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# Effect of thermochemically fractionation before hydrothermal liquefaction of herbaceous biomass on biocrude characteristics

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ABSTRACT

Hydrothermal liquefaction (HTL) of fractionated two types herbaceous biomass (kenaf and miscanthus) by dilute acid, organosolv, alkaline, or demineralization process was carried out under ethanol water co-solvent at 350 °C for 30 min to examine the biocrude yield and characteristics. The biocrude properties were comprehensively characterized by HPLC, elemental, GC-MS, and TGA analysis. Fractionation technologies before HTL effectively increased biocrude yield up to 38% compared to that of untreated herbaceous biomass (31%), except for organosolv fractionation of miscanthus, especially, HTL after alkaline fractionation showed high yield and energy recovery ratio up to 70%. Elemental analysis showed that HHV of biocrude was negatively affected by hydrolysis reaction of high lignin content after dilute acid fractionation. The GC-MS analysis revealed that carbohydrates-derived compound significantly increased in the biocrude obtained after organosolv and alkaline fractionation due to holocellulose increases through fractionation process. Additionally, TGA results indicated that the ratio of high-boiling-point compounds in biocrude obtained after demineralization was expanded compared with untreated due to ash removal, which could act as a catalyst.



## 1. Introduction

Fossils are used as the main resources for energy production around the world [1]. The problems such as global warming by releasing carbon dioxide arising from the usage of fossil resources can be solved by using biomass. Especially, lignocellulosic biomass derived fuel can be used as alternative fuel. Among lignocellulosic biomass, herbaceous biomass has various advantages such as low cost, eco-friendliness, and good growth, and thus is used as short-term annual non-food crop. It can also absorb heavy metals, chemicals, and $CO_2$, thus reducing environmental pollution [2,3]. Herbaceous biomass has macromolecules linked by chemical bonds such as ether, hydrogen, and C–C bonds and other substances, which must be broken down to light fragments through thermochemical processes [4].

Several reviews have been published on various aspects of hydrothermal processing, including fractionation, carbonization, liquefaction, and gasification using carbonaceous feedstocks over the years [5,6]. Hydrothermal liquefaction (HTL) has a number of advantages unlike other thermochemical technologies of biomass conversion, including the low operating temperature, high throughput, production of products with high energy density, and removal of oxygen from the products. Especially, the ability to use high moisture content feedstocks is one of the most relevant advantages of the technology [7,8], which makes water an excellent reaction medium [9,10].

Although HTL has various advantage, there is still the most crucial bottleneck that is the low yield of biocrude and conversion rate. Recently, many studies have been tried to enhance biocrude yield and quality by using partially ethanol instead of water [11]. Cellulose, hemicellulose, and lignin undergoes only hydrolytic degradation in water, while ethanol helps to dissolve the formed biocrude or the intermediate products, thus preventing the condensation of the intermediate products, which results in greatly increased biocrude yield but decreased solid residue yields [11]. Moreover, ethanol has been reported to be the most effective medium, because it (a) can enhance degradation of macromolecules

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