UNIVERSITI TEKNOLOGI MARA

BIOSYNTHESIS OF TIN(IV) OXIDE NANOPARTICLES FROM LEAVES EXTRACT OF *C. odorata*, *A. malaccensis* AND *P. amaryllifolius* FOR METHYLENE BLUE DEGRADATION

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

Faculty of Applied Sciences

November 2024

ABSTRACT

This study explores a green biosynthesis approach using extracts from *Chromolaena odorata*, *Aquilaria malaccensis* and *Pandanus amaryllifolius* leaves, which are rich in flavonoids, as reducing and capping agents. The approach exhibits novelty by being both rapid in production and effective in the photodegradation of methylene blue. The extracts were mixed with a tin chloride solution at ambient conditions, followed by calcination. Characterization through XRD and FTIR confirmed that the SnO_2 NPs exhibit a rutile phase with a tetragonal structure, with Sn-O and Sn-OH stretching vibrations identified around 900 and 1100 cm^{-1}. HRTEM analyses showed spherical SnO_2 NPs with sizes of 7.68, 9.41 and 7.63 nm. UV-DRS tests revealed energy band gaps of 3.00, 3.12 and 2.79 eV, sufficient to absorb photons for photocatalytic applications. Lattice spacings of 0.3311, 0.3296 and 0.3300 nm, coupled with homogeneous distribution and electronegative charge, further supported their effectiveness. Photocatalytic tests using methylene blue dye under UV irradiation demonstrated high degradation efficiencies of 97%, 94%, and 80% at neutral pH, outperforming both acidic and alkaline conditions. This suggests that, when compared to the other two plant materials, *C. odorata* has demonstrated the greatest significance as a biotemplate for SnO_2 NPs photocatalyst. Furthermore, SnO_2 NPs exhibited high stability and reusability for up to five cycles. In summary, this biosynthesis method for SnO_2 NPs is straightforward, cost-effective, and environmentally friendly, producing highly stable and reusable photocatalysts.

ACKNOWLEDGEMENT

Firstly, I wish to thank Allah for granting me the opportunity to embark on my PhD journey and for seeing me through this long and challenging path to its successful completion. My deepest gratitude goes to my supervisor, Assoc. Prof. Dr. Zuraida Khusaimi and Prof. Dr. Mohamad Rusop Mahmood for their endless guidance and support throughout my studies.

My appreciation also goes to the researchers at the Nano-SciTech research laboratory: Assoc. Prof Ts. Dr. Mohd Firdaus Malek, Ts. Dr. Noor Asnida Asli, Dr. Mohd Husairi Fadzilah Suhaimi, Dr. Asiah Mohd Nor, Mrs. Rabiatuladawiyah Md Akhir, Mrs. Maryam Mohammad and Mr. Kevin Alvin, who consistently helped me solve problems during my studies. Special thanks to the administrative staff, namely Salifairus, Mohd Azlan and Muhamad Faizal, Norashikin, Hasdiyana and Shajaratul Faseha for their support and assistance with technical facilities during experimental activities. Also sincere thanks to Zul Khafiz Mohd Khalid and Mohd Nordin Mustapha for their encouragement. Additionally, I would like to extend my heartfelt thanks to the postgraduate students who cooperated with me, especially Nur Fairuz, Zahidah, Najwa Ezira, Nurul Hidah, Nurul Afaah, Hafsa, Nurfarhana, Nurfazianawatie and Nur Syazwani.

Finally, this thesis is dedicated to my loving family: my better half, my husband Mohd Rozi Jusoh, and our four children, Muhammad Harith Akram, Nur Hafiya Arissa, Nur Hannis Auni and Nur Hayfa Aisyah. Thank you for all your understanding and empathy during the challenging times I faced while completing this thesis. This PhD thesis is also for you. Without a doubt, I wholeheartedly embrace my wonderful self for the hard-fought struggles and unwavering determination. The sweat and tears have finally paid off. Alhamdulillah.

TABLE OF CONTENTS

CHAPTER ONE
INTRODUCTION

1.1 Nanotechnology

Nanotechnology is a multidisciplinary science that involves construction, modulation, imaging, and measurement of nanoscale particles and ascribes at the molecular level between 1 and 100 nm. The advent of nanotechnology has provided sprawling research in recent years by interconnecting with various other branches of science and offers great propositions to human life and the environment. Nanotechnology's main advantage is the enhancement of the material properties that make them different from their bulk counterparts. The newly-nanotechnology-developed material consists of a larger large surface area to volume ratio, which modified physical and chemical characteristics compared to its original chemical existence [1]. It is known that the applications of nanotechnology are incredible growth, in which it is widely utilized in various fields such as biomedical [2], antimicrobial [3], drug development [4], chemical production [5], electronics [6], catalytic activity [7], electron transistor [8], energy [9], space [10] optical application [11] and etc. To this point, the modern designed batteries, solar and fuel cells happened to be lighter, robust, and more rigid thermally and chemically stable than conventional methods after nanotechnology was embedded in the process [12][13].

1.2 Metal Oxide Nanoparticles

Metal oxides nanoparticle is a valuable class of nanomaterials that finds several applications in technological sciences materials due to their attractive magnetic, electronic and optical properties, in which it offers unique properties as sorbents, catalysts, sensors, reducing agents, and bactericides attributed to its fast kinetics and enhanced sorption capacity [14]. The commonly found metal oxides are zinc oxide (ZnO), copper oxide (CuO), titanium oxide (TiO_2), tin oxide (SnO_2), silicon oxide (SiO_2), magnesium oxide (MgO) and many more. The size of metal oxide nanoparticles is within a nanoscale scope, originating from artificial methods or naturally occurring. Due to this range of advantages, metal oxide nanoparticles have become a preferential