**Fast pyrolysis of Ecuadorian biomass for obtaining chemical precursors**

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**Highlights**

* Different lignocellulosic biomass from agricultural processes are pyrolyzed to obtain bio oil.
* Fast Pyrolysis technology in a free fall tubular reactor.

**1. Introduction**

During the last years, biomass has drawn attention as a promising feedstock for its conversion into renewable fuels. The thermochemical process of pyrolysis under which biomass is converted into gas, bio-oil and char has drawn also attention for the different compounds found in bio-oil. Ecuador due to its biodiversity and different climate has different crops with a wide range of compositions, which have shown a great potential for pyrolysis feedstock. Bio-oils obtained from biomass appear to be an attractive option to obtain chemical precursors that have been synthetized from fossil fuels. In this study, we explore the advantages not only about the recovery of chemical precursors from the biomass pyrolysis products, but also the environmental impact of biomass residual waste used as feedstock.

**2. Methods**

A free fall fast pyrolysis equipment has been designed and constructed to study fast pyrolysis. The equipment consist on a quartz reactor with an oven, which can rapidly heat the sample (40 – 1200C). The outlet streams passes through a cyclone to remove the solid char. The gaseous stream passes through two traps the first trap at -20°C collects the volatiles liquid and the second trap at -10 collects the C2 fractions. The rest of the gasses are directly injected into the GC coupled with two detectors (FID and TCD) for its characterization and quantification. The piping used in the equipment is stainless steel 1/4" for the feed system and the purge separation line. For the online analysis stream after the purge, a 1/8" stainless steel pipeline is used which reaches direct to the GC (Thermo Fisher Scientific, TRACE 1310).

The feedstock used are four different types of Ecuadorian residual biomasses, which were characterized to find the cellulose, lignin, protein, fat and ash content. These biomasses were palm fiber, coffee husks, rice husks and palm rachis. Cellulose content was determined using the protocol described by Dominguez [1]. Lignin content was determined using the official method AOAC 973.18 [2]. The Kjeldahl method was used to quantify the amount of protein in the samples using a digester DK6 VLEP Scientifica and a semiautomatic distillation unit UDK 139 based on the official method AOAC 960.52 [2]. A modified version of the official method AOAC 2003.05 and 2003.06 [2], which uses a solvent extractor equipment VELP Scientifica SER 148, was followed to determine the fat content in the samples. Finally, ash content was determined using the official method AOAC 942.05 [2]. A Leica DM500 microscope was used to analyze the size and geometry of the fiber of samples. Pictures were taken using the Leica ICC50 HD camera and the fibers were measured with the software Leica Application Suite EZ.

The setup has a solids feeding system that consists of a glass tube with three Teflon ball valves. Valve 1 is used to purge the feed system, valve 2 is used to insert the carrier gas and purge the system, and valve 3 is used to insert the solid sample, with the carrier gas, inside the reactor. For this investigation, the biomass samples were pyrolyzed in a ceramic tubular vertical free-fall reactor using helium as carrier gas. The reaction temperatures used were 500, 550 and 600.

**3. Results and discussion**

**Biomass characterization**

The characterization of four types of Ecuadorian residual biomasses were performed to find the cellulose, lignin, protein, fat and ash content. The characterization shows that the samples have a significant amount of cellulose in a range between 15-33 wt% of dry biomass. The biomasses were observed in the microscope to have a reference of their shape and size. Palm rachis morphology showed a cylindrical uniform shape, rice husk a powder heterogeneous distribution and coffee husks and pal fiver showed spherical uniform distributions.

**Composition of liquid products of pyrolysis**

The liquid products are retained in the liquid trap at °C, collected and analyzed using GC-MS/FID/TCD. Preliminary characterization of the products show the presence of C2 gases, acetic acid, hydroxytaldehyde, levoglucosan, levogluconsanone, phenol and various poly phenols. Depending on the pyrolysis temperature the amount of the products varies.

**Analysis of the solid products of pyrolysis**

The solid products were characterized using a Leica DM500 optical microscope. The observations done after selecting random fibers for each biomass shown a shrinkage of 30% in length and of 1% to 17% in diameter for all temperatures.

**4. Conclusions**

The wide range of the composition of liquid bio-oils products obtained from Ecuadorian fast pyrolysis show a great potential to obtain chemical precursors for further upgrading processes.

**References**

[1] M. M. Domínguez Domínguez, A. Alvarez-Castillo, T. Castrejón-Rosales, M. J. Granados Baeza, F. J. Hernández Campos, V. H. Alcalá Octaviano, and J. C. Tapia Picazo, “Estudio de la cinética de la hidrólisis ácida de bagazo de caña de azúcar sin pretratamiento para la obtención de azúcares reductores,” *Rev. Iberoam. Polímeros*, vol. 12, no. 3, pp. 153–159, 2011.

[2] AOAC, *Official Methods of Analysis of AOAC International*. Gaithersburg: AOAC International, 2012.