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TITLE:

Characterization Of Bioplastic Derived From Tapioca Starch And Its Degradation In Soil

SUPERVISOR:

Prof. Madya Ts. Dr. Sarifah Fauziah Syed Draman

SCHOOL OF CHEMICAL ENGINEERING

COLLEGE OF ENGINEERING

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Author's Declaration

" I hereby declare that this report is the rest of my own work except for quotations and summaries which have been duly acknowledged."

Name of Student	:	Lela Zaidatol Akmal Binti Zainol Abidin
Student ID No.	:	2022481832
Programme	:	Diploma in Chemical Engineering
College/School	:	College of Engineering / School of Chemical Engineering
Signature of Student	:	
Date	:	12 February 2025

Abstract

Plastic pollution is a significant global challenge, prompting the search for eco-friendly alternatives such as bioplastics. Commercial tapioca starch-based bioplastics are a promising solution due to their biodegradability and compatibility with the natural environment. However, the efficacy and practicality of tapioca starch-derived bioplastics depend heavily on their properties. additionally, their degradation in soil plays an essential role in evaluating their environmental impact and viability as substitutes for conventional plastics. This study aims to characterize the properties of commercial bioplastics derived from tapioca starch and examine their degradation in soil to assess their environmental impact. The characterization was conducted using various testing methods (soaking in water, water absorption, moisture absorption, and solubility test) to evaluate the physical and chemical properties of bioplastic samples. The detection of functional groups in the bioplastic samples buried in soil was analyzed using Fourier Transform Infrared (FTIR) Spectroscopy. In addition, the degradation of bioplastics was studied by burying samples in soils from two distinct locations, UiTM Campus Kuala Terengganu (5°15'48.5"N 103°09'53.7" E) and Al-Muktafi Billah Shah (AMBS) (4°36'12.8"N 103°12'38.3" E), which have experienced plastic contamination over time. The findings revealed noticeable swelling and softening of the bioplastic material, indicating partial disintegration during the four-week immersion test. Percentages of water absorption and moisture retention were recorded at 12% and 9.15%, respectively. Solubility tests indicated that the bioplastic resists dissolution in water but reacts more actively with alcohol-based solvents and alkaline solutions when exposed to varying temperatures (room temperature and elevated temperatures of 60°C–75°C). Additionally, FTIR spectral analysis identified peaks at ranges of 3200-3600 cm^{-1}, 1640–1740 cm^{-1}, and 1000–1200 cm^{-1}, corresponding to O-H stretching, C=O stretching (carbonyl groups), and C-O-C stretching, respectively. These findings affirm the presence of tapioca starch-based bioplastic in soil samples. In conclusion, this research provides valuable insights into the functionality and environmental behavior of bioplastics derived from tapioca starch. Further investigations are essential to assess how bioplastics affect soil quality over extended durations.

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CHAPTER ONE

BACKGROUND

1.1 Introduction

Plastics have revolutionized the modern world, becoming a cornerstone of countless industries and applications. Derived primarily from petrochemical feedstocks, conventional plastics are synthetic polymers characterized by their lightweight nature, durability, and versatility. (Kaur, 2024) Their ability to be folded into a wide array of shapes and forms has led to their widespread use in industries ranging from packaging and construction to automotive and healthcare.

However, in terms of environmental consciousness, plastic bag waste has become one of the main global challenges. (Klein et al., 2019) Particularly, it is because they are non-biodegradable and persist in ecosystems for hundreds of years. Traditional plastic bags contribute to pollution, wild wildlife, and make worse the problem of overflowing landfills. According to a study published, approximately 8.3 billion metric tons of plastic have been produced since the 1950s with only 9% being recycled, emphasizing the pressing need for sustainable alternatives. (Geyer et al., 2017)

In response to these challenges, bioplastic bags have emerged as an eco-friendly alternative. By 2050, it is estimated that 26 million tonnes of plastic post-consumer garbage will be created, with half of it being discarded in the environment, posing a perennial waste management problem. (Guglielmi, 2017) These bags are designed to break down into natural elements like water, carbon dioxide, and biomass within a relatively short period under specific environmental conditions. Made from renewable materials such as tapioca, bioplastic bags reduce reliance on fossil fuels and minimize the environmental footprint. Lastly, bioplastics offer a promising solution to mitigate the long-term environmental impact of plastic waste. (Mastrolia, 2022)