CHARACTERIZATION OF EMISSIONS FROM COMBUSTION OF OLIVE WOOD CHIPS

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INTRODUCTION

Combustion is a thermochemical conversion process widely used for heat and power generation through different types of biomass in order to ensure a low environmental impact. Much of the woody biomass used in combustion plants is supplied by the sector of agroforestry, in order to increase energy production from waste material. In Italy olive grove cultivations determines a production of agricultural residual biomass that corresponding to the 45% of the main tree crops and is considered an important biomass source from arboriculture. This work aims to characterize the emissions produced by combustion of olive wood chips that represents an innovative method and a useful tool for the recovery of agricultural lignocellulosic residues that could be used in farms and agro-energy districts in order to provide the disposal of waste biomass destined for open burning and uncontrolled combustion process.

MATERIAL AND METHODS

Characterization of olive wood chips

The characterization of olive wood chips was carried out at the LASER-B (Laboratory for Experimental Activities on Renewable Energy from Biomass) of CREA-IT. For this study, olive wood chips was characterized in order to evaluate the physical and chemical properties. The moisture content was determinated according to the UNI EN ISO 18134-2:2017, using a Memmert UFP800 drying oven to dried the sample at 105±2°C for 24 h. The higher heating value (HHV) was determined according to the UNI EN ISO 18125:2018, using an Anton Paar 6400 isoperibol calorimeter and the lower heating value (LHV) was calculated from the higher heating value, depending on the hydrogen content.
The elemental analysis was carried out according to the UNI EN ISO 16948:2015 by the Costech ECS 4010 CHNS-O. The ash content was measured according to the UNI EN ISO 18122:2016 using a Lenton EF11/8B muffle furnace.

Experimental campaign

The experimental test was carried out in October 2020 burning the biomass in a small boiler 30 kW_{th} (CSA 30-100 GM, D'Alessandro Termomeccanica, Miglianico, CH, Italy). The boiler has an automatic burner and is equipped with a mobile grate for the use of wood chips (± 15mm, max 50% of humidity) and a multicyclone for collecting fly ash. The monitoring of emissions from fixed sources was carried out according to UNI EN 14791, 14792 and 15058. A portable multi-parameter Horiba PG-250 gas analyzer in-line was used for the measurements of macropollutants NOx, SOx, CO, CO_2 and O_2. An isokinetic sampler equipped with a sampling probe, a cooling device and a pumping system was used for particulate matter sampling. The HP5 Dadolab probe and the ST5 Dadolab isokinetic sampler were used to sample PM. PM was collected on glass filters and quantified with gravimetric analysis by Mettler Toledo AL104 analytical balance.

Figure 1: Boiler CSA 30 GM

Figure 2: Probe HP5 and isokinetic sampler ST5

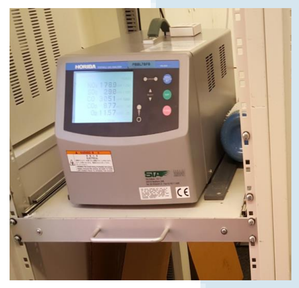

Figure 3: Horiba PG250

RESULTS AND DISCUSSION

Table I: Characterization of olive wood chips

LHV (MJ/kg)	C (%)	H (%)	N (%)	Ash (%)
17.25	43.89	6.48	1.15	7.60

The moisture content was 9.30% and the HHV was 18.60 MJ/kg. The sulphur content was below the LOQ and it was considered negligible. The high C content and low N content represents useful element that suggests the excellent behavior for energetic purposes. The content of N, ash and moisture can be use for the indirect estimation of the combustion quality and the production of emission pollutants. The distributions of these parameters are plotted in Fig. 4 and 5.

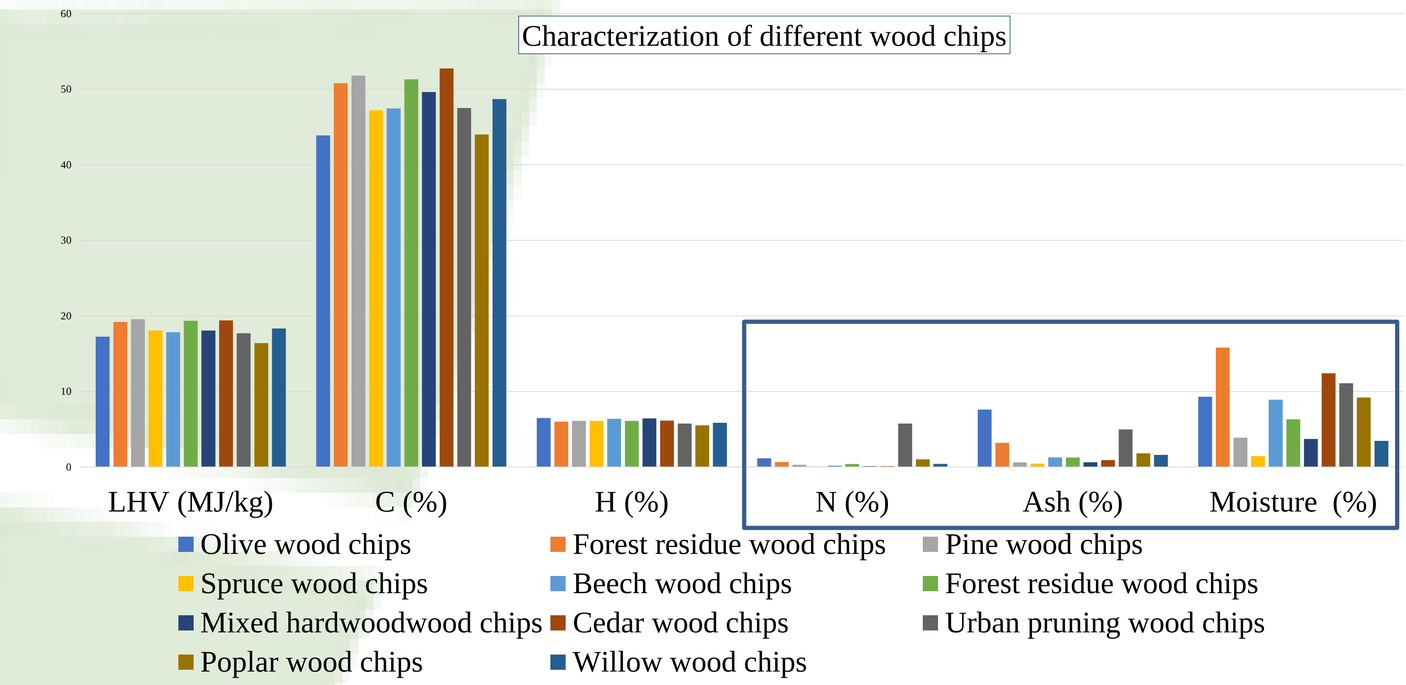

Figure 4: Comparison between chemical and physical parameters of different types of wood chips

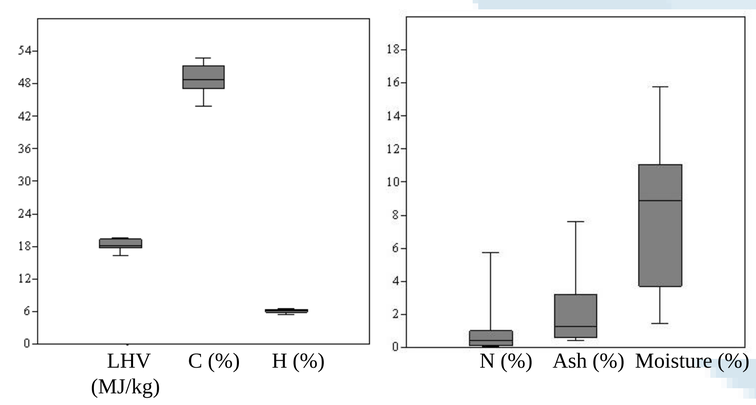

Figure 5: Distribution of chemical and physical parameters

The comparison highlighted a greater variability for N, ash and moisture, that can more influence the combustion conditions, while the LHV, C and H have values more similar to each other.
The values of gas emissions shows that the combustion, probably operate in excess of oxygen, producing high concentrations of CO, NOx, these results are determined by incomplete combustion as also confirmed by high concentrations of PM.

Table II: Characterization of emissions

Emissions	Olive wood chips
CO (mg/Nm^3)	455.13
NO_x (mg/Nm^3)	449.99
SO_2 (mg/Nm^3)	30.78
O_2 (%)	13.49
CO_2 (%)	6.55
PM (mg/Nm^3)	116.12

CONCLUSIONS

- The results obtained from the physical and chemical characterization confirmed that olive wood chips would be a potential raw material for energy scope, and applicable in combustion thanks to high energy power, and low content of N, ash and moisture;
- PM and pollutants in emissions are generated from incomplete combustion and depends mainly on the content of N, ash and humidity which are the factors with greater variability;
- Comparing with literature data, it is highlighted that the presence of abatement systems such as milticyclone is an effective containment measure of the emitted PM.

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