ALMOND PEEL, CHARACTERIZATION OF THE BY-PRODUCT FOR SUSTAINABLE VALORIZATION PROCESSES

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INTRODUCTION

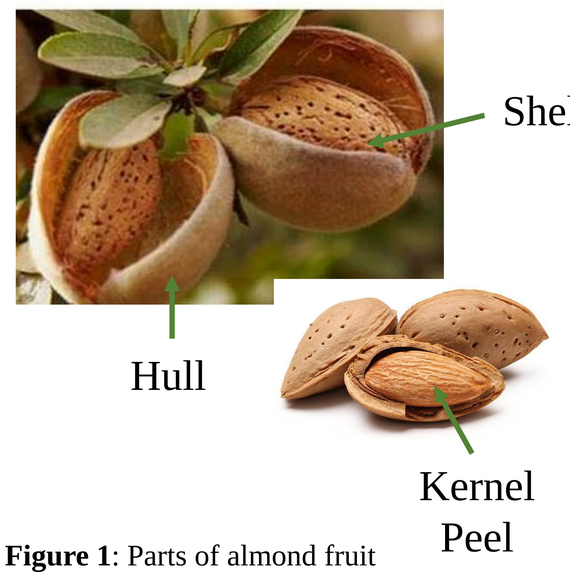

Figure 1: Parts of almond fruit

Almond tree, commonly known as *Prunus dulcis*, (*Rosaceae* family), represent the main important tree nut thanks to its resilience, adaptability to arid climate condition of Mediterranean region (28% of the world production) and to the high commercial value of its fruit. The agri-food industries produce millions of tons of residues (shells, hulls, pruning, leaves and peels), these residues are good feedstocks for production of bioenergy and other compounds. Hulls represent approximately 52% of the total fruit, shells 33%, kernels 11%, while the brown peel represents from the 4% to 8% of the total weight. The reuse of almond peels represents a significant strategy of conversion for applications in chemical, food and energy fields.

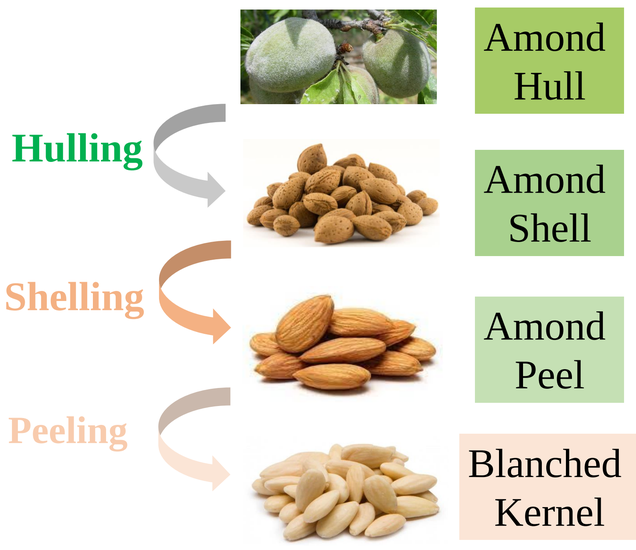

Figure 2: Post harvest process and almond by-products

The aim of this work is investigating the chemical-physical characteristics of almond peels after industrial transformation process identifying potential valorization process, to improve its sustainable management.

MATERIALS AND METHODS

The study is based on the investigation of physical and chemical parameters of almond peel to evaluate its applicability in different fields.
To obtain almond peel like the residual material from the food industry, almonds were treated by simulating peeling processes and subsequently dried and grounded for characterization at the LASER-B (Laboratory for Experimental Activities on Renewable Energy from Biomass) of CREA-IT.

Figure 3: Sample preparation phases

Almond peel characterization

The moisture content was determined following the UNI EN ISO 18134–2:2024 at 105 ± 2 °C in a drying oven for 24 h. The ash content was determined in a muffle furnace according to the UNI EN ISO 18122:2022. The determination of the higher heating value (HHV) was carried out by using an isoperibol calorimeter according to the UNI EN ISO 18125:2017 and the lower heating value (LHV) was calculated starting from the HHV and the hydrogen content. The elemental composition (C, H, N, S, O) of peels was determined by using a Costech ECS 4010 CHNS-O. Finally, thermogravimetric analysis was carried out by using the METTLER TGA/DSC1 STAR to evaluate the degradation of almond peel simulating the pyro-gasification and combustion process.

RESULTS AND DISCUSSION

The almond peel samples have been dried in ambient air for 24 hours and then moisture content was determined (12.5%), the Sulphur content was below the LOQ, and it was considered negligible. The results of Tab.1 shown that Almond peel have high values of Carbon content, LHV, low ash content and C and N ratio in line with biomass used in thermochemical conversion process.

Table 1: Almond peel physico-chemical parameters

C [%]	H [%]	N [%]	O [%]	Ash [%]	LHV [MJ/kg]	C/N
53.71	5.02	2.07	35.47	3.73	20.36	30.27

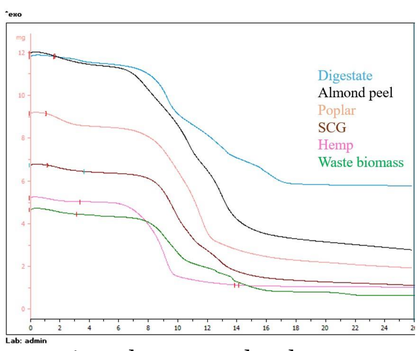

Figure 4: Comparison between the thermogravimetric curves

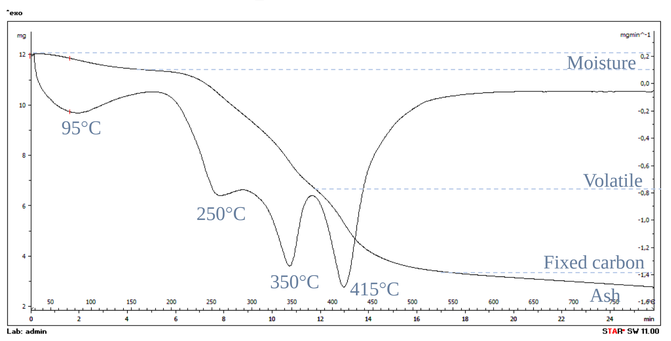

Figure 5: Pyrogasification test

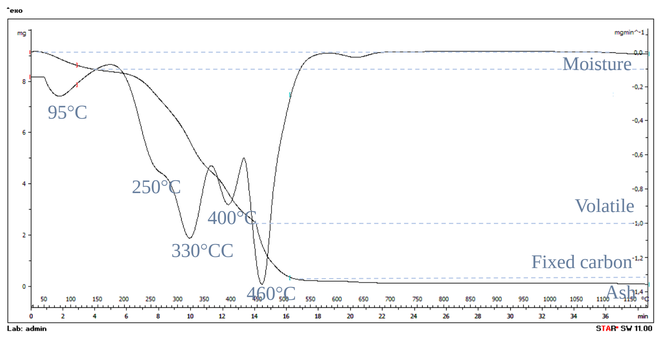

Figure 6: Combustion test

Fig. 4 shown that almond peels degrade similarly to biomasses of different nature used in energy conversion processes. Figures 5 and 6 shown the simulation of the pyrogasification and combustion processes indicating the different phases of the matrix degradation.

CONCLUSIONS

- Almond peel is a potential feedstocks for conversion after post harvest transformation process;
- Pyro-gasification and combustion are considered suitable processes for the valorization of almond peels, having high energy value, and therefore useful as value-added products, e.g. in agropellet mixtures formulation;
- The circular economy of almond grove supply chain is encouraged by using almond peel as by-products for sustainable environmental application.

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