XI ENCONTRO BRASILEIRO DE SUBSTÂNCIAS HÚMICAS

SUBSTÂNCIAS HÚMICAS, CIÊNCIA E TECNOLOGIA

19 a 23 de Outubro de 2015, São Carlos (SP)

Miscanthus x giganteus and *Aspidosperma quebracho-blanco* AS FEEDSTOCK SOURCES FOR BIOCHAR PRODUCTION IN ARGENTINA[1]

Luis Antonio Milesi Delaye[2]; Ivan Bergier[3]; Ana Paula Souza Silva[4]; Marco Aurélio da Silva Carvalho Filho[5], Klaus Dieter Sautter[5]; Marcela Guiotoku[6]; Claudia Maria Branco de Freitas Maia[7]

(1) Trabalho executado com recursos do INTA, Embrapa e CNPq.
(2) Pesquisador, Instituto Nacional de Tecnología Agropecuaria (INTA), Pergamino, BA, Argentina; milesi.luis@inta.gob.ar
(3) Pesquisador; Embrapa Pantanal, Corumbá, MS; ivan.bergier@embrapa.br
(4) Bolsista DTI-C (CNPq 403161/2013-4), Embrapa Pantanal, Corumbá, MS; ana.souza@colaborador.embrapa.br
(5) Professor da Universidade Positivo, Curitiba, PR; marccarv@gmail.com; ksautter@up.edu.br
(6) Analista; Embrapa Florestas, Colombo, PR; marcela.guiotoku@embrapa.br
(7) Pesquisadora; Embrapa Florestas, Colombo, PR; claudia.maia@embrapa.br

Abstract

Argentina is considering using new biomass sources for biofuel industry. Miscanthus and quebracho are two possible options and we evaluated both feedstock to biochar production, since this material is always associated to bioenergy production. As an energy feedstock, quebracho seems to have better value (higher C content). As biochar, quebracho showed higher stability, although both materials have use potential, depending on the main soil function that is wanted to be improved.

Key words: biochar, slow pyrolysis, hot stage, methane, thermogravimetry

Introduction

Argentina has recently embraced bioenergy sources by using mainly soybean, maize and sorghum to biofuel production (MAGyP, 2013). It is now been considered the use of harvest wastes as feedstock which could compromise sustainable crop systems, considering the carbon and nutrients exportation resulting from such a practice (Naylor, 2009). Biomass from bioenergetic crop systems on degraded or marginal soils is one of the possible alternatives to supply feedstock to biofuel industry (Tilman et al., 2006). Perennial C4 grasses are among the most promising biomass options and *Miscanthus x giganteus* (*Miscanthus sinensis* × *Miscanthus sacchariflorus)* is a high yield specie that is able to grow under low fertiliser input, even under low temperature as in the Argentinian prairies. It also has low GHGs emission, high C storage potential and prevents soil erosion (Irizar et al. 2015). In Argentina, it is cultivated in poor soils at the rolling Pampa, with an average yield of 8 Mg ha^{-1}, in the first cycle. A second important specie considered to provide biomass to biofuel industry is the white quebracho (*Aspidosperma quebracho-blanco*), a hardwood (0,87 g cm^{-3}) native species that occurs in a 67,5 Mha area covering part of Argentina, Bolivia, Paraguay and Uruguay. In Argentina, it is the main economical specie of the Chaqueña region due its wood quality and during 2002, 3.7 Mtn of wood was extracted from this region mainly for woodfire and charcoal production. This study aimed to evaluate the biochar quality produced from miscanthus and quebracho by slow pyrolysis.

Materials e methods

Both feedstock were dried and ground to 2 mm to chemical analyses and pyrolysis. Chemical characterization (ashes, extractable fraction, lignin and holocellulose (cellulose + hemicelluloses) of fresh miscanthus and quebracho was done according to Brazilian Standard Procedures. Slow pyrolysis was performed in a tubular oven (EDG FT_HV) at 350 °, 450 ° and 550 °C and heating rate of 10 °C/min by 1 hour and under N_2 flux, with 2 replicates each run. Solid yields was measured and proximate analysis (ashes, moisture, volatiles and fixed Carbon) of all samples was done according to international procedures. Elemental analysis was performed in a Vario Macro Cube Elementar. Thermogravimetric analysis was conducted on Shimadzu DTG 60H equipment, with a heating rate of 10 °C.min^{-1} from room temperature to 900 °C under N_2 atmosphere (20 mL.min^{-1}). A second pyrolysis experiment (from ambient temperature to 600 ^{o}C) was carried out in scanning electron microscope (Quanta 250, FEI Company) at low vacuum mode with hot-stage (Bergier et al 2013). This system was coupled to a tunable diode laser analyser (Los Gatos Research, Inc.) to monitor the methane (CH_4) evolution from pyrolytic gases in the microscope chamber, throughout the pyrolysis experiment.

Results and discussion

Miscanthus showed a higher extractable fraction and ash content (2.6% and 5.8% respectively) and a lower lignin content (26.3%), as expected for a grass. As a wood material, a higher lignin content (33.9%) in quebracho and a lower ash content (2.0%) and extractable (0.9%) was also expected and confirmed. These features were reflected in the biochar pyrolysis (Table 1), since a higher yield were expected to the feedstock with higher lignin content (quebracho). Biochar from quebracho had the higher C content and the higher the pyrolysis temperature the higher the C content in the biochar. Quebracho biochar showed higher stability than miscanthus biochar, as can be seen by its lowest H/C and O/C atomic ratios.

Table 1. Solid yield, C content and atomic ratios of biochar samples made at different temperatures.

Temperature	Yield %	C %	H/C	O/C
Miscanthus 350	40.3	60.5	0.98	0.42
Miscanthus 450	33.4	61.7	0.73	0.41
Miscanthus 550	29.4	69.2	0.55	0.29
Quebracho 350	39.0	67.2	0.91	0.30
Quebracho 450	31.6	72.0	0.71	0.24
Quebracho 550	29.8	79.1	0.54	0.15

Thermogravimetric curves confirmed elemental analysis results, showing that thermal stability of samples increases with the increase of the final carbonization temperature. For miscanthus biochar carbonized at 350, 450 and 550°C, the weight loss begins at 260, 300 and 340°C respectively. For quebracho, biochar charred at 350, 450 and 550°C, the weight loss begins at 270, 300 and 320°C respectively. At 460°C the mass loss is finished for all samples. To fresh miscanthus, the weight loss begins at 200°C and shows two thermal events. The first corresponds to cellulose weight loss and occurs at approximately 340°C and the second is related to the lignin degradation, near to 430°C. In quebracho feedstock, the weight loss begins at 210°C and the maximum degradation rate occurs at 320°C and 410°C to cellulose and lignin, respectively.

Figure 1 indicates that higher mass losses in gas form occur at about 300 oC, which correspond to the thermal degradation of holocellulose (hemicellulose and cellulose). The relatively latter peak of miscanthus indicates a larger fraction of cellulose in this biomass. The peak at 400 oC correspond to the thermal degradation of lignin.

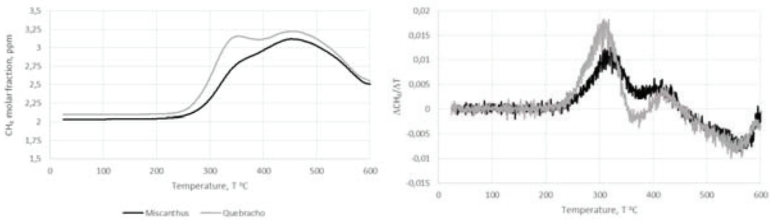

Figure 1. Evolution of methane partial pressure as a function of the hot stage temperature in microscope chamber under water vapor low vacuum at 130 kPa.

Conclusions

Quebracho biochar is a more thermostable material than miscanthus biochar, although both materials have potential to soil use, depending on the main soil function that is wanted to be improved. Methane evolution indicates that both biomasses have similar gas production, although it seems that the amount of cellulose might be higher for miscanthus.

Acknowledgments

To CNPq grant number 403161/2013-4; to INTA and to Embrapa.

References

BERGIER, I.; VINHAL-FREITAS, I.; GUIOTOKU, M. Low vacuum thermochemical conversion of anaerobically digested swine solids. **Chemosphere**, v. 92, p. 714-720, 2013.

IRIZAR, A.B.; MILESI DELAYE, L.A.; AE ANDRIULO, A.E. Projection of Soil Organic Carbon Reserves in the Argentine Rolling Pampa Under Different Agronomic Scenarios. Relationship of these Reserves with Some Soil Properties. **Journal of Open Agriculture,** v. 9, p. 30-41, 2015.

MAGyP (Ministerio de Agricultura, ganadería y Pesca). Biocombustibles 2013 – Agroenergía 2013, 2013. Disponível em: http://www.minagri.gob.ar/site/agregado_de_valor/index.php?edit_accion=noticia&id_info=140515143926. Acesso em 03/09/2015.

NAYLOR, R.L. Managing Food Production Systems for Resilience. In: CHAPIN et al., eds. Principles of Ecosystem Stewardships: Resilience-Based Natural Resource Management in a Changing World, Springer Science+Business Media, LLC, New York, USA; 2009. p. 259-280. ISBN: 978-0-387-73033-2 (Online).

TILMAN, D., HILL, J., LEHMAN, C. Carbon-negative biofuels from low input high-diversity grassland biomass. **Science**, v. 314, n. 5805, p. 1598-1600, 2006.