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Enhancement of semolina pasta with carob molasses pulp

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Abstract: This study aimed to determine the effect of carob molasses pulp flour (CMP) at 5.0, 7.5, and 10.0% on the chemical composition and properties of eggless semolina pasta in terms of colour, nutritional value, cooking quality, and sensory properties. As presumed, carbohydrate and energy values of CMP-added pasta (carbohydrates 73.31–77.40%) were lower than the control (82.17%), whereas dietary fibre values were up to 4 times higher (8.18–12.60% *vs.* 3.71%). There was not a significant difference in the amount of fat (0.48–0.70%), optimum cooking time (6.56–7.06 min), or cooking loss (10.43–12.57%) of CMP-added pasta compared to the non-enriched counterpart ($P > 0.05$). All formulations were sufficient in terms of sensory properties; colour shift occurred in the direction from standard yellow to the dark brown area. The results showed that even the maximal tested dosage of the CMP equal to 10.0% could produce pasta with satisfying overall quality.

Keywords: fortified pasta; cooking quality; fibre; carob by-product; pasta colour; sensorial properties

Among the cereal products, pasta is the second most popular food after bread. It is widely consumed because it is inexpensive, easy to prepare, and has a long shelf-life. High-quality pasta is made with wheat semolina because of its exceptional cooking quality and position in consumer acceptance (Michalak-Majewska et al. 2020). However, it is usually obtained from refined coarse flour of durum wheat [*Triticum turgidum* subsp. *durum* (Desf.)] is rich in carbohydrates but low in phytochemicals, micronutrients, and fibre.

Dietary fibre (DF) plays a vital role in the human body (Dziki 2021). It has various health benefits, improving gastrointestinal health and lowering the risk of chronic diseases such as heart disease, diabetes – type 2, high blood cholesterol, insulin resistance, obesity, and cancer. Moreover, glucose release may be significantly lowered after fibre-added pasta consumption (Tudorică et al. 2002). For barley and oat beta-glucans, sorted among fibre, the European Food Safety Authority has successfully assessed two health claims [EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA) (2011)]. Thus, much attention has been focused on enriching pasta with DF (Dziki 2021).

The addition of bioactive ingredients to pasta is very common nowadays. Vegetable purees (Rekha et al. 2013), onion skin powder (Michalak-Majewska et al. 2020), dried leaves of hairy rock-rose *Cistus incanus* (Lisiecka 2019), and legume flour (Teterycz 2020), carob fibre (Biernacka et al. 2017), banana powder (Biernacka et al. 2020), inulin (Aravind et al. 2012), wheat bran (Sobota et al. 2015), or guar (Tudorică et al. 2002) have been used to fortify pasta. However, DF substitution levels in food formulation are still under investigation in terms of pasta quality, cooking characteristics, structure, texture, and starch digestibility (Tudorică et al. 2002). But in general,

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maximal replacement of the basic flour lies in a range of 15–20 wt%. Thus, the development of pasta with fibre, antioxidants, and resistant starch can improve its nutritional value (Sissons 2008).

Carob bean (*Ceratonia siliqua* L.), which grows widely in the Mediterranean region of Türkiye, consists of 90% pod and 10% seeds (Yalımkaya and Özdemir 2022). Generally, the carob pod is consumed as fresh or processed into a cocoa-like carob powder, carob syrup, and carob molasses. The carob pods contain nutritional components such as minerals (calcium, iron, potassium, etc.), carbohydrates (especially glucose, fructose, and sucrose), and functional components like polyphenolic compounds and dietary fibres with antioxidant activity. Carob products are used in a wide range of food and beverage formulations such as cereal ones (bakery products, pasta, snacks, or health bars), confectionery ones (sweets, cocoa, and chocolate alternatives plus carob spreads), and finally, infusions, and teas (Ozdemir et al. 2021). By-products or wastes of the carob industry, namely molasses, carob extracts and carob syrup, represent inexpensive and available raw materials. The carob pulp molasse (CMP) could serve to produce value-added products that contain high amounts of fibre and polyphenols. It has hypercholesterolaemic properties, improves bowel movements, and prevents diabetes, heart disease, and colon cancer (Owen et al. 2003). However, it is usually disposed of as waste, with very little use as animal feed. The addition of CMP provides product enhancement in DF, minerals, and antioxidants (Özdemir et al. 2022). It has no negative effect on the sensorial properties of foods, so it has been used to fortify the sucuk, a traditional Turkish meat product (up to 10%, Özdemir et al. 2021) and ice cream cone (up to 15%, Özdemir et al. 2022).

This study aimed to determine the characteristics of semolina and CMP and investigate the effect of CMP addition (5–10%) on some physicochemical and cooking properties and sensory attributes of semolina eggless pasta.

MATERIAL AND METHODS

Raw CMP, produced in 2019 in the form of pulp, was obtained from a local carob molasses producer in Mersin, Türkiye. Semolina flour produced in 2019 was supplied by a pasta company, Durum Gida S.A., located in Mersin, Türkiye. The same company also process the durum grain harvested in Türkiye. All chemicals used for the analyses were of analytical grade.

Preparation of carob molasses pulp flour

The raw CMP was dried in an oven (J.P. Selecta, Spain) with up to 13% moisture content at 60 °C. The chunks were milled in a laboratory mill IKA (M20; Labortechnik, Germany) at 20 000 revolutions per minute (rpm) for 1 min. The fraction of this flour was separated using Sieve Shakers (Restch, Germany) with the sieve of 300 μm (working batch, 10 min at 0.90 $mm \cdot g^{-1}$, collecting underflow). Then, it was packed in 500 g of airtight polyethylene bags, closed, and held at 4 °C until further analyses.

Preparation of pasta

Control pasta (C) was prepared by using pure wheat semolina characterised by a median granulation of 300 μm. Distilled water portion formed 27% of flour weight according to the recommendation of this raw material producer. CMP-added pasta was prepared with constant water addition as semolina : CMP : water for variants CMP 5.0 (95 : 5 : 27), CMP 7.5 (92.5 : 7.5 : 27), and CMP 10.0 (90 : 10 : 27) to be able to evaluate the effect of substitution directly. Two-factorial experiments, including the CMP additions at constant pasta-dough consistency (i.e. with adapted portions of recipe water), could be carried out as a next step. The pasta was processed using the method Biernacka et al. (2017) and Dziki (2021) specified. A pilot-scale pasta press (Dolly, Italy) with a vat capacity of 2.5 kg was used. Dry components were homogenised for 5 min. Later, the dough was kneaded in the kneading section for 10 min, and a shortcut penne die was made. A pilot-scale batch-type dryer (Inoksan, Türkiye) was used to remove the moisture from the samples up to 13% moisture content for 90–110 min at 70 °C. Samples were stored in a dark room at 21 °C in polyethene packages until analyses were performed.

Quality characteristics

Analysis of semolina, CMP flour, and pasta. Contents of basic nutritional components were determined according to international norms: moisture analysis (AACC Method No. 44-15A, AACC 2000), fat (AOAC 963.15), proteins (AOAC 992.23), wet and dry gluten (AOAC 38-10.01), sugar components (AOAC 980.13), total sugar (AOAC 920.64), and dietary fibre (AOAC 991.43), ash (AOAC 940.26) (AOAC 1990), and total polyphenols (TPC) as a gallic acid equivalent (GAE) (Yalımkaya and Özdemir 2022).

The carbohydrates and energy amounts were calculated in the agreement paper published by Dülger Altıner and Hallaç (2020) using the formula below (the relevant model is given in Equations 1 and 2).

https://doi.org/10.17221/152/2023-CJFS

$$Carbohydrate\ (\%) = 100 - [moisture\ (\%) + ash\ (\%) + protein\ (\%) + fat\ (\%)] \quad (1)$$

$$Energy\ (\text{kcal}) = 9 \times fat\ (\%) + 4 \times protein\ (\%) + 4 \times [carbohydrate\ (\%) - dietary\ fibre\ (\%)] \quad (2)$$

Technological quality of the pasta. Optimum cooking time (*OCT*; min), weight increase (*WI*; %), and cooking loss (*CL*; %) were determined according to the Approved Method 66-50 (AACC 2000). Pasta samples (100 g) were cooked in boiling distilled water with a pasta : water ratio 1 : 10. A sample was removed from the boiling water every 30 s and examined by squeezing it between two transparent glass slides. The time required for the white-opaque core to disappear was determined as the *OCT*. Cooked at the *OCT*, the water was drained and weighed, and the weight increase was calculated as a percentage by subtracting the weight of the uncooked pasta, as shown in Equation 3. The cooking loss was calculated according to Equation 4. Distilled water (250 mL) was placed in a 500 mL beaker and boiled. Then, a 10 g pasta sample was added and cooked. The filtrate obtained at the end of cooking was placed in glass Petri dishes previously tared at a fixed weight. The sample was dried in an oven at 98 °C to constant mass. It was then transferred to a desiccator, cooled, and weighed.

$$Weight\ increase\ (\%) = \frac{100 \times \left(M_{cp} - M_{dp}\right)}{M_{dp}} \quad (3)$$

where: M_{cp} – mass of the cooked pasta (g); M_{dp} – mass of the dry pasta (g).

$$Cooking\ loss\ (\%) = \frac{100 \times \left(G \times DF\right)}{100 - R} \quad (4)$$

$$DF = \frac{350 \times 100}{25 \times 50} = 28$$

where: G – mass difference between beakers before and after the drying (g); DF – dilution factor; R – moisture content of dry pasta (%).

Colour measurement. The colour of dried pasta granules (300 μm, collecting underflow) was determined by using Hunter colour parameters lightness (L^*), redness (a^*), and yellowness (b^*) with apparatus Minolta CR400 (KonicaMinolta, Japan). The results were presented as the average of three measurements of each sample. In the triple scale of CIE Colour space, L^* = 100 was evaluated as white, L^* = 0 as black, high positive a^* as red, high negative a^* as green, high positive b^* as yellow, and high negative b^* as blue. Colour change was expressed as total colour difference (ΔE) and browning index (BI) according to Equation 5 and 6, respectively (Dey et al. 2023):

$$\Delta E(1) = \begin{bmatrix} \left(L^*_{sample} - L^*_{control}\right)^2 + \\ + \left(a^*_{sample} - a^*_{control}\right)^2 + \\ + \left(b^*_{sample} - L^*_{control}\right)^2 \end{bmatrix}^{\frac{1}{2}} \quad (5)$$

$$BI = \frac{100 \times \left(x - 0.31\right)}{0.17} \quad (6)$$

$$x = \frac{a^* + 1.75 L^*}{5.645 L^* + a^* - 3.012 b^*}$$

In the CIELab colour space, the parameter ΔE quantifies the distance between the enriched sample and the control based on Euclidean rectangular metrics.

Sensory evaluation of cooked pasta. Sensory analysis of pasta was carried out with 24 trained panellists (75% male and 25% female, mean age 32 ± 7, non-smokers, informed in advance) of Durum Gida pasta company. Samples were cooked in boiling water at their *OCT*s, drained, and served separately in plates coded with three digits at room temperature. Sensory parameters of cooked samples were evaluated by applying a 9-point linear hedonic scale scoring test (from 1: extremely dislike to 9: extremely like, Rekha et al. 2013). Mean results are presented in a graphical form.

Statistical analysis

All experiments were conducted in triplicate, and the average and standard deviations were summarised into tables. The experimental data was evaluated by t-test and analysis of variance (ANOVA) with multiple comparisons using Duncan's test ($P \leq 0.05$) to detect any significant differences in semolina and CMP flour and pasta, respectively (SPSS, version 20).

https://doi.org/10.17221/152/2023-CJFS

RESULTS AND DISCUSSION

Composition of semolina and CMP flour. Compositions of semolina and CMP flour are shown in Table 1. The moisture and ash contents of the CMP flour were 12.51% and 2.70%, respectively. The moisture and the ash contents of carob pulp were found in the range of 0.2–13.47% and 2.44–3.89%, respectively (Özdemir et al. 2022). Semolina and CMP flour's protein content was 11.62% and 5.35%, respectively. Protein amount in durum semolina typically ranges between 11% and 16% (dry weight basis), with the optimum amounts determined by the producers (Sissons 2008). The results of semolina and CMP analysis were found to be significantly different from each other, except for the oil composition. According to the *t*-test, this difference was statistically significant within the 99% confidence interval ($P < 0.01$). The amount of gluten in semolina is important for pasta quality. Wet gluten is an elastic substance formed by the swelling of gliadin and glutenin proteins in the wheat composition by absorbing water during kneading (necessary input of mechanical energy). Dry gluten is the amount of wet gluten obtained by removing the moisture of the wet gluten with a drying device and weighing approximately 1/3 of the wet gluten. It has been revealed that strong gluten with high elasticity produces pasta with good cooking quality. A high proportion of protein and strong gluten is required to obtain pasta of the desired quality (Sissons 2008). Semolina contains 30.63% wet and 10.45% dry gluten. However, in CMP, any gluten is presented naturally, which could benefit consumers with gluten intolerance (CMP could serve as a food supplement). The carbohydrate content of CMP was found to be approximately 10 times lower than in semolina as a result of sugar extraction, and its energy value was reported to be approximately 30% lower than in semolina. Semolina had 22 times less dietary fibre than CMP flour. Among the sugar representatives, only fructose was detected in CMP flour after molasses production. Sucrose constitutes 33% of the total sugars in the carob fruit, followed by fructose at 9.0% and glucose at 2.3% (Yalımkaya and Özdemir 2022).

Carob flour is rich in antioxidants, which can resist its processing, so CMP flour has the same content. The total polyphenol content of CMP flour resulted in 1.40% GAE. Adding antioxidant-rich materials such as banana powder to the pasta enhances the antioxidant capacity of the cooked (final) product (Biernacka et al. 2020). When carob flour was used, TPC increased, and antioxidant-rich pasta could be characterised as having better health-promoting attributes (Biernacka et al. 2017).

Table 1. Chemical analysis of semolina and carob molasses pulp flour (CMP)

Constituent	Semolina	CMP
Moisture (%)	13.20 ± 0.34	12.51 ± 0.39**
Ash (%)	0.94 ± 0.03	2.70 ± 0.15***
Protein (%)	11.62 ± 0.55	5.35 ± 0.25***
Dry gluten (%)	10.45 ± 0.30	–
Wet gluten (%)	30.63 ± 0.40	–
Fat (%)	1.72 ± 0.18	1.70 ± 0.13^{ns}
Carbohydrates (%)	69.13 ± 1.63	6.43 ± 0.28***
Fructose (%)	–	1.10 ± 0.02
Dietary fibre (%)	3.54 ± 0.32	78.83 ± 2.88***
GAE (%)	–	1.40 ± 0.31
Energy (kcal)	342.00 ± 22.00	220.00 ± 6.24***
Lightness (L^*)	87.15 ± 0.56	52.42 ± 0.33***
Redness (a^*)	–1.85 ± 0.03	5.23 ± 0.19***
Yellowness (b^*)	19.93 ± 0.18	13.46 ± 0.22***
ΔE^*	0.00 ± 0.00	36.03 ± 0.72***
Browning index	23.71 ± 0.17	36.52 ± 0.82***

, * Significant at $P \leq 0.01$ and $P \leq 0.001$, respectively; ^{ns} not significant; values are means ± SD; $n = 3$; GAE – gallic acid equivalent; ΔE – total colour difference

https://doi.org/10.17221/152/2023-CJFS

The colour of the ingredients used in preparing pasta dough predetermined the final product's colour. Semolina's gold tint is reflected in the characteristic colour of semolina eggless pasta. The base of this bright yellow reflects the presence of active lipoxygenase and carotenoid pigments. Lightness L^* value was lower because of the incorporation of polyphenols such as tannins, redness/greenness a^* value was higher because of cyanidins, and yellowness/blueness b^* value was lower because of the lack of carotenoid pigment in the CMP structure.

Chemical characteristics of control and dried pasta. The chemical values of the pasta samples are shown in Table 2. In the case of the addition of other alternative raw materials, the moisture content was 11–12% in pasta enriched with banana powder (Biernacka et al. 2022), 11% with carob flour (Biernacka et al. 2017) and 12% with the addition of leaves from hairy rockrose (*Cistus incanus* L., Lisiecka 2019). Adding green pea flour, red lentil flour, and grass pea flour resulted in a moisture content of 9.45–10.33% (Teterycz 2020). Vimercati (2020) stated that less than 12% moisture content ensures microbiological steadiness necessary for long-term storage.

According to national standard TS 1620 (2016), the protein amount should be at least 10.5% in dry matter, and the humidity should be 13.0% at most. Viscoelastic properties of cooked semolina pasta are based on the disulphide, hydrogen, and hydrophobic bonds between proteins. The structure of these bonds determines the matrix's tenacity and firmness, which perish moderately, releasing exudates during starch granule gelatinisation during the cooking process. It also causes an increment in cohesiveness and stickiness on the cooked pasta surface (Tudorică et al. 2002). Lower pasta stickiness was observed in spaghetti fortified with chickpea flour with higher protein and amylose contents (Wood 2009). The adhesiveness and stickiness in inulin-added pasta improved depending on the inulin addition to pasta (Tudorică et al. 2002). The hardness of cooked pasta increases due to the high protein in the pasta as the *CL* decreases. A diminished *CL* was observed for carob fibre-enhanced pasta, presenting a less disrupted protein-starch matrix (Biernacka et al. 2017). Pasta cooking losses could be reduced by adding insoluble dietary fibre (Aravind et al. 2012). The protein amount in the structure of the CMP pasta decreased because of the lack of protein in the CMP itself. However, depending on the protein content of the added ingredients such as legumes, e.g. soy flour (Dülger Altıner and Hallaç 2020), green pea flour, red lentil flour, and grass pea flour (Teterycz 2020), the protein proportion in pasta can be maintained even elevated.

The ash content was higher in CMP pasta than in the control. The same trend was observed with the addition of wheat bran (Sobota et al. 2015) to pasta. Usually, the higher the amount of ash, the darker the tint of the raw material, and such a supplement resulted

Table 2. Quality of uncooked semolina control and carob molasses pulp (CMP)-enriched pasta and cooking properties of semolina control and CMP-enriched pasta

Quality of uncooked pasta/ cooking properies	Pasta variant			
	control	CMP 5.0	CMP 7.5	CMP 10.0
Pasta quality attribute				
Moisture (%)	11.38 ± 0.76^{a}	9.31 ± 0.97^{b}	7.61 ± 0.98^{c}	9.16 ± 1.70^{d}
Ash (%)	1.04 ± 0.01^{c}	1.22 ± 0.26^{b}	1.24 ± 0.03^{b}	1.29 ± 0.25^{a}
Proteins (%)	12.74 ± 0.47^{a}	12.48 ± 0.23^{ab}	12.37 ± 0.32^{bc}	12.05 ± 0.30^{c}
Carbohydrates (%)	82.17 ± 1.93^{a}	77.40 ± 1.55^{b}	75.03 ± 0.65^{c}	73.31 ± 0.70^{d}
Fat (%)	0.48 ± 0.15^{b}	0.50 ± 0.19^{ab}	0.63 ± 0.22^{ab}	0.70 ± 0.24^{a}
Dietary fibre (%)	3.71 ± 0.35^{a}	8.18 ± 0.94^{b}	11.25 ± 0.30^{c}	12.60 ± 0.23^{d}
Energy (kcal)	369 ± 8^{a}	331 ± 9^{b}	310 ± 5^{c}	297 ± 2^{d}
Cooking properties				
Optimum cooking time (min)	6.95 ± 0.30^{a}	6.83 ± 0.56^{a}	7.06 ± 0.77^{a}	6.56 ± 0.53^{a}
Weight increase (%)	155.44 ± 2.60^{b}	144.11 ± 2.76^{c}	155.33 ± 2.24^{b}	165.67 ± 2.60^{a}
Cooking loss (%)	11.83 ± 1.84^{a}	11.64 ± 2.10^{a}	10.43 ± 1.75^{a}	12.57 ± 2.51^{a}

$^{a–d}$ Values in the same column are not significantly different ($P > 0.05$); values are means ± SD; $n = 3$; CMP 5.0, CMP 7.5, and CMP 10.0 – pasta variants with 5.0, 7.5, and 10.0% of carob molasses pulp, respectively, as semolina replacement in a darker colour of pasta, as in the case of legume flour (Teterycz et al. 2020).

The amount of carbohydrates in the pasta got lower due to the low amounts of carbohydrates in CMP than in semolina. Consecutively, the energy content of the pasta has been lowered as well. Total carbohydrate content and energy amount varied between 64.35–74.50% and 313–339 kcal, respectively, as the amount of soy flour and carob flour in the pasta changed (Dülger Altıner and Hallaç 2020). The antioxidant content of the pasta (TPC) was enhanced by substituting CMP for semolina.

The amount of dietary fibre in the pasta is enhanced because of the CMP composition compared to semolina. The fibre content of pasta increased when carob flour was added at a rate of 1–5% of the pasta (Seczyk et al. 2016). Dried celery root and dried sugar beet pulp powder added-pasta resulted in higher absorption of water (Minarovičová et al. 2018). Adding non-starch polysaccharides to pasta improves water absorption by disrupting the protein matrix, facilitating the swelling of starch granules, and thus shortening the *OCT* (Kaur et al. 2012).

Cooking properties of pasta. The cooking quality of pasta variants is shown in Table 2. The optimum cooking time of the pasta predetermines the textural properties of the pasta. Biernacka et al. (2017) found that the lowest values of optimum cooking time were obtained for 4% and 5% carob fibre samples, whereas the highest values were obtained for control wheat pasta.

The weight increase value escalates with the CMP addition. Rekha (2013) reported that the water absorption percentages for pasta made with carrots, spinach, tomato, and beetroot were 116.5, 116.3, 105.8, and 118.8%, respectively. Biernacka et al. (2017) enriched pasta by 15% of the dietary fibre extracted from carob fruit and noted the weight increased by about 5–9%. Similarly, the weight increase improved with the stepwise rise of banana powder in portions of the pasta (Biernacka et al. 2020).

The cooking loss is related to pasta's resistance to disintegration, i.e. biopolymer extraction by boiling water during pasta cooking. The higher the cooking loss, the less transparent the cooking water becomes, showing that the cohesivity of the pasta is insufficient, the starch solubility is high, and the cooking tolerance is low; in a general overview, all those trends are undesirable for pasta. For good-quality pasta, the cooking loss should be minimal (Rakhesh et al. 2014); according to national Pasta Standard 'TS 1620' (2016), it should be at most 10% in dry matter.

Colour of dried pasta. The colour values of the pasta variants are shown in Table 3. The L^* and b^* values got lower, and the a^* values got higher for CMP pasta. Values of L^*, a^*, and b^* decreased compared to the control when 5% carob flour was added to pasta (Biernacka et al. 2017). Also, the colour of the pasta was affected unfavourably with the addition of bananas (Biernacka et al. 2020), and L^*, a^*, and b^* of the legume-added pasta were reduced as a result of cooking (Teteryzc 2020).

The browning index of the CMP demonstrated significant changes ($P < 0.01$) compared to semolina. The values of CMP-added pasta showed the only significant changes ($P < 0.05$) for the CMP 5.0, CMP 7.5, and CMP 10.0. These indexes are like the values of control pasta.

Pasta sensory evaluation. The images and sensory evaluation of uncooked and cooked pasta are illustrated in Figures 1 and 2, respectively. There was no statistically significant difference in firmness of pasta, which is anticipated to decrease when the fibre is used instead of semolina (Rakhesh et al. 2014). Similarly, when adding banana powder, pasta's firmness lowered by more than 3% (Biernacka et al. 2020). As wheat spaghetti contains more proteins, less water is absorbed into the pasta during cooking. Chickpea-added spaghet-

Table 3. The colour parameters of control and CMP-enriched dried pasta

Pasta variant	Colour parameter				
	lightness (L^*)	redness (a^*)	yellowness (b^*)	ΔE	BI
Control	82.54 ± 0.11^a	-1.25 ± 0.07^d	23.39 ± 0.76^a	0.00 ± 0.00^d	31.31 ± 1.31^a
CMP 5.0	62.50 ± 0.46^b	4.27 ± 0.24^c	14.90 ± 0.17^b	22.47 ± 0.49^c	31.78 ± 0.36^a
CMP 7.5	58.96 ± 0.29^c	4.89 ± 0.97^b	13.34 ± 0.34^c	26.37 ± 0.46^b	31.30 ± 0.65^a
CMP 10.0	55.03 ± 1.46^d	5.52 ± 0.13^a	11.58 ± 4.63^d	30.63 ± 1.55^a	30.13 ± 0.82^b

[a–d] Values in the same columns are not significantly different ($P > 0.05$); values are means ± SD; $n = 3$; ΔE – total colour difference, a measure of the distance of fortified pasta to control in CIELab colour space (Equation 5); BI – browning index; CMP 5.0, CMP 7.5, and CMP 10.0 – pasta variants with 5.0, 7.5, and 10.0% of carob molasses pulp, respectively, as semolina replacement

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Figure 1. Appearance of uncooked and cooked control (C) semolina pasta and counterparts with 5.0, 7.5, or 10.0% of carob molasses pulp (CMP) as semolina replacement (CMP 5.0, CMP 7.5, CMP 10.0, respectively)

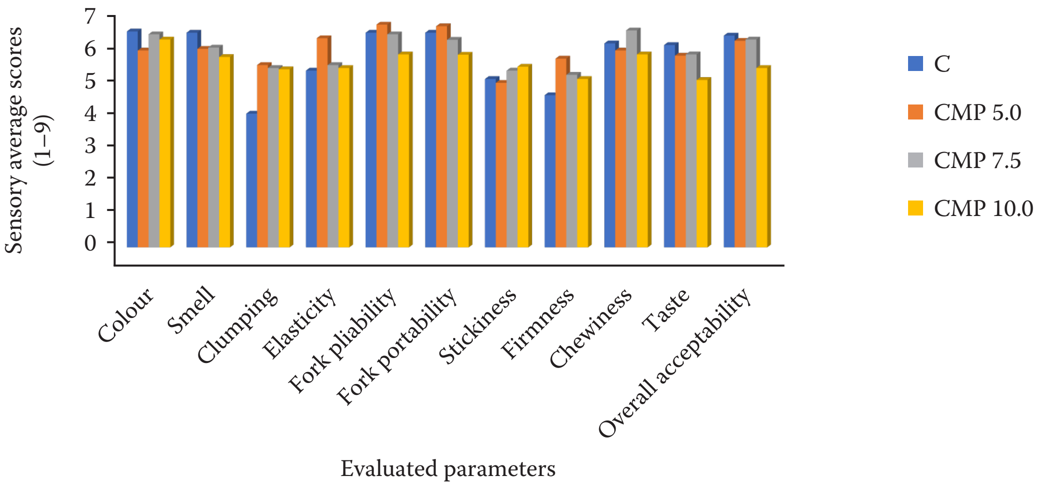

Figure 2. Sensory evaluations of control (C) semolina pasta and counterparts with 5.0, 7.5, and 10.0% of carob molasses pulp (CMP) as semolina replacement (CMP 5.0, CMP 7.5, and CMP 10.0, respectively)

ti showed similar firmness to the control at 10% and 15% substitution levels, whereas firmness decreased at 20–30% substitution levels (pasta has been softened; Wood 2009).

CONCLUSION

Fortified semolina pasta was produced by adding CMP to the formulations as semolina replacement (5–10 wt%). There was a stepwise expansion in the proportions of ash, dietary fibre, total phenolic content, and weight increase in the pasta. In contrast, ones of protein, carbohydrate, and energy values were reduced compared to the control semolina. With the elevating CMP concentrations, L^* and yellowness b^* of the CMP-added pasta decreased, and reversely, the redness a^* pasta colour shift occurred in the direction of dark brown. It has been concluded that CMP may replace up to 10% wheat flour in a pasta recipe.

https://doi.org/10.17221/152/2023-CJFS

The high amount of dietary fibre shows that CMP is an advantageous raw material for increasing the nutritional values of food products and reversing their energy potential. By introducing CMP to the food industry, foods rich in fibre and antioxidants will be produced at lower costs with the current technology. New and healthier products will be brought to the food sector without additional processes and costs. Enriching pasta, which has an extremely important place in human nutrition regarding digestible polysaccharides, will further increase its importance in terms of health. Adding CMP to the pasta will enable consumers to use this fruit, which has high nutritional value widely. Therefore, foodstuffs containing carob fruit will be preferred because of their positive effects on health. Furthermore, carob cultivation will gain importance in this way and increase the market share of carob fruit in the agricultural sector. The use of fibre-rich CMP, known as waste in the market, in different sample types will be beneficial both in terms of increasing the usefulness of the food samples used and in terms of food waste evaluation. Both environmental and economic contributions can be provided by using CMP, which is a remaining from carob molasses production.

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