DETERMINATION OF PRODUCTS BY PYROLYSIS OF BALSA WOOD AND SUGAR CANE RESIDUES

Universitat d'Alacant
Universidad de Alicante

Muñoz M.[1], Rosero M.[1], García A.N.[2], Marcilla A.[2]

[1] Chemical Engineering, Central University of Ecuador, Quito, Ecuador; [2] Chemical Engineering, University of Alicante, Alicante, Spain

Fig. 1 Sugarcane and Balsa wood biomass

ABSTRACT

The pyrolysis of balsa wood residues (Ochroma pyramidale) and sugarcane bagasse (Saccharum officinaru) in their natural state and after an alkaline pretreatment has been studied. The biomasses were cut and grounded to have particle diameters of 0.5 mm. 5 g of NaOH or KOH were dissolved in 50 mL of water; 5 g of sample were added to the solution and mixed thoroughly. The resulting mixture was dried in an oven at 100˚C. Treated and untreated samples were analyzed by TGA-FTIR. Flash pyrolysis of the biomasses was carried out in a pyrolyzer EGA/Py. Volatile products were analyzed by GC/MS.

INTRODUCTION

Production of organic matter derived from agro-industrial processes oscillates at about 155 billion tons/year, however, only a small fraction can be consumed directly, and the remaining organic matter becomes a residue constituting a source of environmental pollution. For this reason, the interest has grown in the use of lignocellulosic waste for different purposes, obtaining products with a high potential for energy use, activated carbon, or added-value chemicals. Furthermore, chemical pretreatments are commonly used to modify the original structure of the biomass for specific purposes (an alkali pretreatment usually increases the hemicellulose and lignin degradation) as well as for catalytic effects.

RESULTS

SUGARCANE

THERMOGRAVIMETRIC ANALYSIS

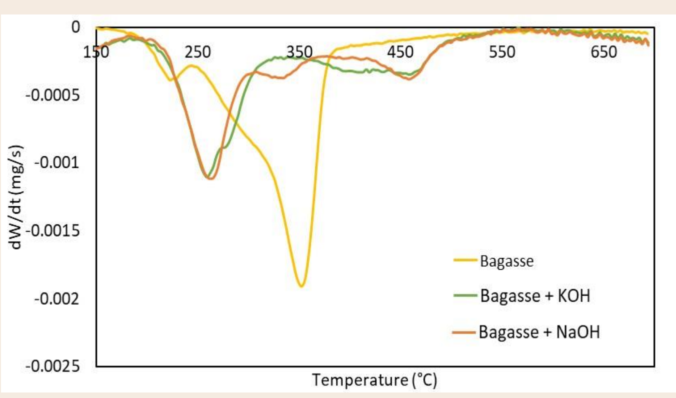

Fig. 2. DTG curve of sugarcane bagasse with and without alkaline treatment

Alkaline treatment modifies significantly the thermal behaviour of the bagasse. The main DTG peak placed at 355˚C is found at 265˚C in alkaline samples. The presence of hydroxides increases the residue.

FTIR SPECTROSCOPY

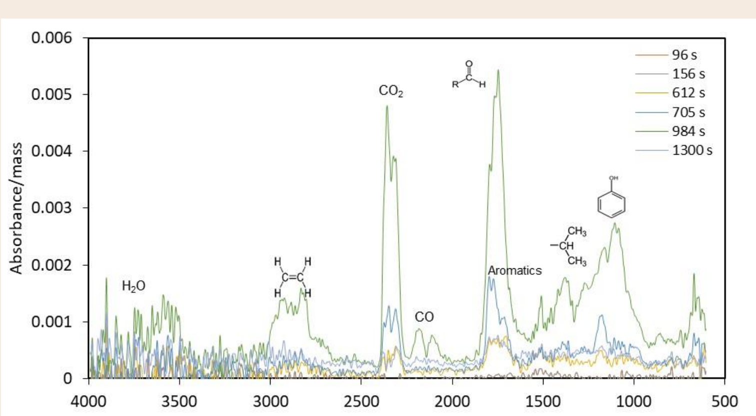

Fig. 5. FTIR spectra of Sugarcane bagasse

Bagasse sample: CO, CO_2, water, alkanes, alkenes, ketones and phenolic groups. **Alkaline samples**: CO_2, CO and H_2O, mainly.

ANALYTICAL PYROLYSIS

Bagasse sample: Acetic acid, light aldehydes, phenol derivatives and levoglucosan.

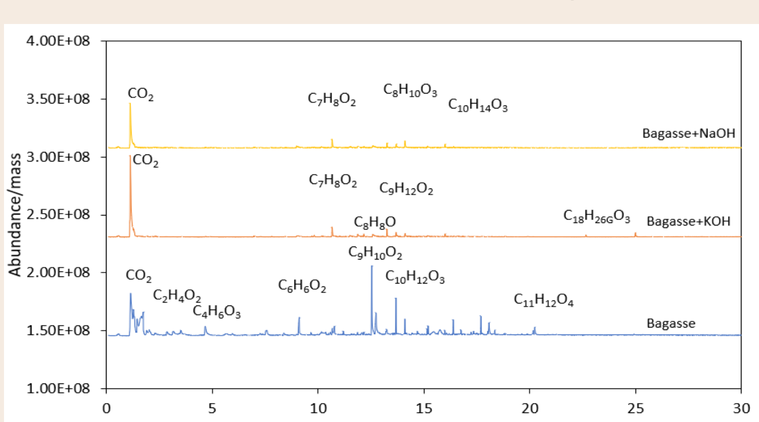

Fig. 7. Comparison of chromatograms of sugarcane bagasse at 400 °C.

Alkaline samples: the yield of CO_2 increases. No levoglucosan is found, being phenol derivatives the main volatiles.

COMPARISON

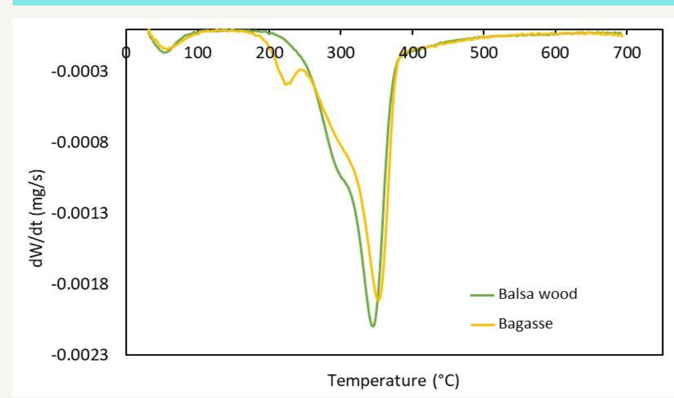

Fig. 3. Comparative DTG curve of balsa wood and sugarcane bagasse

Both samples follow a similar thermal behavior, with a **maximum DTG peak at around 350°C** and a shoulder at around **290°C**.

Both FTIR spectra show **similar bands**, being **their intensity** the **main difference**.

In general, bagasse can generate a greater number of compounds with **carboxyl groups, while pyrolysis of balsa wood generates higher yields of water.**

Flash pyrolysis of both biomasses led also to different volatiles.

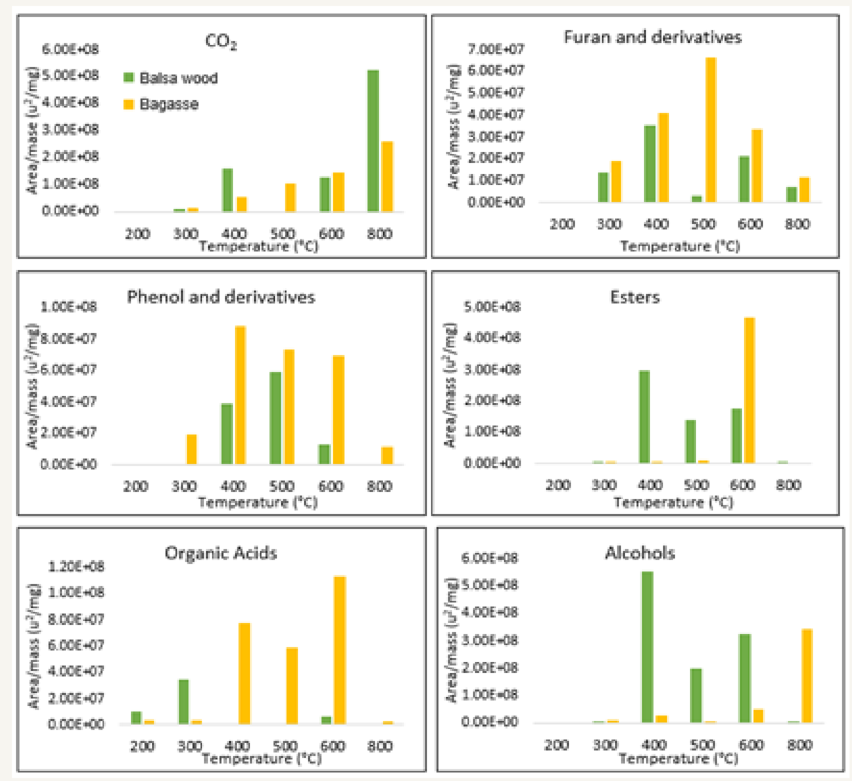

Fig. 8. Comparison of the main products in the pyrolysis of balsa wood and sugarcane bagasse

Due to the difference in the composition of the biomasses, bagasse pyrolysis generate higher yields of organic acids, while balsa wood shows higher abundance of esters and alcohols. Furans and phenols shows a maximum with temperature.

BALSA WOOD

THERMOGRAVIMETRIC ANALYSIS

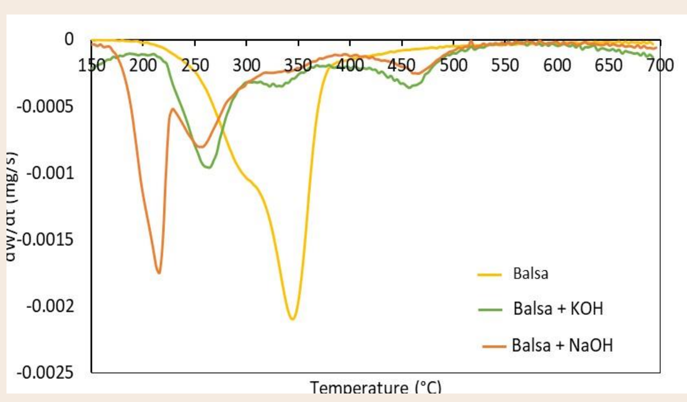

Fig. 4. DTG curve of balsa wood with and without alkaline treatment

Alkaline treatments produce changes in thermal behavior, by reducing the thermal decomposition temperature significantly. Differences between alkaline treatments are also visible.

FTIR SPECTROSCOPY

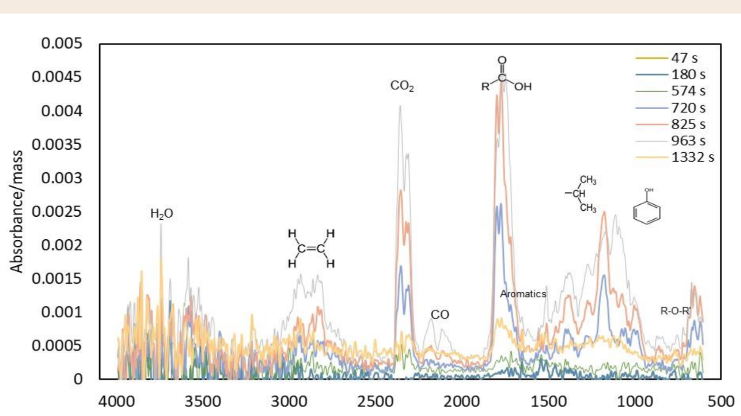

Fig. 6. FTIR spectra of balsa wood

In alkaline samples, **the intensity of the bands has been reduced drastically**.

ANALYTICAL PYROLYSIS

Balsa wood: wide spectrum (alcohols, phenol derivatives, ketones and esters).

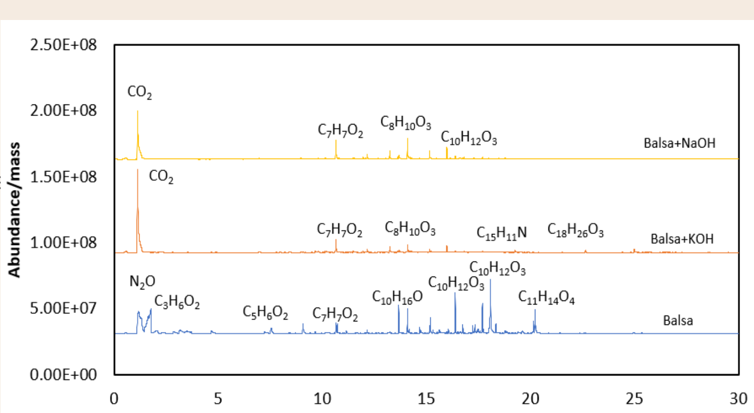

Fig. 9. Comparison of chromatograms of balsa wood, at 400 °C.

In **treated samples**, the percentage of CO_2 and phenolic compounds increase, while organic acids, alcohols, furans and esters decrease.

CONCLUSIONS:

- Balsa wood residues and sugarcane bagasse from agro-industrial processes in Ecuador can be a viable source of products for energy and industrial purposes through thermal decomposition.
- The FTIR analysis of both biomasses shows similar functional groups with different intensity.
- The Py-GC/MS analysis determined that the main pyrolytic products obtained were alkanes, acetic acid, furan, furfural, acetaldehydes, furaldehyde, phenolic derivatives and levoglucosan.
- The alkaline treatment modifies the structure of both biomasses and exerts a catalytic effect on the pyrolysis process, modifying the decomposition mechanism: lower temperatures, greater generation of CO_2 and higher yield of biochar.