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PRODUCTION OF BIO COAL FROM DUCKWEED BY DRY TORREFACTION

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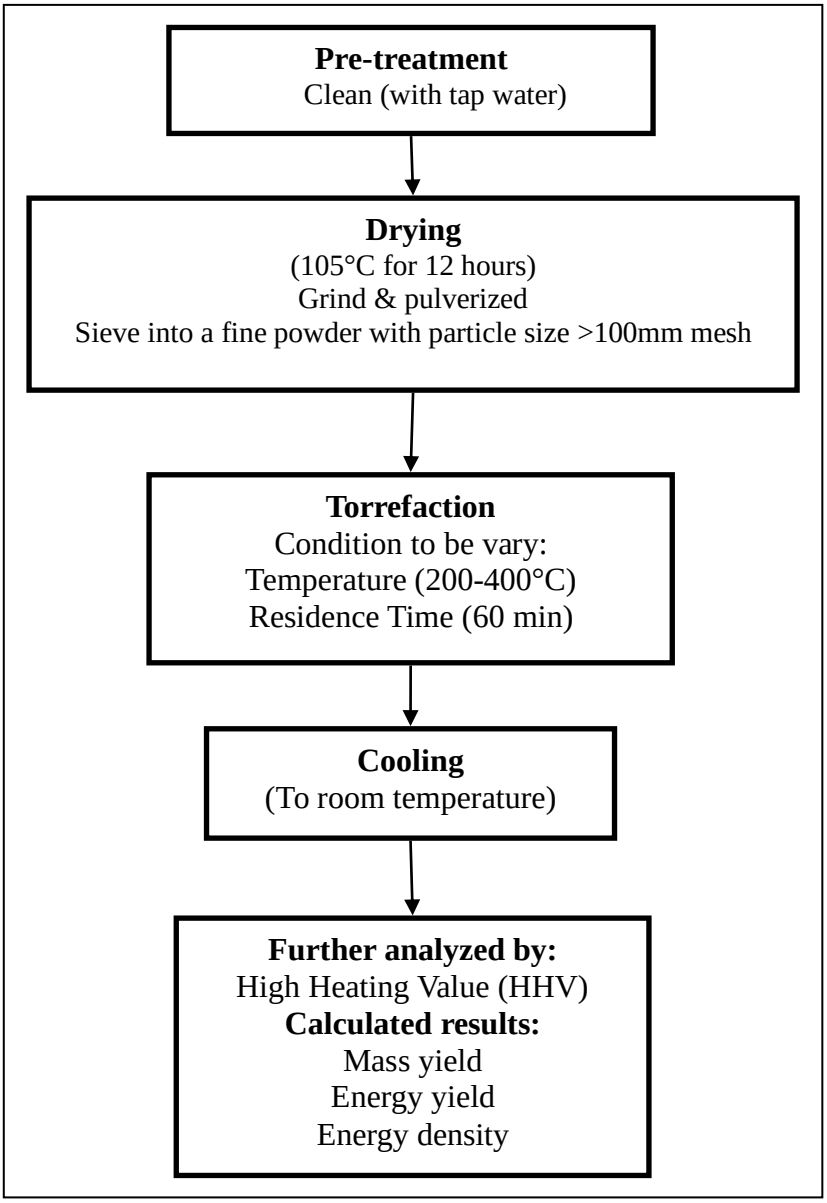
Abstract:
Dry torrefaction is a thermal process that convert biomass into a coal-like material. It is a process of heating of biomass in the absence of oxygen and water at temperature of typically 200 to 300 °C. This process does not only used to improve the structure of biomass, but increases its calorific value and energy density. Since the torrefaction process is still new, the scientific features of feedstock and chemical reaction kinetics, including physico-chemical changes, are not fully understood and the effects of reaction parameters are still being examined. Besides, duckweed and other aquatic plant has becoming a popular prospective source of biomass because of its high proportion of cellulose and starch and low lignin content. It becomes an ultimate choice because it requires minimum pretreatment compared with other biofuels feedstocks such as pine woods, bamboo and corn cob. This study is focused on determining the optimum operating condition for dry torrefaction of duckweed in order to transform into bio-coal and reviewing the fuel properties such as moisture content, higher heating value (HHV), O/C ratio, H/ C ratio and solid yield of bio-coal derived from duckweed. The series of experimental work of torrefaction process was conducted with constant residence time which is 60 minutes. The effect of temperature and flowrate of nitrogen as carrier gas was studied. The torrefied duckweed is analyzed using high heating value (HHV), proximate analysis and ultimate analysis. From the experimental result, severe torrefaction (400 °C) is not suitable for biomass due to very low solid and energy yield. Thus, 300 °C is chosen as the most suitable dry torrefaction temperature. Although the impact of nitrogen flow rate as carrier gas is uncertain, nitrogen supply of 90 ml/min was chosen as the optimum carrier gas used in duckweed torrefaction because it records the highest HHV at all temperature variations.

***Keywords*:**
Renewable energy, thermal conversion; torrefaction; duckweed,bio coal

Objectives:

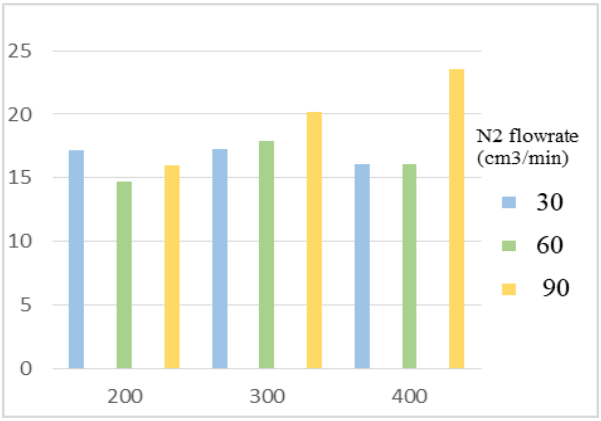
- To determine optimum operating condition for dry torrefaction of duckweed in order to transform into bio-coal.
- To review the fuel properties of duckweed based bio coal.

Methodology:

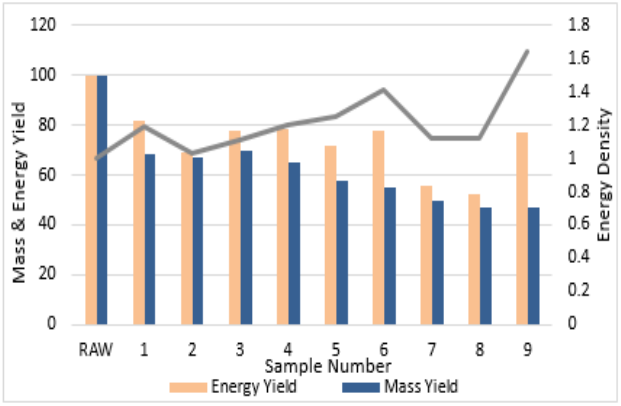


Results:

The values of higher heating value (HHV)



Mass yield, energy yield and energy density for torrefaction of duckweed samples



Conclusion:

This paper reports new experimental data on the production and characterization of bio coal derived from torrefaction process. Torrefaction temperature and holding time are the most important factor to affect the solid yield and quality of biochar. Production of bio coal with torrefaction process improves higher heating value (HHV) and energy yield. The HHV of torrefied duckweed and other biomass are similar to properties of coal fuel that have potential to replace fossil fuel in power generation plant. Besides, the transformation of duckweed to bio coal is a great alternative as it is a lignocellulosic biomass and can grow faster than other biomass and it produce new offshoots rapidly. From the results, 90 mL/min of nitrogen supply is chosen as optimum supply as it results to highest heating value at al temperature variation (200 °C, 300 °C and 400 °C). In addition, severe torrefaction (400 °C) is not suitable for biomass due to very low solid and energy yield, therefore, 300 °C can be considered to be the optimum reaction temperature for dry torrefaction of duckweed samples.