CHAPTER I

INTRODUCTION

I.1. Research Background

Agricultural production can play a pivotal role in poverty alleviation and food security in developing countries. Higher agricultural output indicates greater food availability, thereby supporting a sustainable food supply. According to Mozumdar, developing countries exhibit a positive correlation between agricultural production, poverty reduction, and food security (Fan *et al*., 2024) One of the key factors contributing to the intensification of crop production is the intervention of fertilizer application within the production sector (Zheng *et al*., 2022).

Fertilizers are essential for supplying the nutrients required by the soil to support seed germination and subsequent plant growth, thereby promoting agricultural productivity (Zaib *et al*., 2023). The application of various types of fertilizers, including chemical fertilizers, plays a crucial role in maintaining soil fertility and achieving high crop yields (Liu *et al*., 2024) However, excessive use of chemical fertilizers has led to numerous environmental concerns, including greenhouse gas emissions, soil and water degradation, as well as biodiversity loss and the decline of ecosystem services due to severe chemical contamination (Fan *et al*., 2023)

Recent advances have enabled the use of carbon quantum dots (CQDs) as nanofertilizers, which can penetrate plant tissues and be absorbed directly without microbial decomposition. CQDs enhance nutrient use efficiency, reduce soil

toxicity, and lessen dependence on chemical fertilizers. Their structural properties allow for controlled nutrient release and improved uptake, while their ultrasmall size (<100 nm) and large surface area support plant metabolism and efficient soil–plant interactions (Kumar *et al*., 2022)

The synthesis of carbon quantum dots (CQDs) can be derived from biomass sources, including durian shell. Its main constituents are cellulose, hemicellulose, and lignin, which collectively account for approximately 60–70% of the total composition (Tan *et al*., 2017). Previous studies have demonstrated the conversion of durian shell into organic fertilizers such as compost or biochar. However, the performance of biochar is strongly affected by factors such as feedstock properties, soil conditions, and biotic interactions (Xin *et al*., 2024). Its abundant carbonaceous composition positions durian rind as a sustainable and promising precursor for CQDs synthesis, enabling value-added applications that extend beyond conventional approaches.

In light of these limitations, this study focuses on the synthesis of carbon quantum dots (CQDs) from durian shell using the hydrothermal method, followed by their characterization and evaluation of their activity as nanofertilizers in plant growth. This work is presented under the title of "Synthesis of Carbon Quantum Dots (CQDs) from Durian Shell, Characterization, and Activity Test as Nanofertilizer on Bok Choy Cultivation". This study aims to obtain CQDs with high photoluminescence intensity and expected to provide a substantive contribution to waste-to-wealth conversion and the development of sustainable and environmentally benign nanofertilizers on bok choy cultivation.

I.2. Research Objectives

The overall objectives of this study are outlined below:

1. Synthesis CQDs from durian shell through hydrothermal method with variations in temperature and reaction time.
2. Determine the characteristics of CQDs through photoluminescence (PL) spectrometer, Fourier transform infrared (FTIR) spectrometer, and zetasizer.
3. Assess the activity of CQDs as nanofertilizer on bok choy (*Brassica rapa*) under wick hydroponic cultivation.