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# 論文概要

(Summary of the Thesis/Dissertation)

Student ID: 201736052
Student Name: Sekove VODO

## 1. Title of the Thesis/Dissertation:

Valorization of Sugarcane Bagasse as Novel Emulsifiers by Hydrothermal Liquefaction Technology

## 2. Summary

As natural resources continue to be depleted and rise in greenhouse emissions, biomass valorizations are significant research interests for most governments and research institutes. Biomass resources are forestry residue, agricultural residues, marine products, and municipal solid, to name a few. As agricultural residue bagasse is the most abundant agro-industrial by-product and is composed of bagasse is 40–45% of cellulose, 20–30% lignin, 30–35% hemicelluloses and minor amounts of extractives and inorganic compounds. Cellulose is a linear homopolymer composed of d-glucopyranose units linked by β-1,4-glycosidic bonds. It is associated with hemicellulose molecule via hydrogen bonds and is linked to lignin through covalent bonds. Hemicelluloses are branched polymers of low molecular weight with a degree of polymerization, with xylans being the most abundant hemicellulosic polymers with enormous potential for industrial applications.

Bagasse is a highly productive candidate feedstock for valorization because it has a faster growth cycle and has a high yield compared to sorghum or switchgrass. With cell walls composition having high proportions of pentoses in the wall polysaccharides such as arabinoxylan, disintegrating the complex structure is a limitation. From an industrial viewpoint, thermochemical conversions such as combustion, gasification, pyrolysis and hydrothermal liquefaction (HTL) or a combination of each has been gaining interest for their robustness to treat biomasses. In hydrothermal liquefaction, water is an important reactant and catalyst, as a region of operation is between 150 to 370 °C and between 4 to 25 MPa. Water properties such as the high value of the ionic product of water (KW) in the subcritical range means that high levels of $H^+$ and $OH^-$ will accelerate biomass hydrolysis. Therefore, biomass not usually soluble at room temperature are potentially soluble in these conditions. Batch reactors are the most common type of reactor set up and eventually developed into a more advanced semi-continuous or continuous reactors. Also, HTL treatment is a much quicker, more efficient technique to solubilize and achieve complexation to compounds that have poor water solubility. As technologies continue to evolve, HTL is breaking into territories instead of being regarding as just a pretreatment technique such as it uses on emulsion systems. As a thermodynamically unstable system of two immiscible liquids, an emulsion is achieved by an emulsifier and a homogenization step. As much as synthetic additives dominate the food additives application, natural alternatives are more appealing, yet its availability and functionality are debatable. The work presented herein mainly focuses on the HTL treatment of bagasse and characterization as a natural emulsifier in Oil-water-emulsion.

Firstly, in a HTL reactor, 3% (w/w) grounded bagasse (500 µm) was treated at 160 °C, 30 min, and 1 MPa. For the 3% initial solid concentration used in this study, 47.4% of bagasse was solubilized, and 52.6% remained as insoluble solids. The composition of the bagasse extracts mainly composed of carbohydrates at 51.0%, with approximately 45% of the bagasse extracts existing as the higher molecular weight oligosaccharides other than xylotriose and xylobiose. Together with the presence of organic acids, phenolics compounds contributed to a lower pH of 3.9 detected after HTL. The use of such a treatment technique is an effort to promote more eco-friendly technologies with less dependency on the use of solvents.

Secondly, the liquefied portion separated and freeze-dried before re-dissolving it in 5 mM Phosphate buffer solution (0.5 - 4 wt%) as a continuous phase. Polytron (10,000 rpm, 5 min) and high-pressure homogenization (100 MPa, 4 passes) achieved O/W emulsions with soybean oil before storage at 25 °C.　3 wt%, bagasse extract from HTL was able to stabilize emulsion for 11 days at 25 °C with a dav of 0.79 µm. Likely, the adsorbed layers of the lignin-carbohydrate complex from the bagasse extracts stabilized the O/W emulsion through steric repulsion, and further studies are needed to characterize the potential surface-active macromolecular complexes in bagasse extract.

Lastly, investigating the mechanism stability of the bagasse extract-stabilized emulsions. Three samples, raw bagasse (RB), pith (P), and rind (R), all derived from different parts of the bagasse were treated with HTL and applied as emulsion the different bagasse extracts were able to stabilize emulsion using the high-speed polytron and high-pressure homogenizer. In comparison to RB-stabilized emulsion with 8.0 µm, both P and R-stabilized emulsion achieved 7.7 and 7.9 µm droplet sizes, respectively. The phenolic content in the RB-stabilized emulsion at the interface was 0.13 mg/g extract, while the content in the continuous phase was 0.12 mg/g with the stability of emulsions attributed to the high concentration of carbohydrate that sterically congregate at the aqueous phase

Bagasse extracts containing both hemicellulose and lignified compounds can be valorized using eco-friendly HTL treatment. Therefore, an agro-industrial by-product has potential for application in emulsion such as low-fat salad dressings but, more importantly, adding value through treatment and its applications.