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Biomass characterization and pyrolysis towards bio-oil production

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1. Introduction – Biomass is considered one of the most promising renewable energy sources in the world, mainly due to its extended availability in rural areas. There are many advantages in using biomass as an energy source, namely its carbon neutrality and being a non-polluting source. In this context, the main technologies for fuel and/or energy production are pyrolysis, gasification, or combustion [1].

2. Experimental - Biomass sample (pellets) composition was characterized by proximate analysis, determining the fixed carbon, moisture, volatiles and ashes, ultimate analyses, determining the content of C, H, N, S and O. The content of hemicellulose, lignin and cellulose was also determined. The methodologies are described elsewhere [2]. Bio-oil sample obtained by biomass pyrolysis performed in a fixed-bed vertical pyrolysis oven, with a maximum temperature of 500 °C, a heating rate of 10 °C/min, a retention time of 0.5 h and a N₂ flow of 20 mL/min, was qualitatively characterized using FTIR.

3. Results and Discussion - The results of the biomass characterization are shown in Table 1. It is noteworthy that the pellets have a low value for ashes, being a suitable feedstock for the pyrolysis, as a high concentration of ashes biomass could cause clogging of the equipment during the pyrolysis. According to the ultimate analysis, the average chemical formulation of this biomass would be C₁H_{0.12}N_{0.003}O_{1.03}. The yield of the pyrolysis products (wt% basis) was 23.975 %, 28.31 % and 47.15 % for biochar, bio-oil and non-condensable gases respectively. In Image 1, the main peaks observed are the OH vibrations, in the region of 3100 to 3500 cm⁻¹, the peaks between 1650 and 1720 cm⁻¹ relative to the C=O stretching vibrations, the peaks of 1600 and 1450 cm⁻¹ related to aromatic rings, and the peak in the range of 900 to 700 cm⁻¹ is related to substituents of an aromatic ring [3]

Table I. Characterization of pellets biomass

Parameter	Value (wt%)
Moisture	7.130
Volatile compounds	73.651
Ashes	0.350
Fixed Carbon	18.877
Hemicellulose	55.561
Lignin	41.169
Cellulose	3.27
C	46.526
H	5.576
N	0.119
S	0.000
O	47.779

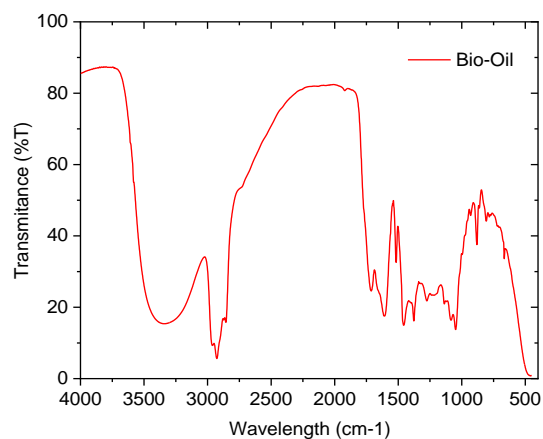


Image 1. Bio-oil FTIR analysis

4. Conclusions - Bio-oil was successfully obtained by the pyrolysis of the biomass, with a yield of 28.3 %, and the pyrolysis proved to be a viable option to obtain renewable energy sources and valorize a worldwide produced waste. Future works will study optimizations of the experimental parameters, such as heating rate, and temperature, alongside testing new biomass sources.

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5. References

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