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DISSERTATION OUTLINE

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Chapter 1. Introduction

In this chapter, the background and objectives of the hydrothermal treatment (HTT) of biomass waste for nutrient recovery are explained. The relationship between agriculture production, energy and fertilizers as well as their trends in the future is firstly introduced. The concept of bio-based fertilizer is mentioned, and poultry residues as potential renewable sources of nutrients for fertilizers are presented. The current review of poultry feather (keratin waste) conversion technology is introduced with strong attention to hydrothermal treatment technology. Furthermore, the brief literature review regarding nitrogen fertilizer management is presented. Finally, the objectives and the originality of this research are stated.

Chapter 2. Effect of reaction parameters on hydrothermal treatment of poultry feather

In this chapter, chicken feathers as model keratin wastes were subjected to HTT at mild reaction conditions ($160\text{ }^{\circ}\text{C} < T < 200\text{ }^{\circ}\text{C}$, $0.6\text{ MPa} < P < 1.53\text{ MPa}$) for 30 min, and the effect of the HTT temperature and catalyst (lime) addition on the feather solubilization rate, the total organic carbon (TOC), the total forms of N (NO_3^- , NH_4^+ and amino acids), and physicochemical properties of the liquid products were investigated. Moreover, the protein breakdown mechanism was studied based on FTIR analysis and literature study.

Chapter 3. Nitrogen mineralization of chicken-feather hydrolysate obtained through hydrothermal treatment

In the Chapter 2, HTT with mild reaction temperature ($180\text{ }^{\circ}\text{C}$ and 1.0 MPa) and lime addition was found very effective to solubilize feather protein and produce the liquid product with a high N content. Understanding mineralization features of organic N from different types of hydrolysate produced in different conditions is essential for optimization of the process and fertilizer recommendations in terms of rates, time and placement. Therefore, in this chapter the attention was directed to determine the N

mineralization characteristics of chicken feather hydrolysate produced from the HTT process by conducting the incubation experiment. In this study, four liquid feather-hydrolysates produced by HTT under various temperatures and one commercial liquid fertilizer were added to two adjacent soils (kuroboku and paddy soils) and evaluated for the nitrogen mineralization behavior in a 30-day incubation study.

Chapter 4. Effect of feather-derived protein hydrolysates (FPH) produced through hydrothermal treatment on growth and yield of patchouli (*Pogostemon cablin Benth*) and mung bean (*Vigna radiata*)

The objective of this chapter is to test the performance of the liquid product obtained from the pilot-scale HTT treatment of feathers. Two crops, patchouli and mung bean, were planted to test the efficacy of feather protein hydrolysate (FPH) application. A field test experiment was conducted in a randomized block design to evaluate the effect of application of sole FPHs (dosage varied: 0-5 ml/l FPH), inorganic fertilizers (commercial urea, SP36, KCl) and combination of FPH and reduced-dosage inorganic fertilizer (50% recommended dose) on the growth of patchouli and mung bean.

Chapter 5. Stability of feather keratin-, manure- and lignocellulose-derived hydrochars on sandy soils

In this chapter, the potential utilization of the solid residue (feather hydrochar) was investigated. Considering that feather hydrochar still has a high N content, the possibility to utilize as a soil amendment is discussed. As agricultural soil amendment, nutrients contained in the hydrochar can be released which make char degradation more appropriate than C sequestration. Therefore, there is competition between the stability and functionality of char related to the specific use. The study is focused on the stability of hydrochar by performing hydrochar characterization and C-N mineralization. In this study, the stability of feather hydrochar is compared with other typical hydrochar, including bagasse- and manure-based hydrochar.

Chapter 6. Conclusions and recommendations

In this chapter, major results and findings of the study are summarized and recommendations for further work and implementation of this research are suggested.