CAROB WASTE AS AGRIFOOD PRODUCT: PHYSICO-CHEMICAL COMPOSITION OF SEEDS

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INTRODUCTION

The carob (*Ceratonia siliqua* L.) is a xerophyte tree of the *Leguminosae* family, typical of the arid Mediterranean region. In recent years, carob's value has increased due to its economic use as a raw material in the food, pharmaceutical, cosmetic, and biofuel industries and to its ecological role. The carob fruits consist of elongated and curved compressed pods, of a bright dark brown color, the main parts are the pulp (90%), and seeds (8-10%) constituted by bark, endosperm, and germ. Carob fruit, largely used in the food-industrial sector for sugar extraction or locust bean gum (LBG) production, is separated by parts after selection, cleaning, drying, grinding, sieving and classification. These processes involve the removal of the peels and can generate residual materials deriving from the transformation of the seeds or contaminated during the processing phases. The present study has the aim to characterize carob seed processing residues considered as feedstock for agronomic, energy and environmental purposes.

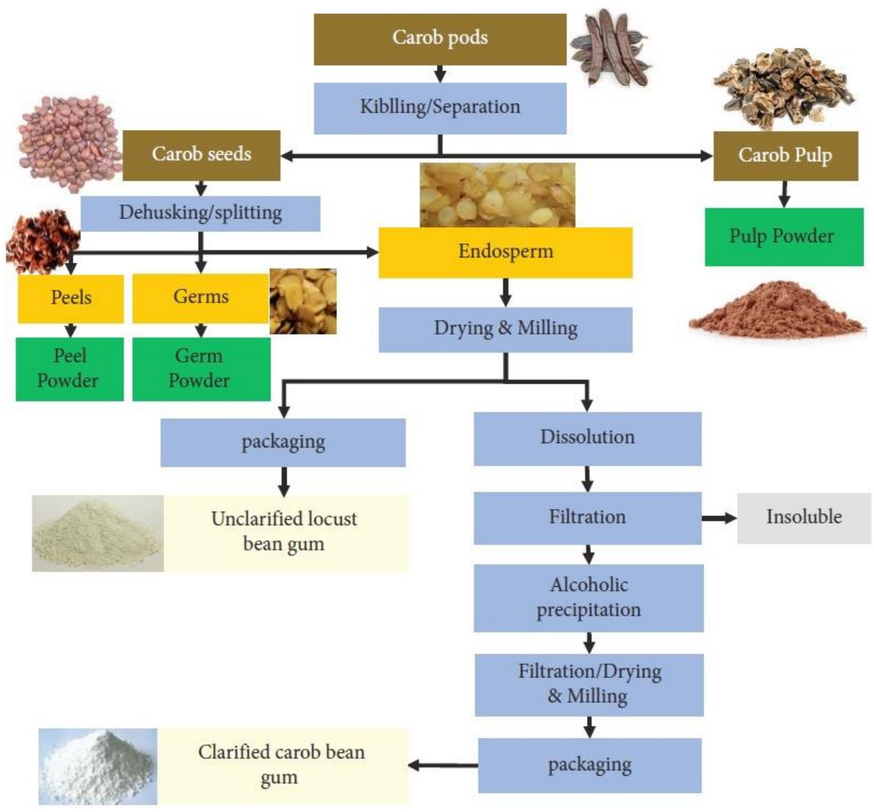

Figure 1: Locust bean gum processing flow chart. Laaraj et al. 2023

MATERIALS AND METHODS

After the separation of the pod, the seeds were grounded, and the resulting powder was sieved to collect the residues for characterization.

Figure 2: Carob pods and seeds

The evaluation of the physical and chemical parameters was carried out determining moisture content (UNI EN ISO 18134-2:2024), LHV (UNI EN ISO 18125:201), seed rate, ash content (UNI EN ISO 18122:2022), pH (UNI EN 13037:2012), elemental composition (UNI EN ISO 16948:2015), macro and micro elements content (ISO 16967:2015 - ISO 16968:2015). Therefore, from the elementary composition, was estimated the theoretical biochemical methane potential (TBMP) by Buswell's formula and the percentage of methane in biogas.

Figure 3: Seed grinding process

RESULTS AND DISCUSSION

Table 1: Physico-chemical characterization of Carob seed residues

Sample	Moisture [%]	LHV [MJ/kg]	Seed rate	Ash [%]	pH	C [%]	H [%]	N [%]	O [%]	C/N [%]
Carob seed residues	5.15	12.94	6.69	2.36	6.5	37.02	5.00	0.82	54.80	52.67

Table 2: Macroelements cotent

Macroelements	[g/kg]
Na	0.016
Mg	1.418
K	9.015
Ca	0.411
Mn	0.026
Fe	0.162
Cu	0.005
Zn	0.019
Al	0.238

Table 3: Microelements cotent

Microelements	[mg/kg]
Cr	1.049
Co	0.081
Ni	1.073
As	0.064
Se	<LOQ
Sr	3.991
Cd	0.003
Pb	0.229

Results of Tab. 1, show a low moisture content and LHV. The pH value represents a favorable condition for reaction in conversion processes. From the elemental analysis, a higher oxygen content emerges, and Sulphur is <LOQ, therefore negligible. Furthermore, the C/N ratio, being greater than 30, suggests a more suitable applicability in thermochemical conversion processes. In Tab. 2 emerges mainly the potassium and magnesium content, and non-significant toxicity values in Tab. 3. The TBMP estimated value (294.1 mL CH_4 g-1vs) is in the range observed for waste materials from agro-food industries. The percentage of methane in biogas 41.59% represents a value slightly lower than the literature data for agro-industrial biomasses.

CONCLUSIONS

- Carob seed residues can be considered a by-product with energy and agronomic potential value, due to their composition and properties. They present characteristics such as low moisture and high C/N ratio, which make them useful in thermochemical conversion processes, and other parameters such as LHV, pH and TBMP, which could be applied in anaerobic digestion. Therefore, with regard to macro and microelements, they are also considered a value-added material in composting and fertilization processes as an organic amendment.

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Progetto "Azioni di VALOrizzazione e REcupero per le filiere Italiane di Nocciolo, CAstagno, Mandorlo,Pistacchio e carrubO - VALO.RE I.N. CA.M.P.O" - Finanziato dal MASAF D.D. N. 667521 del 30.12.2022

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