moral support while completing this study.

Finally, my deepest gratitude goes to my beloved parents, Mohamad Asri bin Hamid and my husband, Muhammad Firdaus bin Muhammad Ridzwan, and my sister, Nur Aniqah Syamimi for their endless love, prayers and encouragement. Their love has always given me the strength to face any problems or obstacles endured.

To those who indirectly contributed to this research, your kindness means a lot to me

Thank you.

***NUR ASSYIQAH SYUHADA MOHAMAD ASRI, 2019***

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# CHAPTER ONE
# INTRODUCTION

## 1.1 Research Background

In recent years, there were many new technologies for food packaging introduced to suit consumer behaviour, product demand and the current level of global warming. As demand in the food manufacturing industry increases, types of packaging become a vital component to ensure that the quality of the food product is maintained from any physical, chemical and environmental damages. Food packaging also can be defined as a system to protect the product to satisfy the ultimate consumer during transportation, distribution, storage, retailing and end-user with an optimum cost [1]. As stated by The World Packaging Organization (WPO), more than 25% of food wasted due to poor packaging system including preservation, protection and storage [2]. Thus, the goal for food packaging is to reduce the amount of food waste to provide cost-effective ways that satisfy industry requirement.

For many years, petrochemical-based plastics originated from crude oil such as polystyrene (PS), polyamide (PA), polyethylene terephthalate (PET) and polyethylene (PE) are widely used in food packaging application. These materials have large availability at relatively low cost, good mechanical performance, provide an excellent barrier of oxygen, carbon dioxide and aroma compound, heat stability and available corresponding to its capability and durability [3]–[6]. According to Ritchie (2018), there were more than 381 million tonnes of plastics generated for current global consumption by the year 2015, and most of it was made up of petroleum [7]. In Malaysia, National Solid Waste Management Department Ministry of Housing and Local Government claimed that production of plastics has increased drastically year by year, and the demand for plastic material in Asia also has increased rapidly since 1980 which is from 2 kg/year per capita to 27 kg/year per capita at the end of 2010 [8].

However, these petroleum-based plastics gives a terrible impact on the environment due to its non-biodegradability that may lead to serious environmental problems such as climate change and pollution. These materials required hundreds of years to degrade due to their resistance to microbial degradation and tend to contaminate the food due to the presence of the carcinogenic substance. It is harmful to