Croatian Journal of Food Science and Technology
journal homepage: www.ptfos.unios.hr/cjfst/

Original scientific paper

DOI: 10.17508/CJFST.2019.11.1.13

Functional properties of parsley fortified homemade Turkish noodles (Erişte)

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ARTICLE INFO

Article history:
Received: June 26, 2018
Accepted: May 5, 2019

Keywords:
Turkish noodles (Erişte)
parsley
cooking test
sensory analysis

ABSTRACT

Turkish noodle is a staple traditional dish in the Turkish cuisine and generally made out of wheat flour, egg, salt and vegetable oil. The aims of this study were to improve the formulation of Turkish noodles by the addition of minced parsley (2, 4, 6 and 8% weight), to improve their functional properties and swelling volume, to determine the effect on the physical properties (moisture content, water activity, and colour) and chemical composition (vitamin C, total chlorophyll, total carotenoid, and protein content) of the homemade plain and fortified Turkish noddle dough (FHTD) and the fortified homemade Turkish noodles (FHTN), to determine the traditional and microwave cooking characteristics and to indicate consumer preferences of FHTN with fresh parsley. The results showed that the amount of addition of fresh parsley caused a significant increase in the moisture content values of FHTD (31.59-36.08%) ($P<0.05$). The vitamin C, total chlorophyll and total carotenoid contents of the FHTD and FHTN were improved with the addition of fresh parsley. The traditionally cooked FHTN have got higher water absorption (30.25-38.90g) and swelling volume values (237.50-267.50%) than microwave cooked FHTN (WA=29.03–34.77g, SV=240.00-265.00%) ($p<0.05$). The noodles containing 2% parsley had the highest rating compared to both plain and other samples.

Introduction

Erişte (Turkish noodles, egg noodles) is a traditional dish in the Turkish cuisine which is generally produced from wheat flour, egg, salt, water, and vegetable oil (Bilgiçli, 2009; Aktaş et al., 2014). The process of homemade Turkish noodle production consists of the dough preparation (mixing the ingredients), sheeting of the dough, pre-drying, cutting and final drying (under the sun, roasting over a pan, etc.). Stages and the parameters of these steps may vary between the recipes throughout Turkey (Bilgiçli, 2009; Akıllıoğlu and Yalçın, 2010). The quality of Turkish noodles depends on the chemical composition of raw materials (ash, gluten and protein content of the flour, etc.) and production techniques such as dough mixing time, sheeting, resting time and drying methods (Bilgiçli, 2009; Özkaya et al., 2001). The pasta products are rich in carbohydrates, but they usually lack fibres , vitamins, minerals, phenolic and antioxidant compounds, etc. For this reason, many studies have been performed in order to expand the nutritional and nutraceutical quality such as vitamin, mineral, and phenolic content of wheat pasta by the addition of oregano and carrot leaves (Boroski et al., 2011), dry amaranth leaves flour (Borneo and Aguirre, 2008), elderberry juice concentrate (Sun-Waterhouse et al., 2013), pea flour (Padalino et al., 2014), mint (Dirim and Çalışkan, 2017), powdered parsley leaves (Seczyk et al., 2016) etc. The addition of vegetables or herbs to the noodle formulation leads to multiple changes in the nutritional, nutraceutical and technological properties and consumer acceptance of these products (Dirim and Çalışkan, 2017; Seczyk et al., 2016; Lebesi and Tzia, 2011). In addition, there is a potential for the marketability of the vegetable-added pasta noodles. The pasta products are often served with cheese, meat, mint, parsley and several kinds of sauces which make them all the more nutritious and tasty. Parsley (*Petroselinum crispum* Mill.) which has

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several pharmacological properties such as antioxidant, hepatoprotective, brain protective, anti-diabetic, immunosuppressant, gastroprotective, cytoprotective, estrogenic, diuretic, hypotensive, antibacterial, and antifungal is a popular culinary vegetable native to the countries of the Mediterranean region (Farzaei et al., 2013). The aims of this study were to fortify noodles by the addition of minced parsley (2, 4, 6 and 8% weight/weight) to the dough formulation, to improve their functional properties, to determine the effect of addition of fresh parsley on physical properties (moisture content, water activity, and colour) and chemical composition (vitamin C, chlorophyll, total carotenoid, and protein contents) of the plain and fortified dough and the noodles, to determine the traditional and microwave cooking characteristics (total soluble solid loss, total water absorption, and total swelling volume) and to indicate consumer preferences (sensory evaluation) of fortified homemade Turkish noodles (FHTN) with fresh parsley.

Materials and methods

Materials

Fresh parsley, wheat flour (Sinangil Gıda San. ve Tic. A.Ş.), sunflower oil (Küçükbay Gıda San. ve Tic. A.Ş.,), eggs (Keskinoğlu Gıda San. ve Tic. A.Ş.,), and table salt (Billur Tuz San. A.Ş.) were obtained from a local supermarket in Izmir, Turkey.

Methods

Preparation of enriched Turkish noodles

All ingredients (63.9% flour, 35% whole egg, 1% sunflower oil, 0.1% table salt and the additional amount of minced parsley in the percentages 2, 4, 6 or 8% w/w of the total weight) were mixed in a bowl and kneaded by hand in order to obtain a homogenous dough. Then, the dough was flattened and brought into a regular shape at the same thickness with a kitchen type pasta making machine (Fackelmann, Germany). The pieces of flattened dough were predried in the oven (Siemens, Germany) for 10 min at 60 °C (Oliviero and Fogliano, 2016). Then the flattened dough was cut by the kitchen type pasta making machine into long stripes (0.65cm width). The shape of the completed Turkish noodle was achieved by cutting the long stripes into 4cm pieces and the final drying was performed in the oven for 90 min at 60 °C. The obtained noodles were stored in small plastic bags at room temperature for further use.

Physical analysis

The moisture content, water activity, and colour values (L*, a*, and b*, CIE LAB system) of plain and fortified dough and Turkish noodles were determined according to AOAC (2000), measured by using a Testo-AG 400, German water activity measurement device, or by using a Minolta CR-400 Colorimeter, Japan.
The total colour change (ΔE), (Equation 1) was calculated in plain noodles which were considered to be the standard for colour and browning index (BI) was calculated as shown in Equations 2 and 3 (Pathare et al., 2013) below;

$$\Delta E = \sqrt{(L^* - L^*_{ref})^2 + (a^* - a^*_{ref})^2 + (b^* - b^*_{ref})^2} \quad (1)$$

$$BI = \frac{100 * (x - 0.31)}{0.17} \quad (2)$$

$$x = \frac{a^* + 1.75 L^*}{5.645 L^* - a^* - 3.0126 b^*} \quad (3)$$

Chemical analysis

The vitamin C, total chlorophyll and total carotenoid content of plain and fortified dough and Turkish noodles were determined according to Hışıl (2007), Ferna´ndez-Leo´n et al. (2010), and Lee and Castle (2001), respectively. The protein content of the dough and the FHTN were determined by using Leco FP-528, USA Nitrogen/Protein Analyzer.

Cooking tests

Two different cooking tests were applied to samples. Traditional cooking was performed in a water bath at 100±5 °C in a beaker (250 ml). For this purpose, the 25 g of noodles was added to boiling water in the beaker and boiled for 20 min. The ratio of noodles to water was chosen as 1:10 (w/w). A similar setup was used for microwave cooking (Arçelik MD 595, Turkey) at 720 Watt for 10 minutes. The total water absorption (g) and total swelling volume (%) (Yalçın and Basman, 2008) of FHTN and the total soluble solid content (TSSC, Brix (°Bx), FG-103 - Chincan, China) of the cooking water were determined.

Sensory analysis

Descriptive sensory analysis (1 (poor) to 5 (excellent)), which included the attributes such as colour, texture, odour, flavour, and overall acceptability, was conducted by 10 semi-trained panelists chosen among the students of the Department of Food Engineering (Ege University, Izmir, Turkey). The panelists were not informed about the amount of addition of fresh parsley to the dough formulation prior to sensory evaluation.

Statistical analysis

The data were analysed using statistical software SPSS 20.0 (SPSS Inc., Chicago, IL, USA). The data were also subjected to the analysis of variance (ANOVA) and Duncan's multiple range test (α= 0.05) was used to determine the difference between means. The preparation steps were replicated twice and all the analyses were triplicated.

Results and discussion

Pasta products like noodles and spaghetti can be fortified with several ingredients such as high-fibre ingredients, pulse flour, etc. to improve their nutritional value or functionality. The fortification attempts have become increasingly popular and some of the studies related to the pasta products focused on the development of new enriched pasta products (Mercier et al., 2016). The main purposes of fortification are to provide additional sources of fibre , minerals, antioxidants, vitamins, etc. or to compensate for nutritional deficiencies such as low lysine and threonine contents (Chillo et al., 2008; Marti and Pagani, 2013). Parsley is an aromatic food which is also a good source of vitamins, phenols, etc. The fresh parsley leaves generally used in different kinds of pasta recipes or sauces and the consumer preferences for such dishes are very high. For this reason, in this study, the homemade Turkish noodles were fortified by the addition of different amount of parsley in order to improve their functional properties.

Results of the physical analysis

Moisture content, water activity, total colour change, and Browning Index values of the FHTD and FHTN are given in Table 1. The moisture content (%, wet basis) and water activity values of plain dough and plain Turkish Noodles were found to be as 31.43±1.02% and 9.69±0.92%, and 0.99±0.03 and 0.53±0.09, respectively. The results showed that the amount of addition of fresh parsley caused a significant increase in the moisture content values of FHTD compared to plain dough (p<0.05) and although the moisture content values increased, this increase was insignificant compared to the plain noodle (p>0.05) (Table 1) due to high moisture content of fresh parsley (80.14±2.29%, wet basis). The moisture content values of FHTD significantly increased depending on the additional amount of the fresh parsley (p<0.05). The pre and final drying processes caused 67.72% (average) moisture loss from the plain and fortified doughs. The moisture content of FHTN was not significantly affected by the fresh parsley concentration (p>0.05). Seczyk et al. (2016) reported that the moisture content values of spaghetti pasta (Semolina wheat flour: water 2.5:1 (w/w), 1-4% parsley (w/w), 2.5 mm thickness, 40mm length, the drying temperature is 40 °C) fortified with dried parsley leaves (8 g/100g) was 12 g/100 g. The moisture content of FHTN was lower than this value due to the different dough formulation and the processing conditions such as drying time, temperature, etc. The final moisture content of all FHTN were found to be lower than 14% which is important for a long shelf life, up to 1–2 years (Fu, 2008). The water activity values of FHTD and FHTN were found to be as 0.99 (for all samples) and 0.4-0.53, respectively (Table 1). The fresh parsley concentration did not significantly affect the water activity values of dough and FHTN (except for 6%) (p>0.05).

Traditionally produced Turkish noodles should have a golden colour. On the other hand, the noodles which have different colour due to a different kind of fortification such as tomato, carrot etc. are also finding space in Turkish markets (Dirim and Çalışkan, 2017). For this reason, colour is an important quality parameter of Turkish noodles because it can be evaluated directly by consumers at the time of purchase (Carini et al., 2009). The produced fortified homemade Turkish noodles are shown in Fig. 1. The colour values of the plain and fortified dough and the Turkish noodles are shown in Fig. 2 and Fig. 3, respectively. The increase in the parsley (for fresh parsley, L^*=23.21±1.64, a^*=-13.25±0.42, and b^*=18.41±0.85) concentration resulted in a significant decrease in the L* and a* values of both FHTD and the FHTN (P<0.05) due to lower L^* and a^* values of fresh parsley compared to the wheat flour (L^*=94.51, a^*=−0.77, and b^*=9.59) which is the main ingredient of Turkish noodles. The b^* values of FHTN were found to be significantly lower compared to the plain noodle (p<0.05). However, the parsley concentration was not found to be statistically effective on the b^* values of FHTD (p>0.05). The pre and final drying processes caused a significant decrease (data is not given) in the colour values (L^*, a^*, and b^*) of FHTN (p<0.05). The degradation of chlorophyll or browning reactions due to temperature effect may be related to pigment destruction and may cause the colour loss. The total colour change and Browning Index values of the FHTD and FHTN were calculated and the results are given in Table 1. The total colour changes increased depending on the increasing the parsley concentration (p<0.05). The colour change values of food materials during thermal processing such as drying takes place due to the pigment degradation, especially carotenoids and chlorophyll, browning reactions such as Maillard and oxidation of ascorbic acid and so on (Dadali et al., 2007). The browning index value of plain noodle was calculated to be 48.94±7.93 and the addition of fresh parsley to the dough formulation resulted in a significant decrease in the browning index values of the noodles (P<0.05).

Table 1. Moisture content (wet basis, wb), water activity, total colour change, and Browning Index values of the FHTD and FHTN (n=3)

Analysis	Concentration [%]	FHTD	FHTN
Moisture Content (wet basis, (wb) (%)	Plain	31.43±1.02^{a}	9.69±0.92^{a}
	2	31.59±0.92^{a}	11.22±2.43^{a}
	4	32.66±1.16^{ab}	9.60±1.46^{a}
	6	33.61±0.41^{b}	11.62±2.91^{a}
	8	36.08±0.49^{c}	11.21±3.44^{a}
Water Activity	Plain	0.99±0.03^{a}	0.53±0.09^{a}
	2	0.99±0.01^{a}	0.53±0.09^{a}
	4	0.99±0.01^{a}	0.41±0.18^{a}
	6	0.99±0.01^{a}	0.53±0.02^{ab}
	8	0.99±0.01^{a}	0.40±0.10^{a}
Total Colour Change (ΔE)	Plain	-	-
	2	9.90±3.83^{a}	6.45±1.87^{a}
	4	13.14±3.18^{b}	9.77±2.82^{b}
	6	15.53±3.29^{b}	13.39±2.23^{c}
	8	18.80±3.73^{c}	17.15±2.36^{d}
Browning Index (BI)	Plain	-	48.94±7.93^{b}
	2	-	40.90±2.62^{ab}
	4	-	42.81±2.49^{b}
	6	-	41.63±4.56^{ab}
	8	-	39.67±3.09^{a}

$^{a\text{-}c}$ Different letters in the column show a significant difference in the column (p<0.05)

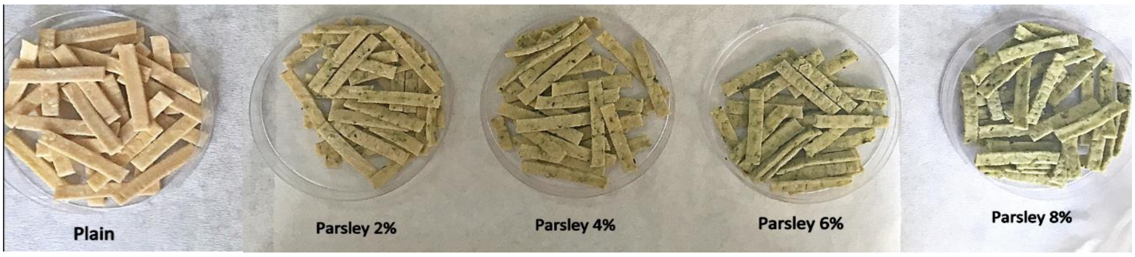

Fig. 1. Plain and fortified homemade Turkish noodles (FHTN).

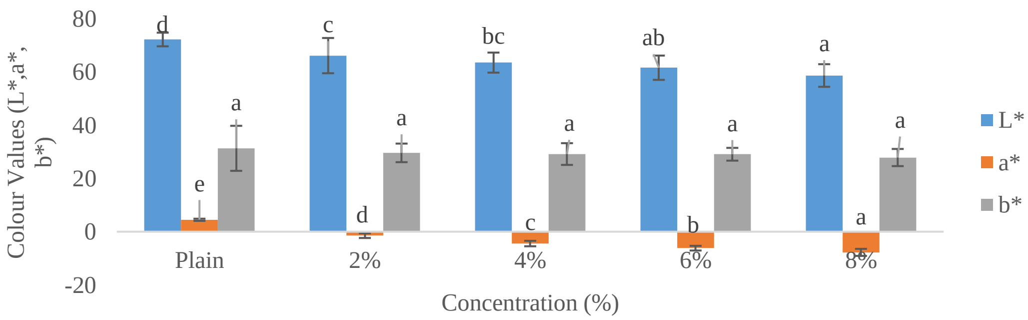

Fig. 2. Colour Values (*L**, *a**, and *b**) of the plain and fortified dough ($^{a\text{-}e}$ Show the significant differences between the samples (p<0.05)).

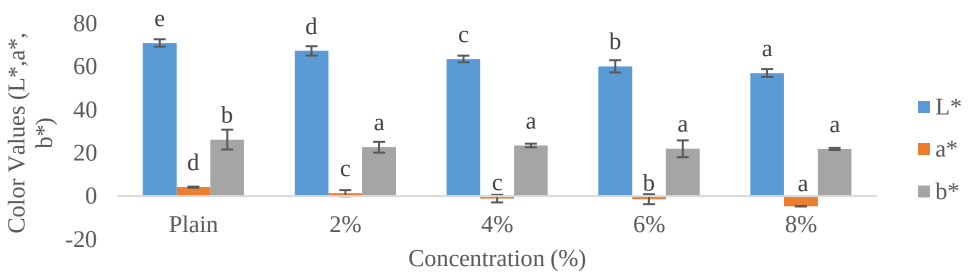

Fig. 3. Colour Values (*L**, *a**, and *b**) of the plain and fortified homemade Turkish noodle ([a-e] Show the significant differences between the samples (p<0.05)).

Table 2. Chemical Composition of Fortified Dough and Fortified Homemade Turkish Noodles (n=3)

Analysis	Concentration [%]	FHTD	FHTN
Vitamin C Content (mg/100g, db)	Plain	-	-
	2	17.63±2.14^{a}	-
	4	33.32±6.96^{c}	-
	6	31.40±4.47^{c}	10.87±0.31^{a}
	8	25.33±5.19^{b}	10.43±0.64^{a}
Total Chlorophyll Content (ppm, db)	Plain	158.20±19.27 ^{a}	127.90±15.02 ^{a}
	2	1038.35±46.52^{b}	641.61±85.95^{b}
	4	1517.83±75.13^{c}	999.48±74.89^{c}
	6	1646.51±97.48^{d}	1137.93±49.68^{d}
	8	1823.46±78.29^{e}	1349.54±58.87^{e}
Total Carotenoid Content (mg/100g FHTN, db)	Plain	-	-
	2	5.05±0.67^{a}	4.75±0.12^{ab}
	4	5.68±0.75^{a}	5.16±0.67^{b}
	6	6.61±0.59^{ab}	5.64±0.74^{b}
	8	7.32±0.65^{b}	6.71±0.69^{b}
Protein Content (%, db)	Plain	15.19±0.02 ^{b}	19.50±0.13 ^{b}
	2	15.08±0.63^{b}	19.95±0.17^{b}
	4	15.34±0.51^{b}	18.41±1.37^{ab}
	6	13.79±0.40^{a}	18.31±0.25^{a}
	8	14.84±0.23^{b}	18.23±0.15^{a}

[a-d] Different letters in the column show a significant difference in the column (p<0.05)

Results of the chemical analysis

The vitamin C, total chlorophyll, total carotenoid and protein contents of the samples are given in Table 2.

The vitamin C, total chlorophyll and total carotenoid content of parsley were found to be 377.29±4.83 mg/100g (db), 246.23±10.58 mg/100g (db), and 8.3±1.21 mg/100g (db) for parsley. Lisiewska and Kmiecik (1997) reported that the moisture, vitamin C, total chlorophyll and total carotenoid content values of fresh leaves of Hamburg parsley are 80g/100g (db), 310mg/100g (db), 203 mg/100g (db), and 7.5 mg/100g (db), respectively. The obtained results in this study are consistent with the results of Lisiewska and Kmiecik (1997). Quite opposite to the plain dough and plain Turkish noodles, where the vitamin C and total carotenoid contents were undetectable, the vitamin C and total carotenoid contents of the FHTD and FHTN were improved with the addition of fresh parsley (P<0.05). Drying processes in the preparation of noodles caused a significant decrease in the vitamin C, total chlorophyll, and total carotenoid content of FHTN (P<0.05). No vitamin C content was detected for FHTN including 2% and 4% parsley and the calculated values were observed to be decreased to 65.38% and 58.82% for FHTN including 6% and 8% parsley, respectively. The total chlorophyll content of the plain dough and Turkish Noodles was found to be 158.20±19.27 and 127.90±15.02ppm (db), respectively.

The results showed that an increase in the parsley concentration caused a significant increase in chlorophyll content of both FHTD and FHTN (p<0.05). The chlorophyll losses during drying decreased depending on the increasing of parsley concentration (on the average of 32.31%). Similar results were also reported by Ajila et al. (2010) where the total polyphenol (0.460±0.008 mg GAE/g), the carotenoid (4.65±0.15 μg/g), and total dietary fibre (8.58±0.2%) contents of macaroni (semolina (500g), warm distilled water (150ml), and mango peel powder (0%, 2.5%, 5%, and 7.5%)) increased with the increasing of the amount of additional amount of mango peel powder and ranged between 1.470-1.803 mg GAE/g, 26.5-84 μg/g, and 13.8- 17.8%, respectively. Dirim and Caliskan (2017) also reported that the vitamin C, total chlorophyll, and carotenoid contents of Turkish noodles improved by the addition of different amounts of mint. The losses of total carotenoid content during drying generally increased according to the parsley concentration and were calculated to be 5.95%, 9.15%, 14.67%, and 8.33% for FHTN with 2%, 4%, 6%, and 8% parsley, respectively. Oliviero and Fogliano (2016) reported that drying at high temperature can lead to degradation of heat sensitive bioactive compounds of pasta products, and the cooking pasta in boiling water (which is drained at the end of the cooking) can also substantially decrease the number of bioactive compounds due to leaching into the cooking water and/or thermal degradation. In addition, during the cooking the vegetable cells are damaged because part of the phytochemicals can move into the cooking medium. Van Boekel et al. (2010) reported that vitamin C is a sensitive compound and can be degraded upon thermal treatments (drying and cooking). Therefore, the losses of the vitamin C, total chlorophyll, and carotenoid contents of FHTN during drying may be due to temperature effect, leaching into the cooking water and damaging the cells.

The protein content of the plain dough and Turkish noodles was found to be 15.19±0.02% and 19.50±0.13% (dry basis), respectively. The addition of the fresh parsley to the dough formulation caused significantly lower protein content (for dough 13.79- 15.34% and noodle 18.23-19.95%, db) (P<0.05). In the literature, the protein content of Turkish noodles was reported to be as 15.84±0.13% (wheat flour (100g), whole egg (30g), and salt (0.5g), Aktaş et al., 2014), and 13.2±0.28 (wheat flour (200g), whole egg (40g), and salt (1g), Bilgiçli, 2009) which are consistent with this study where the differences between the results may be due to the different noodle formulations.

Results of the cooking tests

The results of the cooking tests and total soluble solid loss values are given in Table 3. The cooking time of noodles in a microwave oven and traditional cooking were decided by preliminary sensory evaluation (taste and texture). The cooking time (10 min) of the noodle samples cooked at 720 W power was found to be half of the traditionally cooked samples. In general, by using microwave cooking time, energy and cost might be reduced (Pilli et al., 2009). According to the results of the cooking tests, it can be said that traditionally cooked samples have significantly higher water absorption and swelling volume values than microwave cooked samples (p<0.05). In microwave cooking, the increase in the parsley concentration caused a significant increase in the water absorption and swelling volume of FHTN and total soluble solid content of boiling water (p<0.05). During pasta cooking, soluble parts of starch and other soluble components including non-starch polysaccharides leach into the cooking medium (Ajila et al., 2010). The higher loss of total soluble solid of FHTN at the higher parsley concentration may be due to the lower protein (gluten) content which is related to the composition of pasta. Ajila et al. (2010) also reported that higher cooking loss values were observed at the higher concentration of the mango peel powder due to the disruption of the protein-starch matrix by the fibre and uneven distribution of water within the macaroni matrix due to the competitive hydration tendency of the fibre . The higher soluble solid loss was observed for microwave cooked FHTN (0.00-0.40 °Bx) due to the destruction of cells or starch damage under the microwave energy (p<0.05). Similar results were also obtained for enriched Turkish noodle with mint (63.9% flour, 35% whole egg, 1% sunflower oil, 0.1% table salt and the additional amount of mint in the percentages 2, 4, 6 or 8% w/w, Dirim and Caliskan (2017). Dirim and Caliskan (2017) reported that traditionally cooked enriched Turkish noodles with mint have significantly higher water absorption (36.55-42.40 g) and swelling volume (265.00-307.50%) values and lower total soluble solid loss (0.00-0.40 °Bx) than microwave cooked enriched Turkish noodle with mint (WA=33.23-39.06g; SV=235.00 - 257.50%; TSSC=0.00-0.50 °Bx). Bilgiçli (2009) reported that the volume increase of the Turkish noodle (flour (200.0 g), whole egg (40.0 g), salt (1.0 g), water, buckwheat flour BWF was substituted at levels of 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35% and 40% of wheat flours) ranged between 285-298%. The differences between the results may be due to the differences in Turkish noodle formulations. The addition of 4% of parsley to the dough formulation caused a significant decrease both in water absorption and swelling volume of traditionally cooked FHTN ($p<0.05$). Steglich et al. (2014) also reported that the lower weight increase values of pasta enriched with high fibre ingredients could be explained by the entrapment of semolina starch granules by the fibre particles, reducing the swelling of the starch granules during cooking. Statistically, there is no significant difference between all microwave cooked samples in water absorption values ($p>0.05$) but in swelling volumes. A difference can be seen after the addition of parsley beyond 8% ($p<0.05$). Mercier et al. (2016) reported that in the literature, the majority (75%) of the colour measurements were performed on uncooked pasta, however, the effect of the cooking process on the colour values and consumer perception of the pasta is unclear. The effect of traditional and microwave drying processes on the colour of FHTN were also determined and the results are shown in Fig. 4 and Fig. 5, respectively. The $L*$ value increased, $a*$ and $b*$ values decreased in both traditionally and microwave cooking processes compared to uncooked samples ($P<0.05$). Mercier et al. (2016) also reported that the cooking process increased the L value of pasta by an average of 3.0 ± 2.2, but decreased the a and b values by an average of 3.4±0.6, and 8.7±2.0, respectively. The results are consistent with these findings. The colour values of traditionally cooked FHTN were found to be generally higher when compared to the microwave cooked FHTN indicating the significant effect of the cooking process on the colour values of FHTN ($p<0.05$).

Results of the sensory evaluation

Mercier et al. (2016) reported that the sensory evaluations showed that enrichment levels below 10% generally do not affect consumer acceptance, but higher enrichment levels significantly decrease it. For this reason, in this study, the fresh parsley concentration was kept under 10%. The results of the sensory evaluation are shown in Fig. 6 and according to the results of the sensorial analysis, it can be stated that the FHTN containing 2% parsley had the highest rating compared both to plain and other samples (except for odour and flavour). However, statistically, no significant difference was observed between all the samples ($p>0.05$).

Table 3. Results of cooking tests and total soluble solid loss (n=3)

Type of Cooking	Concentration [%]	Water absorption [g]	Swelling volume [%]	TSSC [°Bx]
Traditional Cooking	Plain	38.90±3.22^{bx}	267.50±3.54^{cy}	0.00±0.00^{ax}
	2	38.90±3.22^{by}	267.50±3.54^{cy}	0.00±0.00^{ax}
	4	30.25±4.24^{ax}	237.50±3.54^{ax}	0.00±0.00^{ax}
	6	34.66±4.59^{ax}	257.50±10.6^{bx}	0.00±0.00^{ax}
	8	31.68±1.00^{ax}	262.50±17.68^{bcx}	0.20±0.00^{bx}
Microwave Cooking	Plain	34.77±10.38^{ax}	245.00±12.43^{ax}	0.00±0.00^{ax}
	2	29.17±5.32^{ax}	240.00±14.14^{ax}	0.20±0.00^{by}
	4	29.03±4.27^{ax}	242.50±3.54^{ay}	0.25±0.07^{bcy}
	6	32.95±1.54^{ax}	255.00±0.00^{ax}	0.35±0.07^{cdy}
	8	34.05±1.80^{ay}	265.00±7.07^{bx}	0.40±0.00^{dy}

$^{a-d}$ shows a significant difference in the samples according to the concentration of parsley (P<0.05).
$^{x-y}$ shows a significant difference in the samples according to cooking tests (P<0.05).

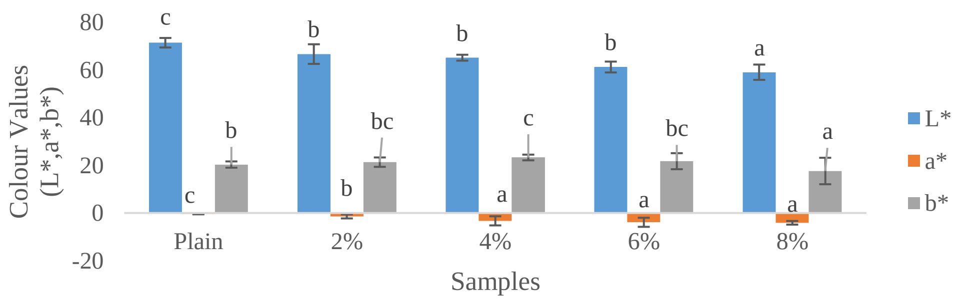

Fig. 4. Colour Values (L*, a*, and b*) of the traditionally cooked plain and fortified homemade Turkish noodles ($^{a-e}$ Show the significant differences between the samples (P<0.05)).

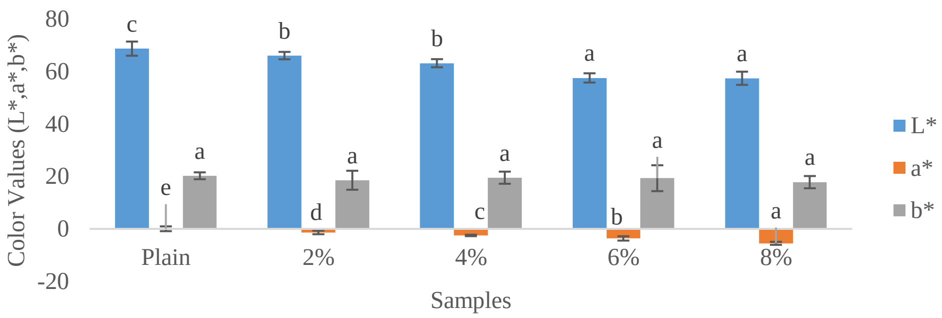

Fig. 5. Colour Values (L*, a*, and b*) of the microwave cooked plain and fortified homemade Turkish noodle ([a-e] Show the significant differences between the samples (P<0.05)).

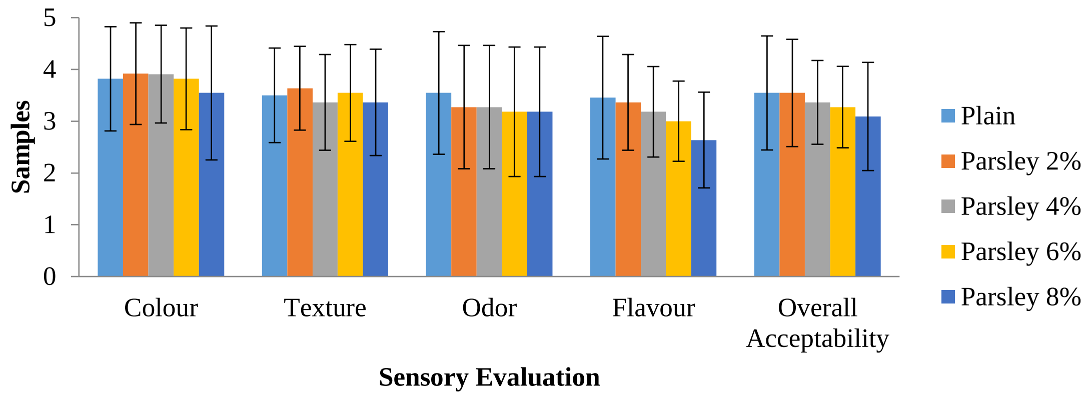

Fig. 6. Sensory ratings for the plain and the fortified Turkish noodles.

Conclusion

Development and utilization of functional and nutritional products such as herbs, plants or waste parts of fruits or vegetables can be used to improve the nutritional value of pasta products. In this study, the homemade Turkish noodles (Erişte) were fortified by the addition of fresh parsley, which is generally used in different pasta recipes or sauces, in order to improve their functional properties. The final moisture content of all FHTN was found to be less than 14% which is important for a long shelf life, up to 1–2 years. The colour values of the dough and FHTN significantly decreased depending on the increase of parsley concentration (P<0.05). The vitamin C, total chlorophyll and total carotene contents of FHTN increased depending on increasing of the parsley concentration (P<0.05). The traditionally cooked FHTN have higher water absorption and swelling volume values compared to the microwave cooked FHTN (P<0.05). Turkish noodles containing 2% parsley had the highest rating (3.92 for colour, 3.64 for texture, and 3.55 for overall acceptability) compared to both plain and other samples.

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