Biomass characterization and pyrolysis towards bio-oil production

G.F. Batista (1), P. Brito (1)

(1) Centro de Investigação de Montanha (CIMO), Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal

gabriel.batista@ipb.pt, +351 913 690 761

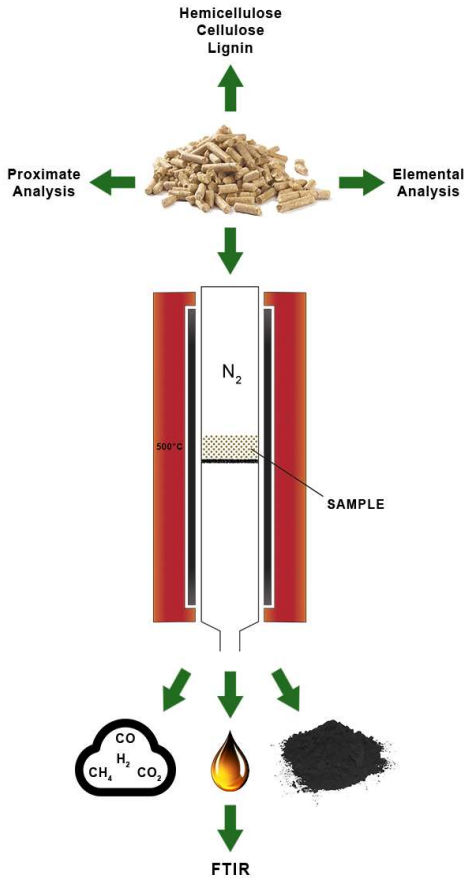
Introduction

One of the greatest challenges humanity has to deal with nowadays is climate change. An important strategy to mitigate climate change is replacing fossil fuels with renewable sources of energy [1].

Biomass is considered one of the world's most promising renewable energy sources, mainly due to its nearly endless availability. Worldwide, each year plants convert approximately 125 gigatons of carbon from atmosphere into biomass, which is equivalent to almost 300 million tons of oil per day [2].

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 from biomass are pyrolysis, gasification, or combustion.

Experimental



Results

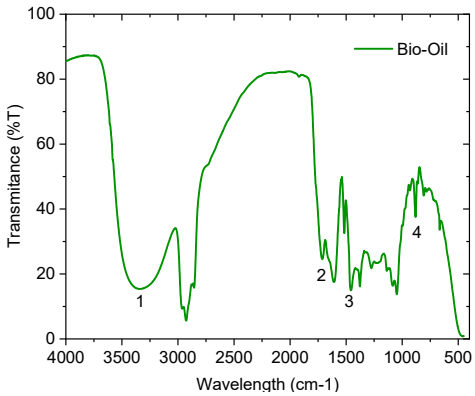
Table I. Characterization of pellets biomass.

Parameter	Value (wt%)
Moisture	7.130
Volatile compounds	73.651
Ashes	0.350
Fixed Carbon (F.C.)	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

Table II. Products yields for the pyrolysis test.

Yield	Value (wt%)
Biochar	23.98
Bio-oil	28.31
Gas	47.71

Figure I. Bio-oil FTIR analysis.



- Pellets have a low value for ashes, being a suitable feedstock for the pyrolysis
- According to the ultimate analysis, the average chemical formula of this biomass would be $C_1H_{0.12}N_{0.003}O_{1.03}$.
- Pyrolysis operational conditions: T_{max}= 500 ºC; Heating rate = 10 ºC/min; Retention time of 0.5 h and a N_2 flow of 20 mL/min.
- Bio-oil higher heating value (HHV) was determined by an equation (Eq 1) proposed elsewhere [4], based on the biomass proximate analysis.

$$HHV\ (MJ\ kg^{-1}) = 0.196*(F.C.) + 14.119 \quad \text{(Eq. 1)}$$

$$HHV = 17.82\ MJ\ kg^{-1}$$

- The main peaks observed in FTIR analysis of Bio-oil are [3]:

  1: OH vibrations,

  2: C=O stretching vibrations;

  3: Related to aromatic rings,

  4: Related to substituents of an aromatic ring.

Conclusions

- Bio-oil was successfully obtained by the pyrolysis of the biomass, with a yield of 28.3 %.
- The pyrolysis proved to be a viable option to obtain renewable energy sources and valorize a worldwide produced waste.
- Future works will study the optimization of experimental parameters, such as heating rate, and temperature, alongside testing new biomass sources.
- Faster pyrolysis (higher heating rates) would favor the production of bio-oil, although other variations in experimental parameters could also influence the nature and amount of the generated products.

References

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Acknowledgment

This work is funded by the Portuguese Foundation of Science and Technology (FCT) within the framework of the SUBe Project, ref.:PCIF/GVB/0197/2017.