Geophysical Research Abstracts
Vol. 15, EGU2013-805-1, 2013
EGU General Assembly 2013

Biochar characteristics produced from malt spent rootlets

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Biochar is a carbon-rich material produced by heating biomass in an oxygen-limited environment. Biochar is mainly used as an additive to soils to sequester carbon and improve soil fertility as well as a sorbent for environmental remediation processes. Surface properties such as point of zero charge, surface area and pore volume, surface topography, surface functional groups and acid-base behavior are important factors, which affect sorption efficiency. Understanding the surface alteration of biochars increases our understanding of the pollutant-sorbent interaction. Malt spent rootlets (MSR) is a by-product formed during beer production, is inexpensive and is produced in high quantities. The objective of the present study was to characterize the surface properties of biochar produced from MSR, and to investigate the effect of thermal treatment conditions on key characteristics that affect sorptive properties.

The surface area, the pore volume, and the average pore size of the biochars were determined using gas (N2) adsorption-desorption cycles using the Brunauer, Emmett, and Teller (BET) equation. Isotherms with 30 adsorption and 20 desorption points were conducted at liquid nitrogen temperature (77K). Open surface area and micropore volume were determined using t-plot method and Harkins & Jura equation. Total organic carbon was also determined because it is an important factor that affects sorption. Raw MSR demonstrates low surface area that increases by 1 order of magnitude by thermal treatment up to 750oC. At temperatures from 750 up to 900oC, pyrolysis results to biochars with surface areas 210-340 m2/g. For the same temperature range, a high percentage (46-73%) of the pore volume of the biochars is due to micropores. Similar results were observed for all the grain size fractions of the raw MSR. The up-scaling of the biochar production was easily performed by using increased biomass analogous to the bigger vessels used each time. Positive results were obtained when high surface area MSR biochars were tested for their ability to remove organic (i.e. phenanthrene) and inorganic (i.e. mercury) compounds from aqueous solutions. All these properties point to a new material that can effectively be used for environmental remediation.