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Study of tropical forest residue combustion: chemical characterization and emissions

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INTRODUCTION

Renewable energy sources have been recommended as substitute for fossil fuels, due to climate change. Among such renewable sources are the biomass from forest and agricultural residues, for example. In tropical forest areas, such as in the Amazon region, there is large amount of dead biomass above the ground, which supports the occurrence and spread of forest fires. In an attempt to find solutions for the reduction of forest fires, the biomass of the rainforest was studied as a fuel for use in combustion process.

METHODOLOGY

BIOMASS COMPOSITION:

-mixture of different species (90% branches- < 2 cm² cross section; 10% of finer branches and leaves);

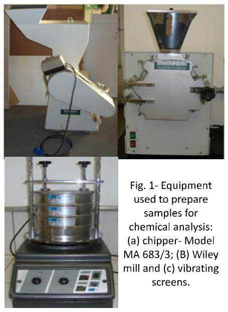

Fig. 1- Equipment used to prepare samples for chemical analysis: (a) chipper- Model MA 683/3; (B) Wiley mill and (c) vibrating screens.

CHEMICAL CHARACTERIZATION:

Variable	Standard
Lignin	T 222 (Tappi, 1998)
Extractive	T 204 (Tappi, 1997)
Holocellulose	difference
HHV	ASTM E 711-87 (2004

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BURNING EXPERIMENTS:

- 5 repetitions (1.5 kg by test);
-Associated Combustion and Propulsion Laboratory - INPE;

CALCULATIONS:

$$EF_x\,(g_x/kg_{fuel}) = \frac{V_{Total\text{-}chimney}}{m_{fuel(dry\ basis)}} \cdot \frac{[\ ]_{x\text{-}gas}}{V_{x(1mol\ at\ 1atm\ and\ 0^oC)}} \cdot M_x$$

$$MCE = \frac{[\ ]_{CO_2}}{[\ ]_{CO_2} + [\ ]_{CO}}$$

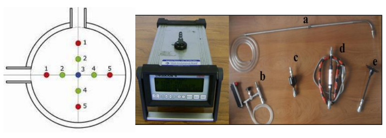


Fig. 2- Number of points in the duct interior, DR4- model 4000, and Accessories: (a) Isokinetic Probe, (b) Particle Thinner, (c) Particulate selector, (d) Heater and (e) Sampling input- Omnidirectional.

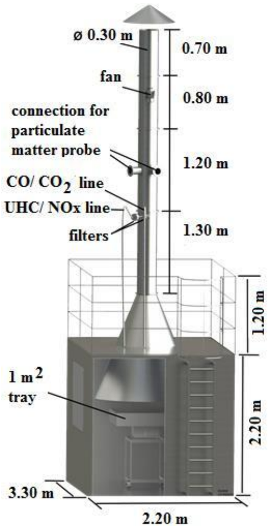


Fig. 3- Schematic of combustion equipment.

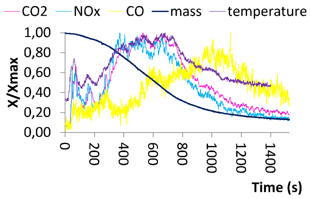
RESULTS AND DISCUSSION

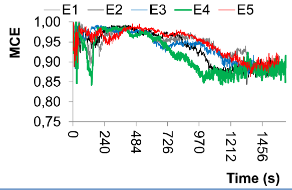
CHEMICAL CHARACTERIZATION:

HC (%)	LC (%)	EC (%)	HHV (MJ/kg)	References	Material
66.70 ± 1.02	23.32 ± 0.68	9.98 ± 0.49	16.59 ± 0.04	This work	Amazon biomass
48.60 _ 61.30	37.10 ± 3.67	9.22 ± 3.99	19.99 ± 0.77	Telmo;Lousada (2011)	Tropical species
49.50 ± ___	26.98 ± ___	___	19.20 ± ___	Miranda et al. (2009)	*Quercus pyrenaica*

Telmo; Lousada (2011): HHV is statistically related to lignin content, which explains the lower HHV.

EMISSIONS:



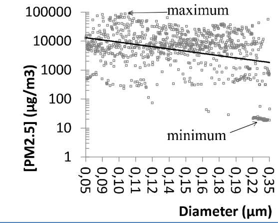


Average consumption, MCE and duration were 81.54±4.31%, 94.15±1.22%, and 27.40±2.88 min, respectively;

Average emissions factors: 1581 ± 29 for CO2, 48.61 ± 6.74 for CO, 2.92 ± 0.18 for NOx, and 3.56 ±1.31 for PM2.5;

Burling et al. (2010): EF CO2= 1786 g/kg;

PM diameter: flaming (0.07 to 0.29 µm); smoldering (0.10 to 0.80 µm).



CONCLUSIONS

-HHV was only 3 MJ/kg lower than that found in the literature;

- Biomass combustion resulted in a high MCE, with predominance of the flaming phase;
- EF values were close to those of literature;
- Fine particles and harmful to health were issued, mainly, on flaming phase and in higher concentrations;
- Tropical forest biomass presented emission similar to other biomass when submitted to combustion. However, other aspects of this material must be evaluated for use as a fuel in combustion process.

REFERENCES

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Miranda, M.T., Arranz, J.I., Rojas, S., et al. , 2009. Energetic characterization of densified residues from Pyrenean oak forest. Fuel 88, 2106–2112.

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