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Chemical and Nutritional Characteristics of Karakilcik Noodles Substituted with Sweet Marjoram

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Abstract

Noodle is a traditional food prepared mainly with wheat flour, salt, and water. Antioxidants like phenolics in foods can remove reactive oxygen and protect humans against degenerative illnesses like cancer and cardiovascular diseases. In this study, it was aimed to improve the noodle formulation by adding ground marjoram (2.5%, 5%, and 10%, w/w) to improve the functional properties of noodles, and to determine the physical properties and chemical composition of control and fortified noodles. Some physical (color, texture), chemical (moisture, ash, fat, protein, extractable and hydrolyzable antioxidant capacity, and total phenolic content), sensory quality properties of the noodles were evaluated. The results showed that the additional amount of marjoram caused a significant increase in the antioxidant capacity of the samples. The ash and protein content values of the noodles increased significantly with the addition of marjoram. Noodles containing 10% marjoram had the highest antioxidant capacity and total phenolic content, whereas they had the lowest sensory acceptability compounds.

Keywords: *Antioxidant capacity, fortified food, total phenolic content*

1. INTRODUCTION

As in many places of the world, the majority of daily caloric needs in Turkey are met from cereals and cereal products. The main reasons why pasta products are preferred so much are their low price, easy preparation, wide variety of uses, flavor properties, and long shelf life (Bergman et al., 1994). Turkish noodle is one of the traditional Turkish food whose raw material is grains and is widely consumed in Turkey. Noodle dough is prepared with wheat flour, salt, water, and eggs in some regions of Turkey. Some ingredients like milk and whey powder can be put into the noodles (Bilgicli et al., 2011). Consumers are becoming more and more conscious of food safety, composition, and health-related issues (Cencic and Chingwaru, 2010). Although pasta products have a high carbohydrate content, they often need enrichment in terms of components such as proteins, vitamins, minerals, and phenolic substances. Many studies have been done for this purpose in the literature. Previous studies have reported the use of wheat germ (Demir et al., 2021), apricot kernel (Eyidemir and Hayta, 2010), mushroom powder, Bengal gram flour and defatted soy flour (Kaur et al., 2011), germinated chickpea flour (Sofi et al., 2020), edible insects (Çabuk and Yılmaz, 2020), beetroot puree (Syyu et al., 2021), cassava leaves (Poonsri et al., 2019), and mango peel powder (Ajila et al., 2010) in order to obtain an improved functional property of noodles and pasta products.

Origanum majorana L. (sweet marjoram), is a plant species from the Lamiaceae family. This plant, which is native to the Mediterranean region, is grown in many countries in Asia, North Africa, and

Europe such as Spain, Hungary, Portugal, Germany, Egypt, Poland, and France (Bina and Rahimi, 2017). It has been conventionally used in the treatment of many digestive and respiratory system diseases (Bruneton, 1995). Studies have shown that marjoram has a high antioxidant capacity due to the polyphenolic compounds it contains (Amarowicz et al., 2009; Roby, Sarhan et al., 2013). Phenolic acids detected in the hydroalcoholic extract of sweet marjoram leaves are vanillic acid, gallic acid, ferulic acid, caffeic acid, syringic acid, *p*- and *m*-hydroxybenzoic acid, coumaric acid, neochlorogenic acid, protocatechuic acid, chlorogenic acid, cryptochlorogenic acid, and kaftaric acid. Phenolic acids found in sweet marjoram essential oil were defined as rosmarinic acid, sinapic acid, vanillic acid, ferulic acid, caffeic acid, syringic acid, *p*- and *m*-hydroxybenzoic acid and coumarinic acid (Bina and Rahimi, 2017).

Karakilcik wheat is a relatively little-known wheat variety, and its reputation is limited to the Seferihisar, district of İzmir, and its surroundings today (Nizam and Yenal, 2020). In a study, protein content and gluten index of karakilcik wheat were found 13.7% and 55, respectively (Sayaslan et al., 2012).

The purpose of the study was to determine the physical, chemical and antioxidant properties of marjoram enriched Karakilcik noodles.

2. MATERIALS AND METHODS

2.1. Materials

Karakilcik flour and table salt were purchased from market. Marjoram, which was collected from Bursa, İznik, in June 2019, were dried at 50 °C for 48 hours, cleaned from the stems, the leaves were ground and sieved. Marjoram, used in noodle production, was purchased in one go, and after the whole batch was ground, it was mixed to make it homogeneous.

2.2. Methods

2.2.1. Noodle production

Karakilcik flour was used in the production of noodles. To enrich the noodle, Karakilcik flour was replaced with 2.5%, 5% and 10% marjoram. These ratios were decided as a result of literature review and preliminary trials. It was thought that the addition of marjoram at a ratio of less than 2.5% would not have an important role in increasing the antioxidant capacity of noodle. It was also determined that the products produced with the addition of more than 10% marjoram were not acceptable sensory. Noodle dough ingredients are given in Table 1. The noodle dough components were kneaded in the dough kneader (Kitchen Aid Professional 600, MI, USA) at low and then high speed for 8 minutes. After the kneading process, the dough was divided into 2 equal parts, then rolled and rested for 20 minutes. For the pre-thinning process (5mm), the dough was rolled out with a roller, and then thin to 2 mm. These were passed through a noodle cutting machine and turned into long strips with a width of 5 mm and these strips were cut with the help of a knife to a length of 4 cm. The noodles were placed in trays and desiccated at 50 °C for 24 hours. Approximately 200 g of noodles were produced for each formulation.

Table 1. Recipe for noodle formulation

Components (g)	**Control	2.5%	5%	10%
Karakilcik Flour	**100**	**97.5**	**95**	**90**
Salt	0.5	0.5	0.5	0.5
Deionized water (mL)	47.5	47.5	47.5	47.5
Marjoram	-	**2.5**	**5**	**10**

*Ingredients of the recipe, the number of which changes are marked in bold font.

2.2.3. Proximate composition of noodles

To determine the proximate composition of noodles, total ash, protein, fat, and moisture content analyzes were performed according to AOAC Methods 923.03, 990.03, 948.22, and 930.15 methods, respectively (AOAC, 2012). Protein contents were analyzed using the Kjeldahl method (AOAC, 2000) with a conversion factor of 5.70 for noodle samples.

For color analysis, noodle samples were ground in a blender (Waring 80118, CT, USA), sieved through a 220 µm sieve. The color analysis (L*, a*, b*) of the noodle samples and karakilcik flour were determined by using a PCE-CSM3 colorimeter (PCE Instruments, Germany).

2.2.4. Cooking quality of noodles

To determine the cooking time, 25 g sample was boiled in boiling water (250 ml), noodles were taken from the sample for certain times, and then compressed between two slides, cooked until there were no white spots, the time was recorded noodles (Ozkaya and Kahveci, 1990).

Noodle samples were cooked in distilled water (1:10), and then noodles were drained and weighed for water absorption (percentage of increased weight) analysis.

$$\boxed{Water\ absorption = \frac{cooked\ noodle\ samples}{dry\ noodle\ samples}}$$

(Ozkaya and Kahveci, 1990)

The volume increase was calculated by dividing the water displacement of cooked noodles by the water displacement of an equivalent amount of uncooked noodles (Ozkaya and Kahveci, 1990).

2.2.5. Extraction of bioactive compounds

Bioactive compounds were extracted according to the method by Vitali et al. (2009) with some modifications. 20 mL HCl_{conc} / methanol/water (1:80:10 v/v) mixture was added to 2 grams of dry and well ground sample, and the mixture was shaken for 2 hours at 20 °C in an orbital shaker. It was then centrifuged at 3500 rpm for 10 minutes and the supernatant was used as extractable phenolics. The extraction of the hydrolyzable phenols was continued with the residue remaining from the extraction of the extractable phenols. 20 mL of methanol / H_2SO_{4conc} was added at a ratio of 10:1 (v/v) and shaken at 85 °C for 20 hours. Finally, it was cooled to room temperature and centrifuged at 4000 rpm for 12 minutes. Supernatants separated by centrifugation contain hydrolyzable phenols.

2.2.6. Total phenolic content (TPC) of noodle samples

The extractable and hydrolysable fractions of total phenolic content of noodles was determined according to Apak et al. (2008). In the evaluation of the samples, a gallic acid calibration curve was prepared with 10 points in the range of 0.001-0.1 mg / ml and the total phenolic content was measured at 750 nm using a spectrophotometer (Shimadzu UV-1280) in 3 repetitions. Total phenolic contents were calculated as the sum of the extractable and hydrolyzable phenolics of each sample.

2.2.7. Evaluation of antioxidant capacity

The antioxidant capacities of the extracts were determined by three different methods: ABTS (2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid) diammonium salt), CUPRAC (cupric reducing antioxidant capacity) and DPPH (2.2-). diphenyl-1-picrylhydrazil) assays. Analytical procedures were performed using minor modifications of the methods proposed by Apak et al., (2008) and Boskou et al. (2006). According to ABTS assay, 7 mM ABTS aqueous solution and 2.45 mM $K_2S_2O_8$ aqueous solution were mixed, and the mixture was left in the dark for 12-16 hours to complete the reaction. The solution was then diluted 1:10 (v/v) with 96% ethanol. (x µL) extract, (4-x) mL of ethanol (95.0%) and 1 mL of diluted ABTS solution were mixed and kept in the dark for 6 minutes. To plot its standard curve, a standard solution of Trolox was diluted with ethanol and mixed with 1 mL of diluted ABTS solution. The reduction of $ABTS^{\cdot+}$ radical was measured with a spectrophotometer (Shimadzu UV-1280) at a wavelength of 734 nm. To determine the antioxidant capacity with the CUPRAC method, 1 mL of 10 mM $CuCl_2$, 1 mL of 7.5 mM neocuproin, 1 mL of 1 M $NH_4CH_4CO_2$, x mL of extract and (4-x) mL of distilled water was mixed. It was kept in the dark for 30 minutes and absorbance was measured at 450 nm with a spectrophotometer (Shimadzu UV-1280). A standard curve was drawn with varying concentrations of Trolox solution. Antioxidant capacity results were calculated as µmol of Trolox equivalent antioxidant capacity (TEAC) per mL sample using the standard curve equation. In the DPPH assay, all extracts (0.1 mL) were placed in a test tube and 3.9 mL of 6 x 10-5 M methanolic DPPH solution was added. After this mixture was left in the dark for 30 minutes, measurements were made with a spectrophotometer (Shimadzu UV-1280). Each experiment was repeated three times.

2.2.8. Sensorial evaluation

The sensory analysis of the cooked and uncooked noodle samples was carried out by a total of 20 untrained panelists, 10 females and 10 males, with an average age of 25 years. All analyzes were carried out in a bright and closed environment so that the panelists would not be affected by each other. Descriptors for sensory evaluation were selected according to studies in the literature. Examples of cooked noodles; It was evaluated in terms of appearance, color, odour, hardness, taste, stickiness, mouthfeel, general taste, and affordability, as well as surface criteria including uncooked noodle colour, appearance, crack, surface criteria. The samples were given a score between 1 and 9 by the panelists according to their liking (1-extremely dislike, 9-extemely like).

2.2.9. Statistical analysis

All experimental results were represented as mean ± standard deviation (S.D.). Differences between samples were analyzed using analysis of variance (ANOVA) with SPSS software version 24.0 (IBM, New York, USA) and Duncan's multiple range test (α=0.05) was used to compare the groups.

3. RESULTS AND DISCUSSION

3.1. Some properties of Karakilcik flour

The chemical composition and color values of Karakilcik flour are shown in Table 2. According to Table 2, moisture content of karakilcik flour was 3.01%, protein content was 9.33%, ash content was 1.58%, and fat content was 1.3%. To determine the color values of Karakilcik flour, L*, a*, b* values were tested and 86.12, 3.03, 11.03 were measured, respectively.

3.2. Physicochemical properties of noodle samples

Some physicochemical analysis results of uncooked noodles enriched with marjoram were indicated in Table 3. Noodle production has not been made with Karakilcik flour so far, and since no product has been made with marjoram substitute, so the results of the analysis could not be compared other studies. The moisture content of noodles decreased significantly ($p<0.05$) with increasing of marjoram concentration. The highest moisture content was determined in the control sample and the lowest value was in the sample added with 10% marjoram concentration (6.29-6.07%). The protein content of samples increased significantly with the addition of marjoram. In a study, it was stated that dried marjoram contains 8% moisture, 14% protein, 5.6% fixed oil, 22% fiber, 6-24% ash and 1.8% essential oil (Charles, 2012). It is thought that the reason for the increase in the protein content of the noodle samples as the marjoram concentration increases was the high protein content of marjoram. Marjoram increased the noodles ash content which is about 1.93-2.93%. The addition of marjoram was found to have a significant effect on the ash content of noodle samples.

Table 2. Chemical composition and color values of Karakilcik flour

Sample	Moisture*	Ash*	Protein*	Fat*	Color Values		
					L*	a*	b*
Karakilcik	3.01±0.01	1.58±0.01	9.33±0.30	1.32±0.13	86.12±2.06	3.03±0.13	11.03 ±0.50

** Mean values ± standard deviation. Within columns, values with the different letter differ significantly from each other according to Duncan's test (p < 0.05).*

The high ash content of marjoram affected the ash content of the noodles. Fat content of the noodle samples decreased with an increase in the percentage of marjoram addition, but this decrease was not statistically significant.

The color values of the noodles are presented in Table 3 as L*, a* and b* values. The desired color characteristics for noodles are traditionally bright white or pale yellow. As the protein content of the flours increases, the noodle color almost always becomes darker. It is stated that the deterioration in color is also associated with higher flour extraction rates, higher ash content and higher starch damage (Morris, 2018).

Table 3. Physicochemical properties of uncooked noodles

Sample	Moisture* (g/100g)	Ash* (g/100g. db)	Protein* (g/100g. db)	Fat* (g/100g. db)	Color Values		
					L*	a*	b*
0	6.29±0.01^{a}	1.93±0.02^{d}	9.78±0.21^{c}	0.85±0.09	67.39±2.06^{a}	6.77±0.07^{a}	15.64±0.57^{c}
2.5	6.22±0.01^{ab}	2.22±0.01^{c}	10.14±0.14^{b}	0.79±0.03	64.02±2.71^{b}	6.69±0.23^{a}	16.56±0.72^{b}
5	6.11±0.03^{b}	2.51±0.01^{b}	10.34±0.16^{b}	0.73±0.18	59.75±1.64^{c}	6.35±0.27^{b}	17.05±0.76^{a}
10	6.07±0.07^{b}	2.93±0.06^{a}	10.58±0.23^{a}	0.71±0.03	53.50±3.53^{d}	6.27±0.26^{b}	17.02±0.72^{a}

Mean values ± standard deviation. Within columns, values with the different letter differ significantly from each other according to Duncan's test ($p < 0.05$).

The L* values of the noodles ranged between 67.39 and 53.50, the a* values between 6.77 and 6.27, and the b* values between 15.64 and 17.02. The control sample is lighter in color than other noodles due to its content of marjoram, which contains colored components. The highest *L and a* values were found in the control sample and these values of the samples diminished significantly with increasing the addition of marjoram. The lowest value was found in the sample containing 10% marjoram. In contrast to the L* and a* values, the b* value increased in parallel with the added marjoram concentration. The maximum b* value was observed in noodles containing 10% marjoram, while the minimum value was observed in the control sample. As the concentration of the substance used for enrichment increases, the color values of the final product change depending on the color characteristics of the raw material used for the enrichment of the product. Green tea powder (Yu et al., 2019), black locust flower (Kowalczewski et al., 2019), parsley (Dirim and Koc, 2019), ground flaxseed (Zhu and Li, 2019), and cassava leaves (Poonsri et al., 2019) to the noodles decreased the L* values of the noodles due to the low L* values of the ingredients used for fortification.

3.3. Cooking properties of noodles Marjoram-enriched noodles showed significant ($p<0.05$) improvements in cooking properties compared to the control noodle sample (Table 4). With the addition of marjoram, longer time required for noodles to cook. The increased cooking time may be associated with reduced water absorption of the noodles by the proteins that marjoram has. In addition, the cooking time increases with the increase in gelatinization temperature due to the increase in the amylose content and crystal structure of the starch granule with the pregelatinization process (Liu et al., 2018). Addition of marjoram plant significantly reduced water absorption (rehydration) of noodle samples ($p<0.05$). A higher percentage of rehydration is an indicator of larger amounts of water needed during cooking and also higher stickiness of the noodle texture (Wandee et al., 2015). The highest value of rehydration (130.70%) was found in control sample. The volume increase values of the noodles ranged from 105.00% to 151.25% (Table 4). The volume increase values of the samples increased significantly ($p<0.05$) with the addition of marjoram.

Table 4. Cooking properties of samples

Sample (%)	Cooking time (min)*	Water absorption* (%)	Volume increase (%)*
0	7.00^{b}	130.70±2.52^{a}	105.00±3.25^{c}
2.5	8.25^{ab}	113.95±0.38^{b}	108.75±2.59^{bc}
5	9.00^{ab}	108.80±3.40^{bc}	121.75±2.20^{b}
10	9.13^{a}	103.50±4.30^{c}	151.25±0.66^{a}

Mean values ± standard deviation. Within columns, values with the different letter differ significantly from each other according to Duncan's test ($p < 0.05$).

3.4. Antioxidant capacity and total phenolic contents of noodle samples

Previous investigations have reported that phenolic compounds of plants exhibit high antioxidant activities and contribute significantly to free radical scavenging capacity (Kong et al., 2012). Antioxidant capacity and TPC of samples (extractable and hydrolyzable phenolics) are given in Table 5. These results showed that the extractable and hydrolyzable phenolics of 10% marjoram added noodles had significantly ($p<0.05$) higher $TEAC_{ABTS}$, $TEAC_{CUPRAC}$ and $TEAC_{DPPH}$ values than the other samples. In addition, it was observed that the CUPRAC assay of the noodle samples generally exhibited higher antioxidant capacity values than the ABTS and DPPH assays (Table 5).

Total phenolic contents of control, 2.5%, 5% and 10% samples were determined as 14.54, 26.88, 31.72 and 33.73 mg/100 g GAE (extractable) and 15.54, 25.31, 28.40 and 33.60 mg/100 g GAE (hydrolyzable), respectively. No significant ($p>0.05$) differences were observed between the extractable and hydrolyzable phenolics of the samples, and the extractable and hydrolyzable phenolics of the 10% marjoram noodle sample had a higher total phenolic content ($p<0.05$) than the other noodle samples. This difference can be explained by the increase in the total amount of phenol as the marjoram concentration increases, and it is an expected situation.

There is a positive relationship between total phenol content and antioxidant capacity values. It is known that antioxidant capacity is mostly derived from phenolic compounds. As seen in Table 5, it is seen that the sample with the highest total phenol content also has the highest antioxidant capacity for each assay.

Table 5. Antioxidant capacity and TPC of samples

Sample	ABTS (μmol troloks/g)		CUPRAC (μmol troloks/g)		DPPH (μmol troloks/g)		TPC (mg GAE/g)	
	Extractable	Hydrolysable	Extractable	Hydrolysable	Extractable	Hydrolysable	Extractable	Hydrolysable
0	0.08±0.01^d	7.30±0.02^c	3.50±0.04^d	8.05±0.02^c	4.00±0.04^d	5.344±0.48^d	14.54±0.76^d	15.54±0.16^d
2.5%	3.50±0.65^c	10.91±0.20^b	13.78±0.78^c	8.44±0.38^c	11.37±0.08^c	10.43±0.06^c	26.88±0.44^c	25.31±1.65^c
5%	9.71±0.28^b	13.56±0.61^a	22.88±0.86^b	12.22±0.17^b	14.5±0.020^b	12.02±0.23^b	31.72±0.19^b	28.40±2.34^b
10%	11.40±0.49^a	14.79±1.05^a	30.59±0.82^a	15.63±1.38^a	16.89±0.35^a	12.41±0.10^a	33.73±0.63^a	33.60±5.39^a

Mean values ± standard deviation. Within columns, values with the different letter differ significantly from each other according to Duncan's test ($p < 0.05$).

In the literature, there are many studies on the antioxidant properties of enriched noodles. In a previous study, it was reported that wheat pasta fortified with powdered parsley leaves at different ratios had higher TPC and antioxidant capacity than the control sample (Sęczyk et al. 2016). Prabhasankar et al. (2009) also notified that aqueous extracts of uncooked and cooked pasta containing seaweed exhibited higher phenolic content as compared to control. Kowalczewski et al. (2019) aimed to investigate changes of antioxidant capacity and phenolic contents of pasta enriched with black locust flower (BLF) addition after thermal processing. The BLF addition increased the content of phenolics and antioxidant capacity. Comparing to the control, the total polyphenol compounds content was two times higher. Sęczyk et al. (2016) investigated the effect of adding carob flour on TPC, antioxidant capacity, dietary characterics and sensorial evaluation of wheat pasta. The phenolic content of the pasta enriched with 5% carob flour was observed to increase approximately 2 times, the antiradical activity 18 times and the reducing power 3 times, compared to control sample. In another study, noodles were prepared with black rice bran (BRB) in different proportions (2%, 5%, 10% and 15%). It was observed that the polyphenolic, flavonoid, and anthocyanin content of noodles with different BRB levels improved compared to the control. In addition, the antioxidant capacity of noodles enriched with BRB was increased compared to the control (Kong et al., 2012).

3.5. Sensorial Evaluation

Sensorial characteristics of cooked and uncooked noodle samples are shown in Table 6 and Table 7. As can be seen from the Table 5, the control sample gets the best scores in all criteria. 10% marjoram samples had lower scores with regards to color. Cracking scores of 5% sample was lower than all samples. Surface smoothness scores of enriched samples were not different from each other (p> 0.05). Cracking scores of 5% sample was lower than all samples. Appearance and overall acceptability of enriched samples were not significantly different (p > .05) from each other and had lower scores then control sample.

Table 6. Sensory properties of uncooked noodles

Sample	Color	Cracking	Surface Smoothness	Appearance	Overall Acceptability
0	8.55±0.34^{a}	8.55±0.29^{a}	8.60±0.60^{a}	8.55±0.06^{a}	8.55±0.96^{a}
2.5%	6.00±0.15^{b}	6.30±0.26^{b}	5.60±0.15^{b}	5.85±0.23^{b}	5.85±0.45^{b}
5%	5.20±0.07^{c}	5.55±0.71^{c}	5.70±0.51^{b}	5.40±0.07^{b}	5.05±0.73^{b}
10%	5.05±0.17^{c}	6.15±0.53^{bc}	6.25±0.96^{b}	5.15±0.64^{b}	5.50±0.87^{b}

Mean values ± standard deviation. Within columns, values with the different letter differ significantly from each other according to Duncan's test (p < 0.05).

Statistically significant differences (p < 0.05) were determined between the overall acceptability scores of the cooked samples. Odor, stickiness, and chewiness scores of cooked noodle samples were not significantly different (p > 0.05) from each other except 10%. The chewiness and affordability scores of 2.5% and 5% samples were similar with control samples. According to Table 7, the panelists liked the flavor of the noodles less as the marjoram ratio increased.

Table 7. Sensory properties of cooked noodle samples

Sample	Appearance	Color	Odor	Stickiness	Chewiness	Flavor	Mouthfeel	Overall Acceptability	Affordability
0	8.65±0.30^{a}	8.25±0.59^{a}	8.85±0.12^{a}	8.95±0.29^{a}	8.25±0.53^{a}	8.70±56^{a}	8.95±0.44^{c}	8.20±0.47^{a}	8.25±0.56^{a}
2.5%	8.95±0.20^{a}	8.20±0.34^{a}	8.95±0.63^{a}	8.45±0.31^{a}	7.80±0.13^{a}	6.55±0.33^{b}	7.50±0.29^{b}	7.10±0.14^{b}	6.50±0.69^{b}
5%	7.45±0.51^{b}	6.25±0.09^{b}	8.00±0.27^{a}	8.35±0.89^{a}	7.70±0.25^{a}	6.30±0.73^{b}	7.50±.083^{b}	6.55±0.16^{c}	6.10±.037^{b}
10%	6.25±0.96^{c}	4.65±0.47^{c}	6.05±0.14^{b}	7.30±0.65^{b}	6.40±0.78^{b}	4.55±0.55^{c}	5.70±.021^{a}	4.95±0.87^{d}	4.80±0.05^{c}

Mean values ± standard deviation. Within columns, values with the different letter differ significantly from each other according to Duncan's test (p < 0.05).

4. CONCLUSIONS

This study concluded that a different level of marjoram provides antioxidant benefits to Turkish noodles. Among these three levels, 10% marjoram showed the strongest effect in terms of antioxidative activity compared to control. Therefore, it is suggested that marjoram can be used to increase the nutritional value of noodles and other foods due to its high phenolic content and antioxidant capacity. However, the flavor of the noodles must be improved to increase consumer acceptability.

REFERENCES

Ajila, C.M., Aalami, M., Leelavathi, K., & Rao U.J.S.P. (2010). Mango Peel powder: a potential source of antioxidant and dietary fiber in macaroni preparations. *Innovative Food Science and Emerging Technologies*, 11(1), 219–224. https://doi.org/10.1016/j.ifset.2009.10.004

Amarowicz, R., Żegarska, Z., Rafałowski, R., Pegg, R.B., Karamać, M., & Kosińska, A. (2009). Antioxidant activity and free radical-scavenging capacity of ethanolic extracts of thyme, oregano, and marjoram. *European Journal of Lipid Science and Technology*, 111(11), 1111–1117. https://doi.org/10.1002/EJLT.200800170

Apak, R., Güçlü, K., Özyürek, M., & Çelik, S.E. (2008). Mechanism of antioxidant capacity assays and the CUPRAC (Cupric ion reducing antioxidant capacity) assay. *Microchimica Acta*, 160(4), 413–419. https://doi.org/10.1007/s00604-007-0777-0

Bergman, C.J., Gualberto, D.G., & Weber, C.W. (1994). Development of a high temperature dried soft wheat pasta supplemented with cowpea, cooking quality, color, and sensory evaluation. *Cereal Chemistry*, 71(6), 523-527.

Bilgiçli, N., Demir, M.K., Ertaş, N., Herken, E.N. (2011). Effects of gluten and emulsifier on some properties of erişte prepared with legume flours. *International Journal Of Food Sciences and Nutrition*, 62(1), 63-70.

Bina, F., & Rahimi, R. (2017). Sweet marjoram: A review of ethnopharmacology, phytochemistry, and biological activities. *Journal of Evidence-Based Complementary and Alternative Medicine*, 22(1), 175–185. https://doi.org/10.1177/2156587216650793

Boskou, G., Salta, F.N., Chrysostomou, S., Mylona, A., Chiou, A., & Andrikopoulos, N.K. (2006). Antioxidant capacity and phenolic profile of table olives from the greek market. *Food Chemistry*, 94(4), 558–564. https://doi.org/10.1016/j.foodchem.2004.12.005

Bruneton, J. (1995). Pharmacognosy, Phytochemistry and Medicinal Plants, English Translation by Hatton, C. K., Lavoisier Publishing, Paris. ISBN 1-898298-13-0.

Cencic, A., & Chingwaru, W. (2010). The role of functional foods, nutraceuticals, and food supplements in ıntestinal health. *Nutrients*, 2, 611–625. https://doi.org/10.3390/nu2060611

Charles, D.J. (2012). Marjoram Sweet. In: Antioxidant Properties of Spices, Herbs and Other Sources. Springer, New York, NY. https://doi.org/10.1007/978-1-4614-4310-0_37

Çabuk, B., & Yılmaz, B. (2020). Fortification of traditional egg pasta (erişte) with edible insects: nutritional quality, cooking properties and sensory characteristics evaluation. *Journal of Food Science and Technology*, 57(7), 2750–2757. https://doi.org/10.1007/S13197-020-04315-7

Demir, M.K., Bilgiçli, N., Türker, S., & Demir, B. (2021). Enriched turkish noodles (erişte) with stabilized wheat germ: chemical, nutritional and cooking properties. *LWT*, 149, 111819. https://doi.org/10.1016/J.LWT.2021.111819

Dirim, S.N., & Koç, G.C. (2019). Functional properties of parsley fortified homemade Turkish noodles (erişte). *Croatian Journal of Food Science and Technology*, 11(1), 88–96. https://doi.org/10.17508/CJFST.2019.11.1.13

Eyidemir, E., & Hayta, M. (2010). The effect of apricot kernel flour ıncorporation on the physicochemical and sensory properties of noodle. *African Journal of Biotechnology*, 8(1), 85–90. https://doi.org/10.4314/ajb.v8i1.59742

Kaur, G., Sharma, S., Nagi, H.P.S., & Ranote, P.S. (2011). Enrichment of pasta with different plant proteins. *Journal of Food Science and Technology*, 50(5), 1000–1005. https://doi.org/10.1007/S13197-011-0404-2

Kong, S., Kim, D.J., Oh, S.K., Choi, I.S., Jeong, H.S., & Lee, J. (2012). Black rice bran as an ıngredient in noodles: chemical and functional evaluation. *Journal of Food Science*, 77(3), 303–307. https://doi.org/10.1111/J.1750-3841.2011.02590.X

Kowalczewski, P.Ł., Pauter, P., Smarzyński, K., Różańska, M.B., Jeżowski, P., Dwiecki, K., & Mildner-Szkudlarz, S. (2019). thermal processing of pasta enriched with black locust flowers affect quality, phenolics, and antioxidant activity. *Journal of Food Processing and Preservation*, 43(10), e14106. https://doi.org/10.1111/jfpp.14106

Liu, Y., Xu, M., Wu, H., Jing, L,. Gong, B., Gou, M., Kun, Z., & Li, W. (2018). The compositional, physicochemical and functional properties of germinated mung bean flour and ıts addition on quality of wheat flour noodle. *Journal of Food Science and Technology*, 55(12), 5142–5152. https://doi.org/10.1007/S13197-018-3460-Z

Morris, C.F. (2018). Determinants of wheat noodle color. *Journal of the Science of Food and Agriculture*, 98(14), 5171–5180. https://doi.org/10.1002/jsfa.9134

Nizam. D., & Yenal, Z. (2020). Seed politics in Turkey: The awakening of a landrace wheat and ıts prospects. *The Journal of Peasant Studies*. 47(4), 741-766. https://doi.org/10.1080/03066150.2019.1708725

Poonsri, T., Jafarzadeh, S., Ariffin, F., & Zainul Abidin, S. (2019). Improving nutrition, physicochemical and antioxidant properties of rice noodles with fiber and protein-rich fractions derived from cassava leaves. *Journal of Food and Nutrition Research*, 7(4), 325–332. https://doi.org/10.12691/jfnr-7-4-10

Prabhasankar, P., Ganesan, P., Bhaskar, N., Hirose, A., Stephen, N., Gowda, L.R., Hosokawa, M., & Miyashita, K. (2009). Edible Japanese seaweed, wakame (undaria pinnatifida) as an ıngredient in pasta: chemical, functional and structural evaluation. *Food Chemistry*, 115(2), 501–508. https://doi.org/10.1016/j.foodchem.2008.12.047

Roby, M.H.H., Sarhan, M.A., Selim, K.A.H., & Khalel, K.I. (2013). Evaluation of antioxidant activity, total phenols and phenolic compounds in thyme (*thymus vulgaris l.*), sage (*salvia officinalis l.*), and marjoram (*Origanum majorana L.*) extracts. *Industrial Crops and Products*, 43, 827- 831. https://doi.org/10.1016/j.indcrop.2012.08.029

Sayaslan, A., Koyuncu, M., Yildirim, A., Eserkaya Güleç, T., Ateş Sönmezoğlu, Ö., & Kandemir, N. (2012). Some quality characteristics of selected durum wheat (*Tritcum durum*) landraces. *Turkish Journal of Agriculture and Forestry*, 36(6), 749–756. https://doi.org/10.3906/tar-1201-69

Sęczyk, Ł., Świeca, M., Gawlik-Dziki, U., Luty, M., & Czyz, J. (2016). Effect of fortification with parsley (petroselinum crispum mill.) leaves on the nutraceutical and nutritional quality of wheat pasta. *Food Chemistry*, 190, 419–428. https://doi.org/10.1016/j.foodchem.2015.05.110

Sofi, S.A., Singh, J., Mir, S.A., & Dar, B.N. (2020). In vitro starch digestibility, cooking quality, rheology and sensory properties of gluten-free pregelatinized rice noodle enriched with germinated chickpea flour. *LWT*, 133, 110090. https://doi.org/10.1016/J.LWT.2020.110090

Syyu, S.,Ying, L., & Weicheng, P. (2021). Physico-chemical and antioxidant properties of noodle enriched with beetroot puree. *Science and Technology of Food Industry*, 42(13), 33–38. https://doi.org/10.13386/J.ISSN1002-0306.2020070353

Vitali, D., Dragojević, I.V., & Šebečić, B. (2009). effects of ıncorporation of ıntegral raw materials and dietary fibre on the selected nutritional and functional properties of biscuits. *Food Chemistry*, 114(4), 1462-1469. https://doi.org/10.1016/j.foodchem.2008.11.032

Wandee, Y., Uttapap, D., Puncha-Arnon, S., Puttanlek, C., Rungsardthong, V., & Wetprasit, N. (2015). Quality assessment of noodles made from blends of rice flour and canna starch. Food Chemistry, 179, 85–93. https://doi.org/10.1016/j.foodchem.2015.01.119

Yu, K., Zhou, H.M., Zhu, K.X., Guo, X.N., & Peng, W. (2019). Increasing the physicochemical stability of stored green tea noodles: analysis of the quality and chemical components. *Food Chemistry*, 278, 333-341. https://doi.org/10.1016/j.foodchem.2018.11.012

Zhu, F., & Li, J. (2019). physicochemical and sensory properties of fresh noodles fortified with ground linseed (linum usitatissimum). *LWT*, 101, 847–853. https://doi.org/10.1016/j.lwt.2018.12.003