UNIVERSITI TEKNOLOGI MARA

OPTIMIZATION OF THE BIOSYNTHESIS OF COPPER NANOPARTICLES USING *ANANAS COMOSUS* (MD2) LEAVES EXTRACT AND THEIR IN VITRO ANTIFUNGAL ACTIVITY AGAINST *FUSARIUM SOLANI, CURVULARIA* SPP., AND *COLLETOTRICHUM GLOEOSPORIOIDES*

NUR DIYANA BINTI ZULPAHMI

Thesis submitted in fulfilment
of the requirements for the degree of
Master of Science

Faculty of Plantation and Agrotechnology

September 2025

ABSTRACT

Environmental issues have arisen due to the substantial quantity of agricultural waste, particularly from the leaves of *Ananas comosus* (MD2). This research suggests a sustainable method by utilizing leaves gathered from Chin Chin, Melaka for the green synthesis of CuNPs, providing a cost-efficient and adaptable technique. The leaves extract serves as a reducing, capping, and stabilizing agent for aqueous $CuSO_4$ in the production of CuNPs with antifungal characteristics. The synthesis process was optimized, revealing a pronounced SPR peak between 266 nm in UV Vis DRS analysis. FTIR analysis confirmed the presence of functional groups associated with flavonoids, alkaloids, and terpenoids, which played a role in stabilization. FESEM imaging displayed CuNPs with spherical shapes and sizes of 39.59 ± 10.4 nm with 75.03% copper elemental composition. HRTEM measurements indicated spherical atomic shapes with 5.84 ± 1.3 nm in sizes. XRD and SAED analyses validated the crystalline structure, with peaks corresponding to the (111), (200), and (220) planes. After a month, stability assessments indicated that copper oxidation impacted the stability and structure of the CuNPs. Antifungal evaluations were performed using varying doses (2, 4, and 6 mL) of colloidal CuNPs against 20 µL of 1×10^6 conidia/mL of *Fusarium solani*, *Curvularia* spp., and *Colletotrichum gloeosporioides* through the food poison method. The results demonstrated a reduction in fungal growth, achieving complete inhibition of *Colletotrichum gloeosporioides* at a dosage of 6 mL. The synthesized CuNPs exhibited the highest efficacy against this particular species. Statistical analysis revealed significant outcomes ($p < 0.01$) and vigorous correlations among treatment factors. These results underscore the potential of CuNPs synthesized using the extract of *Ananas comosus* (MD2) leaves as a promising antifungal agent for agricultural applications.

ACKNOWLEDGEMENT

First and foremost, I express my heartfelt gratitude to God for His grace and guidance during this journey. Without His blessings, the completion of my MSc would not have been achievable. This thesis is dedicated to the cherished memory of my parents, whose sacrifices, support, and aspirations formed the foundation of this accomplishment.

I wish to convey my profound appreciation to my supervisor, Ts. ChM. Dr. Wan Zuraida Wan Mohd Zain, for her unwavering guidance, encouragement, and invaluable insights. Additionally, I extend my thanks to my co-supervisor, Madam Siti Aisha Naílla Che Musa, and the entire FRGS team for their crucial support.

My gratitude extends to the Ministry of Higher Education Malaysia (MOHE) for financing this research through the FRGS [Grant Number: FRGS/1/2022/STG01/UITM/03/2]. I also appreciate the contributions of the Malaysian Pineapple Industry Board (MPIB), Johor Bahru, particularly Mr. Sharifuddin Bin Murad for providing the *Ananas comosus* (MD2) leaves utilized in this study.

I would like to offer special thanks to Ts. ChM. Dr. Irmaizatussyehdany Buniyamin for her assistance with the UV-Vis DRS, XRD, and FTIR analyses, which greatly enriched this work. I am also thankful to Prof. Madya Dr. Fazlena Hamzah for her support with data analysis using OriginPro 2024, and to Madam Nurul Wahida RamLi for her guidance in antifungal research. Furthermore, I am grateful to Madam Nur ‘Amira Hamid for facilitating the MPIB collaboration, and to Dr. Nuraini Mohd Noor for funding the fungal study.

I wish to thank all the lab assistants, particularly Natasha Afzan Tamby Husin, Wan Azizi Wan Mat, Muhamad Nazwan Kudori, Dahyudeen Dahlan, Annuarzamani Che Youb, and Noor Azlin Baharudin, for their technical assistance throughout this research.

I extend my heartfelt gratitude to my esteemed friend, Aida Khalida Hamdan, for her unwavering support, friendship, and for introducing me to UiTM Jasin, an institution that significantly influenced my academic journey. Her encouragement has genuinely made a substantial impact. Additionally, I express my appreciation to my junior, Amira Hazwani Ghazali, for her companionship and support during the trials of postgraduate life, which has enriched this experience immensely.

TABLE OF CONTENTS

CHAPTER 1
INTRODUCTION

1.1 Research Background

The environmental problems caused by agricultural waste are exacerbated by improper disposal methods associated with the peels, stems, seeds and leaves that make up a significant portion of the waste generated during the processing of *Ananas comosus* (pineapple). With the continued global increase in the production and processing of this fruit, the problem of agricultural waste is becoming increasingly important (Hikal et al., 2021). Currently, a large amount of organic waste is either incinerated under suboptimal conditions or discharged into water bodies, posing a significant threat to public welfare (Aswathi et al., 2023). In addition, careless handling of agricultural waste can lead to a surge in the number of rodents and insects that may exceed the permissible limits, thus threatening the well-being of humans and the environment (Nagendran, 2011). The buildup of biodegradable waste can contaminate ecosystems, establishing conditions favorable for the rapid growth of microorganisms. These microbes are capable of spreading a range of illnesses to people, flora, and fauna. Burning this type of waste not only produces malodorous compounds but also discharges greenhouse gases such as carbon dioxide and methane. Furthermore, the buildup of waste can create habitats for rodents and mosquitoes, which act as transmitters for a variety of illnesses (Aswathi et al., 2023). However, this issue also presents a substantial chance to adopt eco-friendly methods focused on transforming *Ananas comosus* waste into beneficial goods. Unlike traditional waste management methods such as landfills disposal, open dumping, and uncontrolled burning, a more environmentally friendly approach prioritizes strategies such as reducing production, waste segregation, material reuse, recycling, and waste-to-energy conversion (Afonso et al. 2024). A particularly encouraging method for managing biodegradable waste is the green synthesis of nanoparticles. This method utilizes natural biological entities as stabilizing and reducing agents in the production of nanoparticles (Afonso et al. 2024). The field of nanomaterials research and development has witnessed a surge in the adoption of green synthesis techniques. This surge is driven by the urgent need to address the environmental concerns associated with conventional methods. Green synthesis is firmly grounded in the principles of