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AN INVESTIGATION OF THE EFFECT OF CHESTNUT FLOUR ADDITIVE ON THE NUTRITIONAL AND QUALITY PROPERTIES OF NOODLE

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ABSTRACT
Chestnut flour (CNF) was added as a substitute for wheat flour in the ratios of 5%, 10%, 20%, 30% and 40% (w/w) to noodle. The physiochemical, cooking and sensory properties of the CNF -added noodles were determined. The total dietary fiber and ash contents of the noodles increased with increasing CNF, while the calorie values decreased compared with control. Decreasing L^* and b^* values, darkening color and increasing a^* values were observed with increasing CNF addition. The CNF addition caused increased cooking loss and decreased volume expansion and weight gain in noodles. According to the sensory analysis, the control sample had the highest overall appreciation score, followed by the 10% CNF-added noodle sample. The results of the study showed that chestnut flour can be added to improve the nutritional and functional properties of noodle and other grain products and use of chestnut flour can contribute to the functional food market.
Key words: Noodle, chestnut flour, total dietary fiber, functional food, sensory

KESTANE UNU KATKISININ ERİŞTENİN BESLEYİCİ VE KALİTE ÖZELLİKLERİNE ETKİSİNİN ARAŞTIRILMASI

ÖZ
Bu çalışmada, erişte üretiminde kestane unu (CNF) % 5, 10, 20, 30 ve % 40 (w/w) katkı oranlarında buğday unu ile ikame olacak şekilde ilave edilmiştir. Kestane unu katkılı eriştelerin fizikokimyasal, pişme ve duyusal özellikleri tespit edilmiştir. CNF katkı miktarı arttıkça eriştelerin toplam diyet lif ve kül miktarları artmış ve kalori değerleri kontrol örneğine göre azalmıştır. Eriştelerde CNF katkısının artışı ile makarnaların L^* ve b^* değerinde azalma ile renkte koyulaşma, a^* değerinde ise artış görülmüştür. CNF katkısı eriştelerde suya geçen madde değerinde artışa, hacim ve ağırlık artışı değerinde azalmaya neden olmuştur. Duyusal analiz sonuçlarına göre genel beğeni puanları açısından kontrol örneği ve en yakın puanı alan %10 CNF katkılı erişte örneği en yüksek puanları almıştır. Bu çalışma besleyici ve fonksiyonel özelliklerin geliştirilmesinde eriştede ve diğer tahıl ürünlerinde kestane unu katkısının kullanılabileceğini ve fonksiyonel gıda pazarına katkı sağlayacağını göstermektedir.
Anahtar kelimeler: Erişte, kestane unu, toplam diyet lif, fonksiyonel gıda, duyusal

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INTRODUCTION

The recent increase in the production and consumption of functional foods is attributable to increased awareness of healthy eating due to increased health problems (Contreras-Rodríguez et al., 2020; Domínguez Díaz et al., 2019). Thus, the interest and demand of the consumers for nutritionally enriched functional foods with a positive health impact have been growing every day (Maqsood et al., 2019; Siró et al., 2008). The studies on noodle, a grain-based functional food, also attract attention in the food industry. Noodle is frequently consumed in Japan, China, Korea and United States of America (Fu, 2008; Rombouts et al., 2014). It is also a traditional food in Turkey (Turkish noodle) and can be produced with different flour additives with or without eggs (Demir, 2008; Bilgiçli, 2009). There have been reports of the use of banana flour (Ritthiruangdej et al., 2011), black rice bran (Kong et al., 2012), refined wheat flour, mixtures of sorghum flour and soybean flour (Rani et al., 2019), flaxseed (Yüksel et al., 2018) and oat flour (Liu et al., 2019) in the production of noodles.

Chestnut is a closed-shell fruit comprising the edible seeds of the trees from the *Castanea* genus of the Fagaceae family (Dong et al., 2020). Chestnut is grown in the Asian, African, European and North American continents (Sartor et al., 2015). The chestnut fruit contains vitamins, minerals, essential fatty acids and high levels of dietary fiber components (Borges, 2008; Ribeiro et al., 2013). Dietary fiber components are known to have protective physiological effects on large intestine and colon diseases, constipation, hemorrhoid, obesity, diabetes and cardiovascular diseases (Prasad and Bondy, 2019). Chestnut flour (CNF) is ground chestnut containing 40-50% starch, 20-32% sugar, 5.8% essential amino acid, a high dietary fiber content of 10.8% and a low fat content of 3.7% (Sacchetti et al., 2004; Dall'Asta et al., 2013; Paciulli et al., 2018). Furthermore, chestnut flour is a commonly used additive for producing gluten-free products that are rich in vitamin B, iron, folate, magnesium, antioxidant capacity and phenolic compounds (Vasconcelos et al., 2010; Dall'Asta et al., 2013; Moreira et al., 2012).

In other studies, chestnut flour used in products such as bread, pasta, biscuit, etc. has often been used in conjunction with other flour blends or rice flour to develop gluten-free products (Paciulli et al., 2018; Rinaldi et al., 2017; Mir et al., 2017; Littardi et al., 2020; Kosović et al., 2016). There are limited studies on the use of chestnut flour in noodle production. The difference of our study from previous studies is that the noodles were specifically chosen as a product and the addition ratio was increased to 40% chestnut flour and the effect of different chestnut flour ratios used on the nutritional, sensory, and quality characteristics of the noodles was given together and compared. Also, compared to the noodles produced using wheat flour, the high dietary fiber content of the chestnut flour-added noodles, enriched in nutrients and reduced-calorie value is important in terms of adequate and balanced nutrition. Therefore, the present study aimed to examine the effect of the use of chestnut flour (0% - control, 5, 10, 20, 30 and 40%, CNF; w / w) as a substitute for wheat flour in noodles production on chemical, functional and sensory properties of noodles.

MATERIALS AND METHOD

Materials

The wheat flour (WF) (moisture 14.8%, ash 1.15%, fat 1.38%, protein 13.9%, wet gluten 33.5%) that was procured from the Bandırma-Toru Flour Factory was used in the production of the noodle samples. The 100% natural chestnut flour (Private Brand, Aydın, Turkey) without any additives was used in the trials. In addition, the refined table salt and drinking water used in noodle production were bought from local markets.

Production of the noodle samples

During the noodle production trials, CFN was added by substituting wheat flour with CFN by weight (0%-control; 5, 10, 20, 30 and 40% (w/w)). In the preliminary trials, when an additive ratio of more than 40% was reached in noodle production, the structure of the dough was observed to be broken down and a homogeneous structure was not obtained. Therefore, it was preferred to use chestnut flour additives in the range of 5-40% to substitute wheat flour. During the production of the dough, 0.5% table salt and 50-57 ml water were used considering the flour weight and the water absorption capacity of the flour, which was determined using the farinograph analysis carried out in pre-trials (ICC, 1992), respectively. A modified version of the noodle production method proposed by Aydın (2009) was used in the study for noodle production. Figure 1 shows the steps for the production of homemade-like noodles under laboratory conditions. A noodle cutting machine (Ampia Noodle Machine, Italy) was used and drying was carried out for 5 hours in a drying oven (Binder 9010-0078 ED53) at 50±5^{o}C. The dry noodles with a reduced moisture content were kept in sealed packages at room temperature. The dried samples were ground when needed for analyses and kept at room temperature until use.

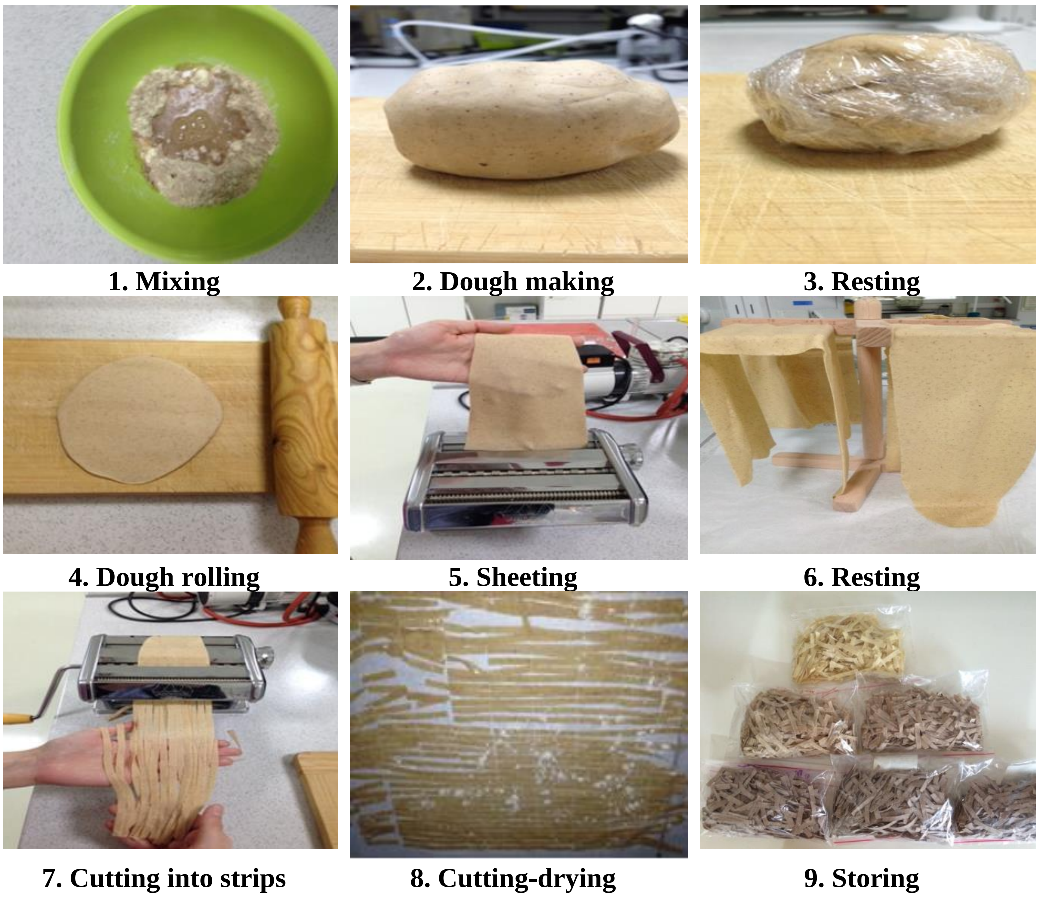

Figure 1. Production steps for the noodle samples

Analytical methods

Moisture, ash and protein contents were determined according to the AACCI Approved Methods 44-15.02, 08-01.01, 46-12.01 and 38-10.01, respectively (AACCI, 1999). For the chestnut flour (CNF) analyses, the moisture (AOAC Method No: 925.40), ash (AOAC Method No: 950.49), protein (using the Kjeldahl method, AOAC Method No: 950.48) and fat (using the Soxhlet system, AOAC Method No: 948.22'e) analyses were carried out in accordance with the AOAC (1990). Titratable acidity (in terms of sulfuric acid) was determined by following the AACC Method No. 02-31 (AACC, 2000) and pH was determined in accordance with Cemeroğlu (2013). The fat content analyses for CNF and noodle samples were also carried out by following the AOAC Method No: 948.22

(AOAC, 1990). The carbohydrate contents and calorie values of the noodle samples and chestnut flour were calculated using the Atwater general factor system. According to the system, the conversion factor is 4.0 kcal/g for protein and carbohydrates and 9.0 kcal/g for fat (Anonymous, 2003). The total dietary fiber contents of the noodle samples and chestnut flour were enzymatically determined (alpha amylase, amyloglucosidase and protease) by following the AOAC Method No. 985.29 (AOAC, 2007). The tests were carried out for at least three repetitions and the mean values were found.

Color analyses

The colors of the noodle samples and chestnut flour were determined using the Minolta CM 3600d model color measurement device. The CIE color values (*L**, *a**, *b**) were evaluated on a three-point scale: L*=100 was regarded as white, *L**=0 was regarded as black; high positive *a** was regarded as red, high negative *a** was regarded as green; high positive *b** was regarded as yellow and high negative *b** was regarded as blue.

Cooking test

In the cooking tests of the noodle samples, the substance amount lost to water, cooking loss (CL), weight gain (water absorption) and volume expansion (VE) values were calculated in accordance with the AACC (2000) and given in percentages (%).

Sensory evaluation

The sensory analysis of the noodle samples was carried out by 20 panelists between the ages of 20-50 years. The 1-5 hedonic scale was used for the evaluations, giving a score of 5 to the most liked noodle sample and 1 to the least liked sample (5 points: Very good, 4 points: Good, 3 Points: Acceptable, 2 Points: Not sufficient, 1 Point: Poor). The cooked noodle samples were evaluated in terms of properties comprising their color, smell, taste, appearance, chewiness and overall appreciation.

Statistical analysis

In the noodle trials, chestnut flour was added in substitute for wheat flour (0% -control, 5, 10, 20, 30 and 40% (w/w) and all analyses were carried out in three repetitions. The SAS Enterprise 5.1 program was used for statistical analyses and the differences due to chestnut flour addition were evaluated. To determine the statistically significant differences between the mean values, the LSD (Least Significant Difference) was used at the P <0.05 probability level.

RESULTS AND DISCUSSION

Nutritional composition of the noodle samples

Table 1 shows the chemical properties of the noodle samples and chestnut flour. The mean moisture content of CNF was 10.97%. For chestnut flour, Šoronja-Simović et al. (2016) reported a moisture content of 6.70% and Demirkesen et al. (2010) reported a moisture content of 10.79%.

The addition of CNF significantly decreased the moisture content when compared with that of the control sample (P <0.05) (Table 1). The lower moisture content is attributable to the high water absorption capacity of chestnut. With the addition of CNF, the ash and fat contents of the noodle samples increased, while their moisture and protein contents significantly decreased (P <0.05) (Table 1). Banana flour-added noodle (Ritthiruangdej et al., 2011) and fax seed-added noodle (Yüksel, 2018) had decreased moisture contents compared with those of the control sample. In agreement with our result, Sacchetti et al. (2004) reported an ash content of 2.77% for CNF and Šoronja-Simović et al. (2016) reported an ash content of 1.80%. In our study, the ash content significantly increased with the addition of CNF to the noodle samples (P <0.05). In their study, Akanbi et al. (2011) reported that the ash contents of the breadfruit starch-added noodle samples ranged from 1.28% to 2.25%. Bilgiçli (2009) found that the ash contents of the buckwheat flour-added noodle samples were in the range of 1.03-1.98%. Their results are close to those found in our study. The fat content of CNF was determined to be 3.70% (Table 1). Pereira-Lorenzo et al. (2006) reported that the fat content of chestnut was lower but was of higher quality compared with that of other nuts. In agreement with the results found in our study, Sacchetti et al. (2004) and Dokić et al. (2014) found that the fat content of CNF was 2.05% and 3.19%, respectively, and Demirkesen et al. (2010) reported a fat content of 3.8%. The fat contents of the samples significantly increased with the addition of CNF (P <0.05) (Table 1). Ritthiruangdej et al. (2011) reported that the addition of banana flour changed the fat content in a range of 0.04% and 0.14%. It can be said that the CNF-added noodle samples had a lower fat content when compared with other grain-added noodles.

Table 1. The effect of the addition of chestnut flour (CNF) on some chemical properties of the noodle samples*

Samples	CNF ratio (%)	Moisture (%)	Ash (%)	Protein (%)**	Fat (%)	TA[1]
CNF		10.97±0.08	2.30±0.01	7.24±0.02	3.70±0.15	0.44±0.0
Control	0	11.38±0.53[a]	1.35±0.02[e]	15.12±0.10[bc]	0.41±0.01[e]	0.07±0.00[c]
	5	11.16±0.99[a]	1.47±0.01[d]	16.74±0.73[a]	0.43±0.01[e]	0.07±0.00[c]
	10	10.14±0.16[a]	1.50±0.00[d]	15.71±0.15[b]	0.73±0.01[d]	0.16±0.01[b]
CNF-added noodles	20	8.46±0.16[b]	1.62±0.01[c]	15.04±0.10[bc]	1.32±0.01[c]	0.17±0.00[b]
	30	8.56±0.02[b]	1.74±0.01[b]	14.37±0.11[c]	1.75±0.01[b]	0.18±0.00[b]
	40	7.33±0.05[b]	1.84±0.01[a]	13.11±0.25[d]	2.01±0.01[a]	0.26±0.01[a]
Min-Max		7.33-11.38	1.35-1.84	13.11-16.74	0.41-2.01	0.07-0.26

Samples	CNF ratio (%)	pH	TCC[1] (%)	TDF[1] (%)	Energy (kcal)
CNF		5.88±0.07	75.8±0.01	23.57±0.01	324.53±0.02
Control	0	6.50±0.02[a]	71.72±0.50[c]	2.74±0.18[e]	340.04±2.75[a]
	5	6.42±0.01[b]	70.42±0.59[d]	3.98±0.17[d]	336.67±4.72[ab]
	10	6.28±0.02 [c]	71.88±0.35[c]	5.23±0.79[c]	336.33±3.59[ab]
CNF-added noodles	20	6.00±0.02[d]	73.54±0.03[b]	6.91±0.17[b]	338.58±1.33[ab]
	30	5.94±0.02[e]	73.52±0.03[b]	7.87±0.94[b]	335.60±3.10[ab]
	40	5.77±0.03[f]	75.58±0.44[a]	10.66±0.72[a]	330.91±2.46[b]
Min-Max		5.77-6.50	70.42-75.58	2.74-10.66	330.91-340.04

**Means with different superscripts in columns indicate significant difference ($P \leq 0.05$). Data are expressed as means ± standard deviations.*

*****The N x 6.25 factor was used for chestnut flour.***

[1]TA: Total Acidity, Total Carbohydrate; TDF: Total Dietary Fiber

For CNF, Sacchetti et al. (2004) determined a protein content of 6.92%, Seferoğlu (2012) determined a protein content of 4.6%, Dokić et al. (2014) determined a protein content of 5.54% and Dall'Asta et al. (2013) determined a protein content of 5.8%, all of which are higher than the protein content found in this study. The protein content in this study is close to that determined by Ahmed and Al-Attar (2015) in their study on CNF. Compared with other flour types, the protein content of CNF is close to rice flour and is an important source in the production of gluten-free foods (Demirkesen et al., 2010). The analysis results revealed that there were no significant differences between the protein contents (P ≥0.05). Although CNF has a lower protein content than wheat flour, it contains important essential amino acids, which is its most important quality (Dokić et al., 2014). Vitali et al. (2009) reported that 25% carob-added biscuits had a lower protein content and a higher ash content compared with those of reference biscuits. The titratable acidity (TEA) of the noodle samples increased depending on the addition of CNF. Güvendi (2011) stated that the acidity values of the triticale-, husked barley- and husked oat-added noodles, control noodle and oat-added noodle varied from 0.06% to 1.34% and the TEA values increased with increasing husked bailey ratio. Since chestnut is an acidic fruit, the same values increased in our study as well.

CNF has a higher dietary fiber content than wheat flour and its mean TDF content was determined to be 23.57% (Table1). This value is higher than those reported by Sacchetti et al. (2004) and Dokić et al. (2014) but close to that reported by Demirkesen et al. (2010). This is attributable to the differences in the growing conditions and structure of chestnut and production steps. The total dietary fiber (TDF) contents of the noodle samples ranged from 2.74% to 10.66% (Table 1). The addition of CNF significantly increased the dietary fiber content of the noodle samples ($P < 0.05$). The TDF content of the banana flour-added noodle was 3.70-5.94% (Ritthiruangdej et al., 2011), TDF content of the 10% tomato peel powder-enriched pasta was 16.80% (Padalino et al., 2017) and TDF content of the 25% apple pomace-added cracker made with gluten-free flour blend was 8.96% (Alexgender et al., 2018). The results found in our study were higher or close to those previously reported by other researchers.

Table 1 shows the carbohydrate and energy values of the noodle samples. In agreement with the results found in our study, Adegunwa et al. (2012) reported a total carbohydrate content of 64.11-73.60% for soybean and carrot powder-added noodle samples. With the addition of CNF, which has a high dietary fiber content and low fat content, the energy values significantly decreased ($P < 0.05$). Seferoğlu (2012) reported that the addition of CNF decreased the energy values and carbohydrate contents of the bread, biscuit and cake samples. Aydın and Göçmen (2014) reported that the use of pumpkin flour decreased the energy value and carbohydrate content of biscuits.

Cooking properties of the noodle samples

Cooking analyses are among important criteria for quality (Köten and Ünsa, 2014). The addition of CNF significantly increased the weight gain, volume expansion (VE) and amount of substance lost to water (cooking loos-CL) in the noodle samples ($P < 0.05$) (Table 2). Weight gain first decreased with increasing chestnut flour amount but reached a close value to that of the control sample (without CNF) when the addition ratio was 40% CNF. The closest VE value to that of the control sample was obtained with the 30-40% CNF-added noodle samples. In apricot kernel powder-added noodle, Eyidemir (2006) reported that the water absorption value of the control sample was 124.25%, while the water absorption value of the melon kernel powder-added sample was 171.87% and volume expansion values were in the range of 150-240%. A low weight gain indicates low water binding capacity, which negatively affects the cooking quality of noodle (Wandee et al., 2014). Low volume expansion is an indicator of low water absorption by noodles, which leads to a hard texture after cooking (Bhattacharya et al., 1999).

Table 2. The effect of the addition of chestnut flour (CNF) on the cooking properties of the noodle samples*

Sample	CNF ratio (%)	Weight gain (%)	Volume expansion (%)	Cooking loss (%)
Control	0	281.62±1.90^{a}	350.00 ±0.01 ^{a}	3.53±0.05 ^{b}
CNF-added noodles	5	272.55±2.10^{b}	350.00±0.01 ^{a}	2.98±0.02 ^{d}
	10	256.13±1.54^{d}	326.00±1.41 ^{c}	3.08±0.02 ^{d}
	20	241.76±1.88^{e}	301.00±1.41 ^{d}	3.31±0.19 ^{c}
	30	265.71±0.87^{c}	338.75±1.76 ^{b}	4.74±0.03 ^{a}
	40	271.52±1.44^{b}	338.75±1.76 ^{b}	4.77±0.03 ^{a}
Min-Max		241.76-281.62	301-350	2.98-4.77

**Means with different superscripts in columns indicate significant difference ($P \le 0.05$). Data are expressed as means ± standard deviations*

Cooking loss (CL) is the amount of solid substance lost to cooking water (Ritthiruangdej et al., 2011). The CL values of the 30% and 40% CNF-added noodle samples were higher when compared with that of the control sample (P <0.05). A high amount of substance lost to water indicates that starch is highly dissolved, which results in water turbidity, stickiness and low cooking tolerance. Thus, it is an undesired quality in noodle. Cooking loss is also an indicator of the ability of noodle to maintain its structural integrity (Wandee et al., 2014). Ugarčić-Hardi et al., (2007) reported cooking losses ranging from 7.07% to 13.21% for noodles made with different flour additives. Rani et al., (2019) found a cooking loss of 8.1% for the control sample (refined wheat flour-containing noodle) and 12% for multi-grain noodle. In our study, although the amount of substance lost to water slightly increased, it was lower than those reported in the literature. Izydorczyk et al. (2004) associated cooking loss with either poor protein-starch matrix or the disintegration of the protein-starch matrix. The functional gluten amount in noodle decreased with the addition of CNF, which can lead to increased cooking loss in noodles. In their study, Güvendi (2011) found that cooking loss increased with the addition of whole grain flour. Eyidemir (2006) reported that cooking loss increased in parallel with the addition of apricot kernel flour.

Color values and sensory properties of the noodle samples

Table 3 shows the color analysis results for chestnut flour. With the addition of CNF to the noodle samples, the L^* (brightness) and b^* (yellowness) values significantly decreased (P <0.05), while a^* (redness) significantly increased. Increasing amounts of chestnut flour resulted in darkening color. This is associated with the Maillard reactions between sugars and amino acids due to the higher protein and sugar contents of fiber-rich foods (Arshad, 2007). Rekha et al. (2013) reported that the addition of vegetable flour to pasta resulted in decreased color intensity and increased yellowness. In their study on CNF-added breads, Dall'Asta et al. (2013) reported L^* values of 57.4- 49.4, a^* values of 1.9-4.9 and b^* values of 9.2-11.5. In their study on CNF-added biscuits, İnkaya (2008) found close results to those determined in our study.

Table 3. The effect of the addition of chestnut flour (CNF) on color properties of the noodle samples*

Sample	CNF ratio (%)	L^*	a^*	b^*
CNF		47.22±1.94	0.53±0.07	13.85±0.015
Control	0	68.70±1.18^{a}	-0.57±0.13^{e}	17.94±0.14^{a}
CNF-added noodles	5	61.86±0.56^{b}	2.44±0.04^{d}	13.98±0.16^{b}
	10	53.29±2.70^{c}	4.02±0.24^{c}	13.92±0.27^{bc}
	20	49.00±5.36^{c}	4.59±0.24^{b}	12.90±0.37^{d}
	30	52.94±3.35^{c}	4.60±0.30^{b}	13.55±0.11^{c}
	40	49.69±2.32^{c}	5,17±0.06^{a}	14.06±0.23^{b}
Min-Max		49.00-68.70	-0.57-5.17	12.90-17.94

**Means with different superscripts in columns indicate significant difference (P ≤ 0.05). Data are expressed as means ± standard deviations*

Table 4 shows the effect of the addition of CNF on the sensory properties of the noodle samples. An overall review of the sensory analysis results showed that there were no significant differences between the sensory properties of the noodle samples and the control sample (P ≥0.05). The overall appreciation and color scores given by the panelists decreased when the CNF addition ratio was 30%. The closest overall appreciation and taste scores to those of the control sample were obtained with the 10% CNF-added noodle sample. The 10% and 20% addition ratios are recommendable in terms of their sensory properties. In addition to its contribution to the nutritional value of the noodle samples, chestnut flour improved the sensory properties of the samples. Similar to the results of the present study, Yadav et al. (2014) have reported that the use of 25% chestnut flour as a substitute for refined wheat flour was acceptable in terms of textural and sensory properties. In their study, Alexgender et al. (2018) reported that the 10% apple pomace-added gluten-free crackers received higher scores than the control sample in terms of their sensory properties. Öncel (2017) found that the best combination in terms of sensory properties was obtained with the 20% amaranth and 10% quinoa-added sample.

Table 4. The effect of the addition of chestnut flour (CNF) on the sensory properties of the noodle samples

Sample	CNF ratio (%)	Color	Smell	Appearance	Taste	Chewiness	Overall Appreciation
Control	0	4.60 ± 0.60[a]	4.80±0.41[a]	4.70 ± 0.47[a]	4.60 ± 0.50[a]	4.85±0.36[a]	4.63 ± 0.49[a]
CNF-added noodles	5	4.15 ± 0.67[b]	4.85±0.36[a]	4.60 ± 0.50[a]	4.40 ± 0.68[a]	4.80±0.41[a]	4.57 ± 0.60[a]
	10	4.70 ± 0.47[a]	4.70±0.57[a]	4.65 ± 0.58[a]	4.45 ± 0.51[a]	4.70±0.47[a]	4.68 ± 0.59[a]
	20	4.60 ± 0.50[a]	4.65±0.48[a]	4.45 ± 0.60[a]	4.35 ± 0.74[a]	4.65±0.48[a]	4.57 ± 0.50[a]
	30	3.95 ± 0.68[b]	4.30±0.65[b]	3.65 ± 0.58[b]	3.45 ± 0.68[b]	4.25±0.63[b]	3.78 ± 0.78[b]
	40	3.80 ± 1.10[b]	4.20±0.61[b]	3.65 ± 0.74[b]	3.40 ± 1.04[b]	3.95±0.75[b]	3.68 ± 0.88[b]
Min-Max		3.80-4.70	4.20-4.85	3.65-4.70	3.40-4.60	3.95-4.85	3.68-4.68

[*]Means with different superscripts in columns indicate significant difference ($p \leq 0.05$). Data are expressed as means ± standard deviations.

CONCLUSION

The study investigates the effects of chestnut flour addition on certain nutritional, cooking and sensory properties of noodle samples. Compared with noodle made with refined wheat flour, CNF-added noodles had a higher dietary fiber content. Thus, its use in daily diet can be beneficial for health. The addition of chestnut flour increased the nutritional properties of the noodle samples while decreasing their calorie values. The 10% and 20% CNF-added samples received the highest appreciation scores. Therefore, they are recommendable for use in terms of their sensory properties. We recommend investigating chestnut flour addition to other food formulations and examining other properties of chestnut flour using complex analyses to prevent malnutrition.

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CONFLICT OF INTEREST

There are no possible conflicts of interest between the authors.

AUTHOR CONTRIBUTION

Dilek Dülger Altıner contributed as the thesis supervisor in conducting analyzes, statistical analyses of data, writing the article, and writing-review-proofreading-publishing procedures. The Master's thesis student Merve Mete carried out the preparation of samples, analyses, reporting, and writing and correction of literature sources. The authors have read and approved the final version of the article.

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