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Functional profile of carob (*Ceratonia siliqua* L.) beans and pod pulp originated from the Republic of Moldova

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Abstract: This study provides the first insight into the biologically active potential (total phenolic compounds, flavonoids, tannins and antioxidant activity) of Moldavian carob beans and pod pulp in comparison with carob grown in Algeria, Spain, and Italy. The results showed that the samples of Moldavian carob contain significant amounts ($P \leq 0.05$) of biologically active compounds, the content of some of these compounds is far exceeding that of carob from the above-mentioned regions. Thus, the total content of phenolic compounds in Moldavian carob samples is 1.4 times higher, of flavonoids 1.9 times higher compared to the imported ones. The 2,2-diphenyl-1-picrylhydrazyl (DPPH) and 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) antioxidant activity of Moldavian carob samples proved to be about 10–12% higher than the antioxidant activity of samples from other regions. It has been proved that Moldavian carob pod pulp and beans have a high biologically active potential making them possible ingredients for functional food products.

Keywords: antioxidant activity; biologically active compounds; flavonoids; phenols; tannins

Carob represents an evergreen long-lived tree, originated from the Middle East and cultivated mostly in Mediterranean countries (Portugal, Italy, Spain, Morocco, Turkey, Greece, Cyprus, Algeria, etc.). Due to its lower agronomic requirements compared to other fruit species, carob thrives on various types of soil such as rocky, dry, and sloping, as long as it is lightly fertile, and can be penetrated by the root system (Krokou et al. 2019). The plant belongs to the family Fabaceae, subfamily Caesalpinioideae with the species scientific name *Ceratonia siliqua* L., which means 'horny long pod' and conveys well the character of their leathery fruits (Srecec et al. 2018).

Carob pods, which are mainly constituted of pulp (90%) and beans (10%), are easy to harvest and process (di Guardo et al. 2019). Annual world production is estimated at over 315 tonnes of carob products (Baumel et al. 2018). Carob fruits are used in various fields, including the food industry, pharmaceutical [e.g. treatment of gastrointestinal (GI) disorders] (Kaïs Rtibi et al. 2017), cosmetic (e.g. facial care, skin depigmentation, etc.), and biotechnology industries (Roukas and Biliaderis 1995; Gilbert et al. 2013; Moreira et al. 2017; Rasheed et. al. 2019). Due to various phenolic compounds that are similar to those found in cocoa, carob can be used as a replacer of cocoa in several

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cocoa- and chocolate-based products including alternatives to chocolates, chocolate biscuits, beverages, cereal flakes and bars, yoghurt, ice cream and others (Sęczyk et al. 2016, Atasoy 2009, Tsatsaragkou et al. 2014). Considering the fact that cacao is not cultivated in the Republic of Moldova, carob is of great economic importance as raw material for different products. Numerous studies have proved that carob has antiatherogenic (Berrougui et al. 2008), antibacterial, antimicrobial, antifungal, (Aissani et al. 2012), antidiabetic (Mokhtari et al. 2011), and anti-inflammatory effects (Narin et al. 2009). Carob pods are rich in soluble sugars (about 48–56%) and have a low protein (3–4%) and lipid (0.4–0.8%) content (Biernacka et al. 2017). Concerning sugars, the carob pod contains mostly sucrose and glucose, which allows for obtaining sweet products without added sugar (Boublenza et al. 2019).

Currently, the most valuable component of the carob pod is the bean, its endosperm contains the galactomannan locust bean gum (LBG, E 410), which is used as a thickening agent and stabilizer in foods due to its high viscosity in water over a wide range of temperatures and pH (di Guardo et al. 2019).

Carob is also a good source of flavonoids, sterols, pectic substances and phenolic acids. Carob bean powder is used to enhance the nutritional value of yoghurts, pasta, bread, and cakes. Moreover, due to various phytochemicals that are similar to those found in cocoa, carob can be used as a replacer of cocoa in several cocoa- and chocolate-based products including alternatives to chocolates, chocolate biscuits, beverages, cereal flakes and bars, yoghurt, ice cream and others (Sęczyk et al. 2016).

It is necessary to note that gastronomy and folk medicine from Moldova do not have any applications for carob. Information on the study of the chemical composition and nutritional value of carob grown in the Republic of Moldova is missing. Special attention should also be paid to the research of the functional properties and use of carob pods as a source of bioactive substances with a high antioxidant potential for the production of functional products with a special purpose.

It seems that at the moment only the carob seeds are capitalised (which constitute 10–15% of the pod mass). Scientific data on the pod pulp is absent. Thus, 85–90% of carob pods are food waste, and the full recovery of pods (beans and pod pulp) would contribute to the sustainable and ecological solution to the problem of food security.

The main purpose of the paper is to study the nutritional potential of local carob, not only beans but also pod pulp, and the promotion of local carob both on the market of the Republic of Moldova and in other countries.

MATERIAL AND METHODS

Sample collection

The research was performed between Aug 2020 and Dec 2021 in the laboratories of the Department of Food and Nutrition, Technical University of Moldova. The first batch of carob (*Ceratonia siliqua* L.) pod samples for primary experimental data was collected between Aug and Nov 2020, see Figure 1. Seasonal variation in the total phenolic compound content was studied in order to determine the best period of carob sample collection. The second lot of carob pods was

Figure 1. Carob tree and unripe carob pods (central region of Moldova, July 2021, ruler length 47 cm)

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collected randomly during mid-Oct 2021 from various parts of carob trees growing naturally in different locations of the North, Central and West regions of Moldova. The harvested fruits were of uniform shape, size, and the same physiological maturity (dark brown). Carob pods were stored in a dark place, at a temperature of 21 ± 2 °C and below 70% humidity. Carob fine powder (particle size 250 μm) was obtained by grinding in a mill from manually removed beans and peeled pods (carob pod pulp). For a comparative analysis, the commercial products of carob bean powder originating from Italy, Spain, and Algeria (countries typical for the cultivation of this type of raw material) were purchased.

The assortment of carob of foreign origin is offered to the customer both roasted and raw. The technology of carob powder obtained from beans of local origin did not include heat treatment. For the correct comparative analysis within the study, imported unroasted samples of the same granulation were selected.

It should also be noted that there is absolutely no carob on the Moldavian market in any of its forms (powder, syrup, pods, beans, etc.), which served as an additional motive for the study of local raw materials. The Spanish, Italian and Algerian carob samples were bought from local supermarkets in Italy and Romania.

Material

Carob samples from Moldova, Italy, Algeria and Spain have been investigated for the content of phenolic compounds and antioxidant activity.

Preparation of carob powder extracts

In order to determine the physicochemical properties of carob powder, the technological scheme for obtaining extracts from carob powder was developed. The extracts serve as a raw material for making laboratory determinations.

Carob pod washing was performed under a stream of cold water, at a temperature of 15–20 °C for a duration of 5–10 min. The carob fruits were then dried in an oven at 30 °C for 48 h. After drying, the separation of beans from the pod pulp was performed manually. The grinding process was carried out for 4 min, using the Moulinex MC300132 grinder (SEB group, China) to obtain powder both from carob pod pulp and from beans. The extraction was performed according to Brglez et al. (2016). To realize the extraction, aliquots of 2 g of carob powder and methanol with 99.8% purity at a 1 : 1 ratio were used, and the mixture was diluted with distilled water (1 : 1 ratio). The tubes were placed in the SLN75 drying oven (POL-EKO-APARATURA, Poland) for 24 h at a temperature of 37 °C, then centrifuged in a Hettich EBA 20S centrifuge (Tuttlingen, Germany) for 15 min with a frequency of 8 000 rpm. The obtained extracts were filtered.

Methods

UV-Vis spectra analysis. The UV-Vis spectra were recorded following a certain process: lipid or methanol carob extracts were dissolved in the respective solutions at a ratio of 1 : 10, poured into 10 × 10 mm quartz cuvettes, and analysed by Shimadzu UV-1800 spectrophotometer (Shimadzu Inc., Japan) in the range of 200–900 nm. The wavelength absorption maxima, characteristic of the investigated systems (Pretsch et al. 2020), were determined against methanol as a control.

Determination of phenolic compound content (TPC). The reaction with the Folin-Ciocalteu reagent was used to determine the total phenolic compound content (TPC). For the analysis in a 10 mL volumetric flask, 5 mL of double-distilled water, 1 mL of analysed sample, and 0.5 mL of Folin-Ciocalteu reagent were assayed and shaken. After 3 min, 1.5 mL of sodium carbonate (10%) was added and the volume was filled to the mark with double-distilled water. The obtained solution was placed in the thermostatic water bath (Memmert, Germany) at 50 °C for 16 min, then cooled to room temperature. The absorbance of the extracts was read on the Shimadzu UV-1800 spectrophotometer (Shimadzu Inc., Japan) at λ = 765 nm against double-distilled water. Results expressed in mg GAE g^{-1} (GAE – gallic acid equivalent) were obtained using the gallic acid calibration curve ($y = 0.0037x - 0.0027$, $R^2 = 0.9963$; where x is the concentration of gallic acid (Musci and Yao 2017).

Determination of total flavonoid content (TFC). The total flavonoid content (TFC) was determined using formaldehyde precipitation in a strongly acidic medium. Aliquots of 2.5 mL of the extract were placed in a brown-coloured vial. Afterwards, 1.25 mL of HCl diluted with distilled water (50 : 50 by volume) and 1.25 mL of formaldehyde were added to the same vial. The mixture was left to stand for 24 h at the temperature of 4 °C. Then the mixture was filtered (paper filter) and the non-flavonoid content was determined by the method described above. It was calculated by the difference between the total content of phenolic compounds previously determined and the phenolic compound content that remained after flavonoid precipitation with formaldehyde (Cristea et al. 2019).

Determination of total tannin content (TTC). Quantitative estimation of tannin was performed

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by titrating the extract with standard potassium permanganate solution following the method of AOAC (Association of Official Agricultural Chemists). Official Methods of Analysis. Arlington, USA 1980). Aliquots of 5 mL of the extract were mixed with 12.5 mL of indigo-carmine solution and 375 mL of distilled water. The mixture was titrated against potassium manganite solution. When titrating, the blue colour of the indigo-carmine passes to the final yellow, this was considered the end-point (Khasnabis et al. 2015).

DPPH (2,2-diphenyl-1-picrylhydrazyl) antioxidant activity determination. To determine the antioxidant activity of the carob beans and pod powder, a direct reaction was carried out. Aliquots of 0.1 mL of analysed samples were added to 3.9 mL of the DPPH (2,2-diphenyl-1-picrylhydrazyl) (60 μM) methanol solution. Methanol was used as a reference sample. The samples were kept in the dark for 30 min. Meanwhile, one min apart, the absorbance was read on the Shimadzu UV-1800 spectrophotometer (Shimadzu Inc., Japan) at λ = 517 nm to construct the kinetic curves of the interaction between the studied samples and DPPH free radical solution. The antiradical activity was expressed as a percentage of DPPH reduction (Sharma and Bhat 2009).

Antioxidant activity by reaction with ABTS [2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)] radical. The antioxidant activity of the extracts was measured using the assay with ABTS [2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)] radical. ABTS was dissolved in distilled water to 7 mM concentration, after which the ABTS radical cation was produced by the reaction of ABTS stock solution with 2.45 mM potassium persulfate and allowing the mixture to stand in the dark for 12–16 h before use. Before analysis, the ABTS radical solution was diluted and equilibrated to an absorbance of 0.70 (± 0.02) at 734 nm. Aliquots of 2.0 mL of diluted ABTS radical solution were added to 20 μl of the sample, then the absorbance was measured 1 to 6 min after the initial mixing, using ethanol as a blank. The results were expressed as mmol Trolox equivalent (TEAC l^{-1}) (trolox-equivalent antioxidant capacity), from a calibration curve (0–2 000 μmol l^{-1}; R^2 = 0.9974) (Loganayaki et al. 2013).

Statistical analyses. All experiments were carried out using randomly selected raw materials. The results of all experiments were expressed as the mean of triplicate measurements with standard deviations. The data were statistically analysed by ANOVA and Tukey tests (α = 0.05), using the XLSTAT software 2020 version. In order to establish the correlation between some parameters, regression analysis was performed.

RESULTS AND DISCUSSION

In order to determine the best period of carob sample collection, seasonal variation in the total phenolic compound content was determined for carob samples every 15 days from 1st Aug to 15th Nov 2020. According to Table 1, significant differences ($P \leq 0.05$) were observed in the total phenolic compound content between the carob pod pulp and carob beans harvested at different seasonal periods.

Studies have shown a significant seasonal variation ($P \leq 0.05$) in the content of phenolic compounds in the pulp and beans of local carob pods. The total content of phenolic compounds increased gradually, reaching its maximum values in mid-Oct, after which a decrease in content was observed. Values ranged from 12.77 mg GAE g^{-1} (Aug 1) to 27.75 mg GAE g^{-1} (Oct 15) for carob beans and from 13.54 mg GAE g^{-1} (Aug 1)

Table 1. Seasonal variation in the total phenolic compound content of Moldavian carob pod pulp and carob beans (mg GAE g^{-1})

No.	Date of sample harvesting	Total phenolic compound content	
		carob pod pulp	carob beans
1	1st Aug	13.54 ± 0.54^{a}	12.77 ± 0.47^{a}
2	15th Aug	19.28 ± 0.34^{b}	17.45 ± 0.64^{b}
3	1st Sept	22.45 ± 0.46^{bc}	19.34 ± 0.58^{bc}
4	15th Sept	25.76 ± 0.27^{c}	23.67 ± 0.47^{c}
5	1st Oct	28.34 ± 0.38^{cd}	25.76 ± 0.56^{cd}
6	15th Oct	30.56 ± 0.37^{d}	27.75 ± 0.25^{d}
7	1st Nov	24.15 ± 0.24^{bc}	23.42 ± 0.51^{c}
8	15th Nov	21.63 ± 0.79^{b}	19.15 ± 0.48^{bc}

$^{a–d}$ the means in columns followed by the same letter are not statistically different ($P \leq 0.05$); GAE – gallic acid equivalent

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to 30.56 mg GAE g^{-1} (Oct 15) for carob pod pulp. It is assumed that these variations are the result of changes as the product matures. The biosynthesis of phenolic compounds can be induced by stronger sunlight, daylight h, and climatic conditions (Solar et al. 2006), therefore the content of phenolic compounds increases until mid-Oct.

Gradual ripening in optimal climatic conditions promotes the production of phenolic compounds. Their low concentration in Aug is probably associated with the vegetation stage, so the ripening process is at its initial stage. The stress conditions (temperature difference between day and night, irregular precipitation, drought) are also a probable factor that determines the increase of phenolic compound content, which explains the Oct content increase, when the climatic conditions for the ripening process in the Republic of Moldova are optimal (regular rainfall, moderate daytime air temperature, no frosts at night and the temperature varying between +7 and +9 °C).

Plants can accumulate phenolic compounds in their various tissues in response to diverse stressors (Piluzza et al. 2020). Fluctuations in the total content of phenolic compounds in the pulp and beans of carob pod, reported in the present study, can be explained by changes in environmental conditions during the year. As a result, the main studies of the carob physicochemical properties were realised for samples harvested in mid-Oct 2021 with the maximum possible content of bioactive compounds.

The analysis of carob statistical characteristics was performed for 10 lots of Moldavian carob pods, which were manually opened, removing beans and quantitatively fixing the number of fruits with and without defects (Table 2). The average weight of carob pods in a lot was 500 g, which included approximately 60 units of carob fruits.

Carob pods with obvious and localised defects that seriously impaired the appearance of the fruits, such as darkening, spots, scars, bruises and other similar defects, including different surface defects caused by mould or agricultural pests, were excluded. The yield of carob pods without defects in a lot was more than 90%.

In antiquity, dry carob beans were used as a standard weight for jewellery mass appreciation, which was known as the carat (the initial name of *Ceratonia siliqua* L.). The beans of different plants were used as mass etalon because of their invariably reputed weight. The average mass of analysed beans was very close to the metric carat (200 mg) (Lindsay et al. 2006) and amounted to 0.211 ± 0.007 g.

The yield of carob pod pulp in the samples originated from the Republic of Moldova was on average 70.8% of carob beans 29.2%. In concordance with foreign statistical data, the standard ratio of carob pulp and beans is 90–10 (di Guardo et al. 2019). This means that the yield of carob beans in Moldavian samples is higher by 20%, which represents a very good indicator of its cultivation. It is necessary to note that in most cases of carob powder production the carob pod pulp is considered food waste, and it seems that the experimental data on physicochemical properties are missing. A full valorisation of pods (beans and pod pulp) would contribute to the sustainable and ecological solution to the problem of food security.

UV-Vis spectra analysis. The application of spectral analysis to food product properties is an important developing trend in the field of quality monitoring. Spectrophotometric methods are used for different reasons, mainly to evaluate qualitatively/quantitatively the classes of compounds, their advantages are undeniable for quick and easy comparison of product composition particularities (Pretsch et al. 2020). To study the potential of carob beans and pod pulp, the UV-Vis spectra of their alcoholic extracts (solution 1 : 10) in the wavelength range of 200 to 900 nm were examined (Figure 2).

Table 2. Statistical characteristics of the quality of Moldavian carob fruits

No.	Indicators	Unit of measurement	Values
1	Number of carob pods in a lot	pcs	60.1 ± 1.8
2	Weight of carob pods in a lot	g	502.3 ± 3.7
3	Yield of carob pods without defects in a lot	%	93.2 ± 0.5
4	Average weight of carob pod	g	8.32 ± 1.86
5	Number of carob beans per pod	pcs	12.2 ± 1.3
6	Average weight of carob bean	g	0.211 ± 0.007
7	Yield of carob pod pulp	%	70.8 ± 0.6
8	Yield of carob beans	%	29.2 ± 0.4

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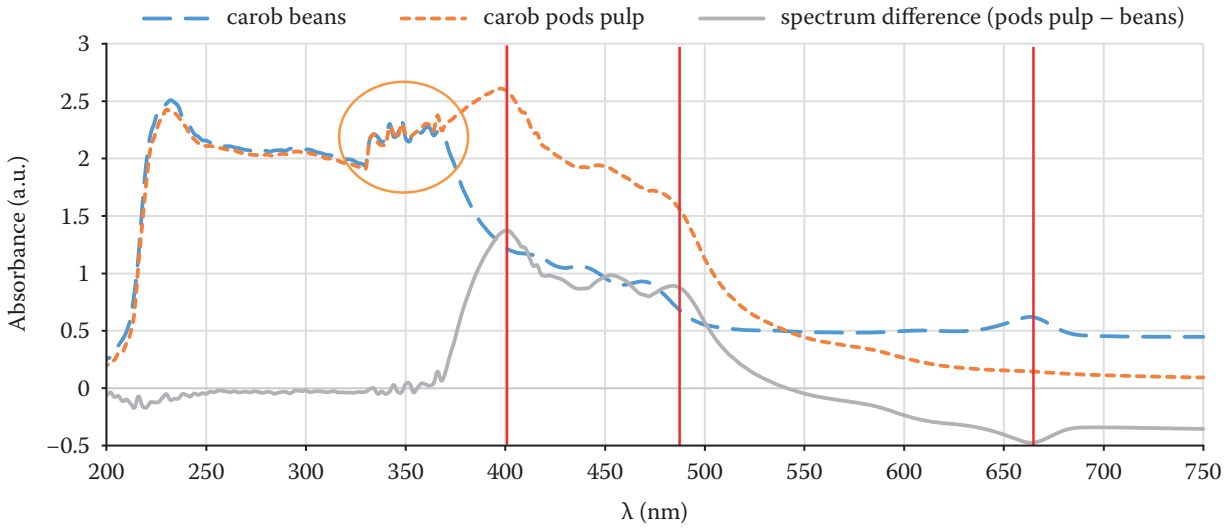

Figure 2. The UV-Vis spectra of carob methanol extracts (solution 1 : 10)

a.u. – absorbance unit

The researched extracts have similar absorption curves in the 200–320 nm wavelength range (Figure 2). This can be explained by the total absorption in that range. Peaks in the 340–360 nm range were observed. Such absorption maxima indicate the presence of flavones, flavonoids, and flavanones in the sample composition. These compounds are powerful antioxidants that help to fight cell damage, their oxidation, and help to prevent cancer and cardiovascular diseases (Morton et al. 2000).

According to peaks between 400 and 480 nm, the carotenoid composition of carob pods is more promising than that of carob beans in the methanol extracts. On the other hand, the peak at 663 nm wavelength, characteristic of chlorophyll α, was highlighted in the UV-Vis spectrum of carob bean extract (Popovici et al. 2019). This data demonstrates that the active carob components remain in their native state during the extraction and characterize the carob as a product with high nutritive potential.

For the quantitative analysis of carotenoids and chlorophylls in experimental samples of carob, lipid extracts were obtained and evaluated by UV-Vis spectroscopy (Figure 3).

Pronounced peaks registered in the range from 425 to 480 nm wavelength confirmed the presence of biologically active substances in carob samples,

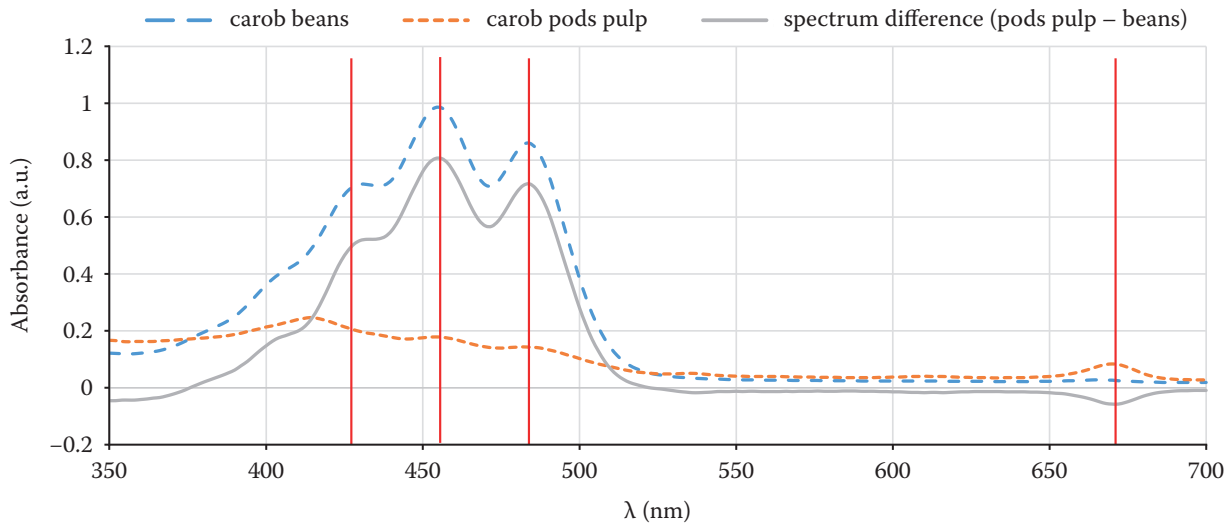

Figure 3. The UV-Vis spectra of carob lipid extracts (solution 1 : 10)

a.u. – absorbance unit

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Table 3. Phenolic compound content in carob samples

Sample	Total phenolic content (mg GAE g^{-1})		Total flavonoid content (mg GAE g^{-1})		Total tannin content (mg g^{-1})	
	min–max	mean	min–max	mean	min–max	mean
Spanish carob beans (n = 5)	20.20–26.90	22.72^{a}	0.90–1.40	1.11^{a}	0.71–1.28	0.94^{ab}
Italian carob beans (n = 5)	21.30–28.50	23.94^{a}	1.20–2.10	1.45^{b}	0.75–1.20	0.89^{a}
Algerian carob beans (n = 5)	21.90–30.10	25.15^{ab}	1.35–2.15	1.67^{c}	0.80–1.22	1.01^{b}
Carob pod pulp from Moldova (n = 10)	27.90–35.60	30.56^{c}	1.67–2.56	1.98^{d}	1.30–1.92	1.51^{d}
Carob beans from Moldova (n = 10)	25.40–29.80	27.75^{b}	1.28–2.48	1.74^{cd}	1.10–1.45	1.262^{c}

$^{a–d}$ The means in columns followed by the same letter are not statistically different ($P \leq 0.05$); n – number of samples from each region; GAE – gallic acid equivalent

belonging to the group of carotenoids (α-carotene, β-carotene, lycopene, zeaxanthin). Maximum absorption at 410 and 670 nm wavelength demonstrated the presence of the chlorophyll group. It should be noted that the UV-Vis spectra analysis of lipid carob extracts established the high carotenoid concentration in carob beans and the chlorophyll potential of pod pulp, which is clearly shown in spectrum differences.

Phenolic compound content and antioxidant activity. Carob is enriched with several primary metabolite classes, including sugars, galactomannan gum, aside from proteins, fatty acids, minerals and dietary fibres. Carob secondary metabolites also draw attention for its use as a functional food, mostly for its abundance in phenolic acids, tannins and flavonoids (Rasheed et al. 2019, see Table 3).

Experimental data showed a high content of phenolic compounds in carob, both in beans and in carob pod pulp. Comparative analysis of the experimental data shows that the phenolic compound content in local carob beans is higher than in the carob beans imported from Spain, Italy and Algeria, but the difference is not considerable and on average it is higher by 16%. For imported and local beans, the phenolic compound content ranged from 22.94 to 27.75 mg GAE g^{-1}. The content of phenolic compounds in the local pod pulp is 30.56 ± 0.37 mg GAE g^{-1}, which exceeds the average content of phenolic compounds in all bean samples (28%) and confirms the high biological potential of this raw material.

The content of flavonoids and tannins showed the same trend. According to the obtained results, the total flavonoid content of imported carob beans is almost the same. The flavonoid content in the local pod pulp is 1.98 ± 0.19 mg GAE g^{-1} and the tannin content amounts to 1.51 ± 0.08 mg g^{-1}, which is more on average by 45% and 60%, respectively, in comparison with imported beans samples. The difference in the composition of biologically active substances in local and imported beans is not so significant (27–33%, $P \leq 0.05$). Therefore we can conclude that the local beans do not have a lower quality index than the imported ones, but the local pod pulp should be considered an important source of biologically active compounds.

The DPPH and ABTS radical scavenging ability of methanol carob extracts is shown in Table 4. The analysis of these parameters is necessary because certain biologically active substances have different antioxidant activities.

Table 4. Antioxidant activities of biological compounds in carob samples

Sample	DPPH antioxidant activity (%)		Antioxidant activity by reaction with ABTS radical (mg TEAC g^{-1})	
	min–max	mean	min–max	mean
Spanish carob beans (n = 5)	75.10–79.70	77.36^{a}	18.90–20.80	19.87^{a}
Italian carob beans (n = 5)	77.80–82.50	80.12^{b}	20.40–22.50	21.42^{b}
Algerian carob beans (n = 5)	79.20–83.40	81.28^{b}	20.60–22.90	21.79^{b}
Carob pod pulp from Moldova (n = 10)	84.10–86.20	85.13^{c}	24.30–26.70	25.52^{c}
Carob beans from Moldova (n = 10)	79.50–83.30	81.40^{b}	24.10–25.60	22.84^{bc}

$^{a–c}$ The means in columns followed by the same letter are not statistically different ($P \leq 0.05$); DPPH – 2,2-diphenyl-1-picrylhydrazyl; ABTS – 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid); TEAC – trolox-equivalent antioxidant capacity; n – number of samples from each region

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Table 5. Correlation coefficient R^2 between the antioxidant assay and total phenolic content (TPC), total flavonoid content (TFC), and total tannin content (TTC) of carob beans and pulp

Antioxidant assay	R^2		
	TPC	TFC	TTC
DPPH	0.94	0.97	0.86
ABTS	0.98	0.94	0.93

R^2 – correlation coefficient; TPC – totalphenolic content; TFC – total flavonoid content; TTC – total tannin content; DPPH – 2,2-diphenyl-1-picrylhydrazyl; ABTS – 2,2'-azinobis(3-ethylbenzothiazoline-6-sulfonic acid)

The obtained results show a significant ($P \leq 0.05$) direct correlation (Table 5) between the total flavonoids, tannins and phenolic compounds and the antioxidant capacity of carob beans and pod pulp.

This fact can be explained by the antioxidant potential of the phenolic compounds in the studied product and by the fact that it has undergone similar processing treatments.

Therefore, it can be concluded that carob is an important agri-food source in order to obtain functional compounds. Similar data were obtained by Kumazawa et al. (2002) when antioxidant activity and polyphenols of carob pods were studied. According to Singh et al. (2016) the established correlation is due to the electron-donating properties of phenolic compounds.

CONCLUSION

In this work data on the composition of bioactive compounds such as phenolics and their antioxidant activity in Moldavian carob pods are reported for the first time. Particular attention was paid to research into the functional properties and use of carob as a source of bioactive substances with high antioxidant potential for the production of special-purpose functional products.

Due to the evaluation of the total phenolic compound content, the optimal harvesting period of carob was determined to be mid-Oct. After testing the potential of carob (*Ceratonia siliqua* L.), it was found that carob is an important source of phenolic compounds, which have high antioxidant activity and exhibit antiradical properties, it is an important source of tannins, which have an inhibitory role in digestive enzymes.

Carob pod pulp and beans from the Republic of Moldova are an important source of biologically active compounds compared to carob grown in other regions. This property makes carob a possible functional ingredient in order to obtain functional products with a flavour of dark chocolate or caramel, without the need to add sugar or other types of sweeteners.

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