

Chemical composition, antioxidant capacity and phenolic contents of carob (*Ceratonia siliqua L.*) flour as related to seed presence and roasting effects



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PORTO

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Introduction

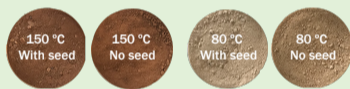
Carob is the fruit of an evergreen tree (*Ceratonia siliqua L.*) cultivated in the Mediterranean area, where Portugal has a high-cultivated extent with relevant production and low prices. Carob is well known for its valuable locust bean gum. However, carob pods contain various relevant nutrients, including proteins, carbohydrates and fiber, and phytochemicals such as polyphenols, which position carob flour with great potential to be used as a functional ingredient.

Objectives

This study aimed to evaluate the impact of different roasting processes of carob flour (with and without seeds) on its nutritional composition and antioxidant activity.

Methods

Carob pods were obtained from a local manufacturer from Algarve, Portugal. The pods were collected in September 2019 and identified. They were a blend of three varieties: Canela, Mulata da Parra and Dolores. The pods were cleaned and crushed into little pieces with a hammer. The pods pieces were separated into two groups: with seeds and without seeds. The two separated groups were roasted in an air forced draft oven at two different temperatures/times, 80 °C/ON and 150 °C/60 min. These roasting temperatures were selected for being used in conventional roasting. Then, they were milled with a hammer mil. Four samples were obtained:

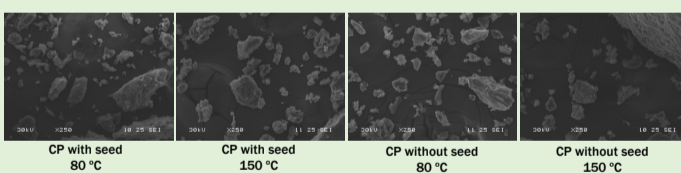


All carob powder (CP) samples were further analysed for nutritional characterization and antioxidant activity.

Results & Discussion

The milling and sieving procedure originated heterogenous carob flours with the highest particle fraction in all batches ranging between 250 and 500 µm. The results were confirmed through the SEM micrographs obtained.

Particle Size [µm]	Sample (%)			
	CP with seed		CP without seed	
	80 °C	150 °C	80 °C	150 °C
≥ 630	33.21 ± 0.14 ^b	25.51 ± 0.78 ^{a,b}	33.48 ± 0.22 ^b	24.12 ± 0.26 ^a
500 ≤ x < 630	5.18 ± 0.13 ^{a,b}	6.96 ± 0.30 ^b	7.79 ± 0.41 ^b	8.02 ± 0.27 ^{a,b}
250 ≤ x < 500	37.80 ± 3.01 ^a	49.90 ± 1.22 ^a	52.76 ± 2.46 ^a	48.03 ± 3.83 ^a
100 ≤ x < 250	23.53 ± 0.63 ^b	17.47 ± 0.37 ^{a,b}	5.97 ± 0.32 ^{a,b}	19.74 ± 0.06 ^a
< 100	0.29 ± 0.00	0.16 ± 0.00	0.1 ± 0.00	0.09 ± 0.00



Conclusions

The presence of seed in the carob powders doesn't affect particle granulometry, as well as increase the nutritional compounds. The highest roasting temperature influenced the antioxidant activity of the CPs which directly related to TPC determined. These findings confirm the importance of understanding the impact of processing on the nutritional value and bioactive properties of carob flours, to use them efficiently as a functional food ingredient

Acknowledgements

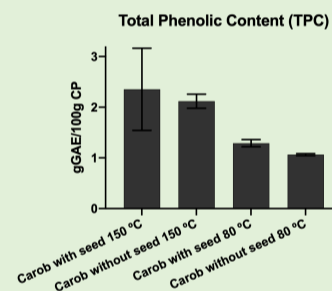
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The nutritional content on the tested CPs shows significantly lower values of moisture for CPs without seeds processed at 150 °C and higher ashes content in CPs processed at 150 °C. The differences observed might be associated with differences in drying temperatures. The high content in total carbohydrates doesn't show significant differences among sample. The total protein content exhibited a significant increase in value for CP with seed processed at 80 °C.

Content [g/100 g DW]	Sample			
	CP with seed		CP without seed	
	80 °C	150 °C	80 °C	150 °C
Moisture	4.03 ± 0.14 ^b	3.53 ± 0.78 ^{a,b}	3.93 ± 0.22 ^b	2.77 ± 0.26 ^a
Ash	3.09 ± 0.13 ^{a,b}	3.55 ± 0.30 ^a	2.66 ± 0.41 ^b	3.28 ± 0.27 ^{a,b}
Total Carbohydrate	88.06 ± 0.54 ^a	88.83 ± 0.32 ^a	89.39 ± 0.87 ^a	90.44 ± 0.20 ^a
Total Protein	4.52 ± 0.63 ^b	3.79 ± 0.37 ^{a,b}	3.92 ± 0.32 ^{a,b}	3.30 ± 0.06 ^a
Total Fat	0.3 ± 0.00	0.3 ± 0.00	0.1 ± 0.00	0.2 ± 0.00
Energy [kcal/100g]	373.02 ± 0.77 ^a	373.18 ± 1.95 ^a	374.17 ± 2.23 ^a	376.8 ± 1.04 ^a

The different superscripts in the same row were significant different ($p < 0.05$).

The TPC for 150 °C processed CPs was twice as high as 80 °C processed CPs, possibly due to the formation of Maillard reaction products (MRPs), or the degradation of certain phenolic compounds during the roasting process which originate other compounds that may increase the antioxidant activity.



The results on ORAC and ABTS assays are in accordance with TPC, therefore exhibiting higher activity for samples processed at 150 °C. These results can be due to the MRPs which have significant antioxidant activity in thermically processed foods and hydrolysable tannins which can release phenolic compounds previously chained. The DPPH assay doesn't show significant differences between samples.

