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# Characteristics of biochar produced from slow pyrolysis of Geodae-Uksae 1

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## HIGHLIGHTS

- Geodae-Uksae 1 (Giant *Miscanthus*) is a variety of *Miscanthus sacchariflorus* for energy crop.
- Ideal temperature to produce biochar by slow pyrolysis was 500 °C.
- The biochar had a mass yield of 27 wt.% at 500 °C with a carbon content of 79 wt.%.
- The surface area and large pores of biochar was well-developed at 500 °C for application to soil.

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## ABSTRACTS

This study investigated producing biochar from Geodae-Uksae 1 for soil applications to sequestrate carbon from the atmosphere and improve the productivity of crops. Using a lab-scale packed bed reactor, pyrolysis products of Geodae-Uksae 1 were produced over a temperature range of 300–700 °C with a heating rate of 10 °C/min. Pyrolysis at 500 °C was found appropriate for biochar production considering the properties of char and the amount of heat required. It yielded biochar of 27.2 wt.% that contained approximately 48% carbon in the raw biomass. The surface area of the biochar rapidly increased to 181 $m^2$/g. Large cylindrical pores with diameters of 5–40 μm developed within the biochar due to the vascular cell structure of the parent biomass. The byproducts (bio-oil and gases) were also analyzed for use as fuel.



## 1. Introduction

Geodae-Uksae is the Korean term for giant *Miscanthus*. Geodae-Uksae 1 is a variety of *Miscanthus sacchariflorus* (Amur silvergrass) recently discovered in Korea (Moon and Koo, 2011) that grows approximately 4 m tall with an average stalk diameter of 1 cm, which is approximately twice as tall and thick as common *M. sacchariflorus*. The mass yield of the dry stalk is as much as 30 ton/ha, which is twice that of common *Miscanthus*. Due to the superior yield, Geodae-Uksae 1 is being mass-cultivated in Korea as an energy crop for bioenergy. Various methods are being considered for the energy conversion of Geodae-Uksae 1, including hydrolysis and fermentation for bioethanol production, combustion through pelletization and fast pyrolysis for the production of bio-oil.

This study investigates a method for producing biochar from Geodae-Uksae 1 for the sequestration of carbon in soil and to increase the productivity of various food crops (Lehmann, 2007). Biochar is the highly carbonaceous solid product of the pyrolysis of biomass, which can be used to improve the yield of various agricultural crops as a soil amendment. Due to its strong resistance to biological decomposition, the carbon in biochar can be removed from the atmosphere to mitigate climate change. Since carbon originates from atmospheric carbon dioxide, the application of biochar to soil may contribute to reductions of $CO_2$ concentration. Biochar has been used in horticulture and agriculture with its appearance in literature as early as 1697 (Lehmann and Joseph, 2009). Biochar has drawn interest from a wider scientific community due to a study by Lehmann et al. (2003) examining the sustained fertility of Amazonian dark soil, also known as Terra Preta. When applied to soil, biochar can effectively retain nutrients and water, and therefore reduce the need for fertilizers. In addition to carbon removal, biochar in soil reduces the emissions of other major greenhouse gases, such as $N_2O$ and $CH_4$ (Van Zweiten et al., 2009), which have a global warming potential of 298 and 25, respectively, compared to the greenhouse effect of $CO_2$ over a 100 year period (IPCC, 2007). These

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