Enhancement of the Functional Properties of Home-Made Style Turkish Noodles (Erişte) with the Addition of Fresh Mints.

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Abstract. The primary focus of this study is the assessment of the benefits of fortified noodle products by the addition of mint to improve their functional properties. Therefore, the addition of mint in different amounts (2, 4, 6 and 8% weight:weight (w:w)) to the dough of the noodles was tried and the dough formulations were analyzed to maximise the effect of the mint without compromising appearance and consistency of the dough and to achieve a rich green colour for attractiveness of the finished product. Physical properties (moisture content, water activity and colour) and chemical composition (vitamin C, chlorophyll, total carotenoid and protein content analysis) of the plain and enriched dough and the noodles were determined. Cooking tests have also been implemented for a comparison between the samples for water absorption, swelling volume and cooking loss as well as a sensory analysis. The results showed that the addition of fresh mint beyond 4% caused a significant increase in the moisture content of the noodles compared to plain noodle ($P<0.05$). The water activity of plain dough and noodle were found to be as 0.99±0.03 and 0.59±0.09, respectively. The protein content of dough and "Enriched Turkish Noodle (ETN)" ranged between 15.00 - 16.77 and 16.45 - 19.43% (db), respectively. The water absorption and the total volume increase of all the samples for traditional and microwave cooking test ranged between 36.55 - 42.40g and 265.00 - 307.5%, and 33.23 - 39.06g and 235.00 - 257.50%, respectively. According to results of the sensorial analysis, the noodles containing 4% mint have the highest acceptability compared to both the plain and the other samples.

Keywords:

Turkish Noodles,
Mint,
Cooking Test,
Sensory Analysis

INTRODUCTION

Turkish Noodle (Erişte) is a staple traditional dish in the Turkish cuisine and generally made out of wheat flour, egg, salt and vegetable oil (Aktaş et al., 2014). The process of Turkish noodle production covers the dough preparation, the pre-drying, the cutting and drying as the final stage. Specific parameters of these steps may vary between the recipes throughout Turkey (Akillioglu and Yalcin, 2010). The matrix of wheat flour dough contains gluten as the continuous component and starch as the filler particles which make up the main rheological properties of a wheat-based noodle product (Edwards et al., 2002). Egg can act to improve the handling of dough while preparing and also helps with the elasticity of the cooked product and guarantees a cohesive mass achieved by denaturation (Alamprese et al., 2005). Besides those two main ingredients, oil and salt can be added for further improvement of consistency and flavour. Although noodle products are rich in carbohydrates, they are lack of protein, fibre, vitamins or antioxidants. By the addition of vegetables or herbs to the noodle formulation the beneficial constituents such as fibres, minerals and vitamins of noodles can be increased. Health-enhancing characteristics may come from a wide variety of plant sources which provide important components when used in food systems (Lebesi & Tzia, 2011). Mint has high amount of vitamins (vitamin C and E), minerals, dietary fibre, and other nutrients such as phenolic components which contribute to antioxidant capacity (Pietta, 1997, Kähkönen et al., 1999). The production of pasta enriched with vegetables can increase the vegetable intake and vegetables can be a very good carrier of healthy compounds: dried pasta is a very good matrix to stabilize phytochemicals that otherwise, in fresh vegetables, are easily degraded during storage, transportation etc. (Jin et al., 2014).

The aims of this study were; to fortify noodles by the addition of minced mint (2, 4, 6 and 8% weight/weight) to dough formulation to improve their functional properties, to determine the effect of addition of mint on physical properties (moisture content, water activity and colour) and chemical composition (vitamin C, chlorophyll, total carotenoid and protein content analysis) of the plain and enriched dough and the noodles, to determine the cooking characteristics and to indicate consumer preferences of ETN with mint.

MATERIAL AND METHODS

Materials

Fresh mints, 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 Noodle

The plain dough was prepared with the formulation given in Table 1. In order to obtain ETN, the mints were cleaned, stalks were removed and leaves were grinded in a blender (Tefal Smart, MB450141, Turkey). All the dough formulations were prepared on the basis of plain dough with additional amount of mint in the percentages of 2, 4, 6 and 8%, respectively (w:w). All ingredients were mixed in a bowl and kneaded by hand in order to obtain homogenous dough. Then, the dough was flattened and brought into a regular shape at the same thickness with a pasta making machine (Fackelmann, Germany). The pieces of flattened dough were pre-dried in the oven (Siemens, Germany) for 10 minutes at 60°C (low temperature drying (Oliviero & Fogliano, 2016)). Then flattened dough was cut by the pasta making machine into long stripes with a width of 0.65cm. The shape of completed Turkish noodle was achieved by cutting the long stripes into 4cm pieces.

Final drying was performed in the oven for 90 minutes at 60°C. The obtained noodles were stored in small plastic bags at room temperature for further use.

Table 1: Standard dough formulation

Ingredient	Amount (g, dry basis)
Flour	63.9
Egg	35
Oil	1.0
Table Salt	0.1

Physical Analysis

The moisture content of the dough and the ETN were determined according to AOAC, 2000. The water activity of samples was measured by using Testo-AG 400, Germany water activity measurement device. The colour values (L*, a*, and b*) of samples were measured with a Minolta CR-400 Colorimeter, Japan and results were expressed in accordance with the CIE Lab system.

Chemical Analysis

The vitamin C content of dough and the Turkish noodles were determined according to Hısıl (2007). The method of Ferna´ndez-Leo´n et al. 2010 was applied to samples in order to determine the chlorophyll content of samples. The total carotenoid content of samples was determined according to the modified form of Lee and Castle, 2001 method. Protein content of samples was determined by using Leco FP-528, USA protein/ nitrogen determinator as percentage (%) of the total amount of sample.

Tests Cooking

Two different cooking tests were applied to samples. Traditional cooking was performed in a water bath at 100°C in a beaker (250ml). For this purpose, 25g noodle was added to boiling water in the beaker and boiled for 20min. A similar setup was used for microwave cooking at 720 Watt for 10 minutes. The total water absorption was determined by weighing of the sample before and after cooking (Yalçin & Basman, 2008). The total swelling volume is the percentage of increase in volume of a 25g sample after cooking. The swelling was determined by observing the increase of volume in 250ml water in the granulated cylinder after adding the samples (Yalçin & Basman, 2008). The total soluble solid content (TSSC) of the cooking water was analysed by using a refractometer (FG-103 - Chincan, China) measuring the index of refraction in degrees Brix (°Bx).

Sensory Analysis

Hedonic sensory tests were conducted by semi-trained 10 panellists among students of the Department of Food Engineering (Ege University, Izmir, Turkey). The sensory test included the attributes such as colour, texture, odour, flavour, and overall acceptability which were to rate on a five-points hedonic scales from 1 (poor) to 5 (excellent). The panellists were not informed by the amount of addition of mint to the dough formulation prior to sensory evaluation.

Statistical Analysis

The data were analyzed using statistical software SPSS 16.0 (SPSS Inc., USA). The data were also subjected to an 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

Results of Physical Analysis

The ETN samples were prepared according to the formulation of the plain Turkish noodle and enriched with mint as can be seen in Figure 1**.** The moisture content and water activity values of the samples were given in the Table 2. The moisture content of mint, plain dough and plain Turkish Noodle were found to be as 86.45±1.02%, 31.43±1.02% and 9.69±0.92% (wb), respectively. The moisture content of plain Turkish noodles and fortified spaghetti with parsley leaves were reported as 8.66±0.50% (Aktaş et al., 2014) and 12% (Sęczyk et al., 2015) which are in the same range with this study. In addition, Fu, 2008 reported that the final moisture content of dried noodles is usually less than 14%. Due to the low moisture content, noodles have a long shelf life, up to 1–2 years (Fu, 2008). The addition of mint beyond 4% caused a significant increase in the moisture content of Turkish noodles compared to the plain sample ($P<0.05$). The water activity of the plain dough and plain Turkish Noodle were found to be as 0.99±0.03 and 0.53±0.09, respectively. According to results, it can be seen that the amount of addition of fresh mint did not cause a significant increase in the moisture content and water activity values of dough and ETN ($P>0.05$). The water activity values of all ETN were found to be significantly higher than the plain Turkish noodle ($P<0.05$). It can be due to high water activity values of mint (0.99±0.03).

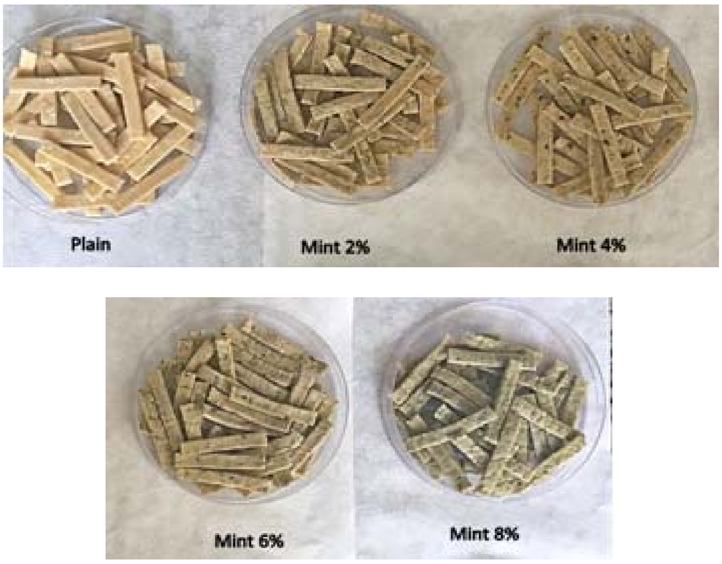

Figure 1
Enriched Turkish Noodles

Table 2: Moisture content (wet basis, wb) and water activity of the dough and ETN

Analysis	Concentration [%]	Dough	ETN
Moisture Content (wet basis, (wb)%)	2	31.73±1.44[a]	9.15±0.37[a]
	4	34.56±1.52[a]	10.51 ±0.12[a]
	6	34.21±2.56[a]	11.61±3.01[a]
	8	34.85±1.41[a]	10.43±0.33[a]
Water Activity	2	0.99±0.03[a]	0.55±0.05[a]
	4	0.99±0.03[a]	0.57±0.10[a]
	6	0.99±0.03[a]	0.66±0.24[a]
	8	0.99±0.03[a]	0.60±0.09[a]

Different letters in the column show significant difference in the column (P<0.05)

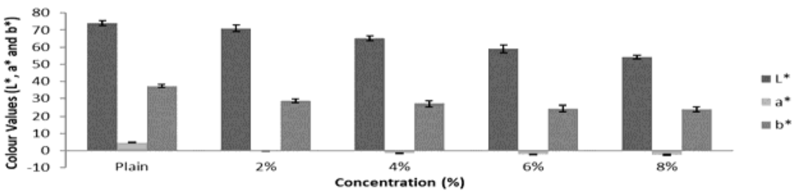

Figure 2
Colour Values (L*, a*, and b*) of dough

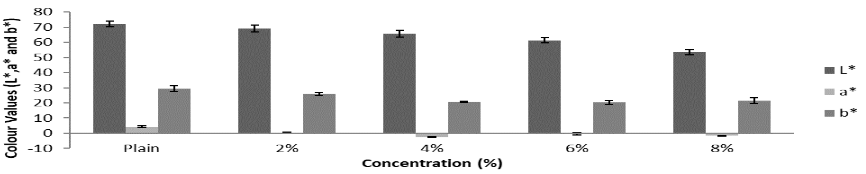

Figure 3
Colour Values (L*, a*, and b*) of Enriched Turkish Noodles

Colour is an important quality factor which affects visual attraction to consumers. It is expected by the Turkish consumers that the traditionally produced Turkish noodles should have golden colour. However, the noodles which have different colour due to different kind of fortification such as tomato, carrot etc. are also finding space in the markets. The colour values of the samples were given in the Figures 2 and 3. The colour values (L*, a*, and b*) decreased depending on the increase of mint concentration due to the colour values of mint (L*=21.44±0.46, a*=-7.04±0.71). The wheat flour (L*=94.51, a*=−0.77, and b*=9.59) which is the main ingredient of Turkish noodles have higher L* and a* values. For this reason, increasing the mint concentration resulted in a significant decrease in the brightness (L*) and greenness/redness (a*) values of dough (P<0.05). The amount of fresh mint addition beyond 4% did not cause a significant decrease in the blueness/yellowness (b*) values of dough (P>0.05). Drying processes caused a significant decrease in the colour values of ETN (P<0.05). The degradation of chlorophyll or browning reactions may be related to pigment destruction and may caused the colour loss (L* and a*). Similarly, the brightness values of ETN significantly decreased according to increasing mint concentration (P<0.05).

The Results of the Chemical Analysis

The vitamin C (mg/ 100gram, dry basis (db)), total chlorophyll (ppm, db), total carotenoid (ppm, db) and protein contents (%, db) of the samples were given in Table 3**.** The Vitamin C content of fresh mint was found to be as 216.36±12.45 mg/ 100g (db). The results showed that increasing the mint concentration resulted in a significant increase in the vitamin C content of dough and ETN (P<0.05). Drying processes caused a significant decrease in the vitamin C content of ETN (P<0.05). Exposure to heat, light, oxygen, and metals may also lead to vitamin C losses, therefore the losses of vitamin C can not only be due to the drying processes, but also by the operations before and after drying such as kneading, cutting etc. Considering the plain dough and plain Turkish noodle where the vitamin C content was undetectable, vitamin C contents of the dough and ETN were improved with the addition of mint. Although the aim of this study was to improve the formulation of the Turkish noodles and to increase the attractiveness of them for the consumers, the increase in vitamin C content of noodles represents an important achievement. Van Boekel et al., 2010 reported that the drying and cooking temperatures can influence the losses of heat sensitive phytochemicals such as vitamin C which is well known to be degraded upon thermal treatments. Thus both drying and cooking can reduce the vitamin C concentration in the final product.

The total chlorophyll content of the plain dough and Turkish Noodle was found to be as 158.20±19.27 and 127.90±15.02 ppm (db), respectively. The results showed that an increase in the mint concentration caused a significant increase in chlorophyll content of both the dough and ETN (P<0.05). Drying processes caused a significant decrease in the chlorophyll content of Turkish noodle (P<0.05). The loss of chlorophyll content was found to be around 81%. It might be due to heat effect on the chlorophyll destruction. Since, chlorophyll is sensitive to heat and its retention is affected by temperature and duration of heat treatment (Naidu et al., 2012).

The carotenoid content of dough and ETN increased depending on increasing mint concentration (P<0.05). On the other hand, the drying processes during the preparation caused a significant decrease in the carotenoid content of ETN (P<0.05). Carotenoids are sensitive to heat, oxygen, light, and enzymes. Preparing the Turkish noodle process includes flattening, pre-drying, cutting and final drying stages. During these applications, the dough was exposed to heat, oxygen and light. It might be the reason of the loss of carotenoid. Van Boekel et al., 2010 reported that both drying and cooking can also have the opposite effect enhancing the bioaccessibility of some phytochemicals such as β-carotene. In a study conducted by Oliviero & Fogliano, 2016 who added the freeze dried carrot powder to the pasta formulation at different concentrations (10, 20 and 30%), it was observed that drying (at 100 °C for 3 h) reduced β-carotene content of pasta around 24-35% due to isomerization of β- carotene during exposure to heat. However, boiling process did not affect β- carotene content. β- carotene content in the fresh-cooked pasta was found to be higher compared to dried-cooked pasta. This can be related to an initial higher content of fresh pasta, a shorter boiling time, and the wet conditions that prevent carotenoids isomerization.

The protein content of the plain dough and Turkish Noodle was found to be as 15.19±0.02% and 19.50±0.13% (db), respectively. The protein content of Turkish noodles was found to be as 15.84±0.13% (Aktas et al., 2014), 14.29±4.2 (Yalçin & Basman, 2008) and 13.2±0.28 (Bilgicli, 2009) which is consistent with this study. No significant differences were observed in the protein content of dough (P>0.05).

Table 3: Chemical Composition of Dough and Enriched Turkish Noodles

Analysis	Concentration [%]	Dough	ETN
Vitamin C Content (mg/ 100g, db)	2	45.81±2.15^{a}	-
	4	47.62±3.43^{a}	-
	6	77.11±3.21^{b}	23.62±1.26^{a}
	8	119.00±5.34^{c}	25.94±2.13^{a}
Total Chlorophyll Content (ppm, db)	2	352.70±23.23^{a}	83.45±17.34^{a}
	4	523.81±31.20^{b}	98.84±25.45^{b}
	6	811.29±37.65^{c}	134.36±16.98^{c}
	8	991.86±43.65^{d}	173.84±34.76^{d}
Total Carotenoid Content (ppm, db)	2	96.03±12.23^{a}	50.29±7.56^{a}
	4	184.89±17.54^{c}	100.49±14.32^{c}
	6	149.65±23.21^{b}	70.42±20.12^{b}
	8	285.73±21.34^{c}	149.61±15.21^{d}
Protein Content (%, db)	2	15.87±0.06^{a}	16.45±0.09^{a}
	4	16.04±0.12^{a}	17.00±0.20^{a}
	6	15.00±0.85^{a}	19.43±0.18^{b}
	8	16.77±0.35^{a}	17.00±0.08^{a}

$^{a-d}$ shows significant difference in the column (P<0.05)

Results of the Cooking Tests

Boiling is a simple process but being very critical in terms of noodle quality. The key factors for boiling are ratio of noodle to water (1:10-20 w:w), boiling time, and quality of boiling water (Fu, 2008). In this study, the ratio of noodles to water was chosen as 1:10 w:w. The results of traditional and microwave cooking tests of samples were given in Table 4. The determination of these characteristics gives an important overview in cooking behaviour of the noodles and describes the increase in weight and volume as well as the loss of solids while cooking. Cooking time of noodles was determined by sensory evaluation (taste and texture). Decrease in cooking time of the noodle samples cooked at 720W power was found to be as 50% compared to traditionally cooked samples. By using microwave cooking time, energy and cost might be reduced. Pilli et al. (2009) also reported that the microwave energy caused reduction in cooking time of pasta samples as compared to conventional cooking. Recently, with changes in our lifestyles, reduction of cooking time is desired because it takes a relatively long time for water outside the noodle to migrate into dried and ungelatinized center of the noodle. 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 ($P<0.05$). Bilgicli, 2015 reported that the water uptake and volume increase values of noodles which includes different amount of buck wheat flour ranged between 237-248% and between 285-298%, respectively. The increase in the mint concentration caused a significant increase in the total soluble solid content of boiling water ($P<0.05$). Keeping cooking loss to a low level in the boiling process is extremely important. Formation of a sufficient and uniform gluten matrix in the sheeting process is necessary for low cooking losses. (Fu, 2008). The reason of higher total soluble solid loss in microwave boiling may be due to destruction of cells or starch damage under the microwave energy as Izydorczyk et al. (2005) reported that cooking losses are attributed to the weakening and/or disruption of the protein-starch matrix. In this study, the increase of cooking loss could be due to a disruption of the protein-starch matrix. In addition, total soluble solid content of cooking water during cooking is due to loss of soluble components in the noodle (Fu 2008, Sun-Waterhouse et al. 2013). TSSC of boiling water of ETN increased depending on the increase of mint concentration.

Results of Sensory Evaluation

Consumer research is one of the key applications for companies in order to take product decisions, such as the development and marketing of new products, the reformulation of existing products, the acceptance of suppliers and processes, and the establishment of quality control specifications. The results of the sensory analysis were given in Figure 4 where the scores of the samples of ETN with 4% mint addition were found to be favourable samples in terms of colour, flavour, and overall acceptability ratings.

Table 4: Results of the cooking test of Enriched Turkish Noodle

Type of Cooking	Concentration [%]	Water absorption [g]	Swelling volume [%]	TSSC [°Bx]
Traditional Cooking	Plain	38.90 ± 3.22^{ay}	267.50 ± 3.54^{ax}	0.00 ± 0.00^{ax}
	2	41.83 ± 6.56^{ax}	307.50 ± 3.54^{ay}	0.20 ± 0.00^{bx}
	4	42.40 ± 1.35^{ay}	265.00 ± 21.21^{ax}	0.20 ± 0.00^{bx}
	6	36.55 ± 7.26^{ax}	265.00 ± 21.21^{ax}	0.25 ± 0.07^{bx}
	8	36.77 ± 0.26^{ax}	275.00 ± 28.28^{ay}	0.40 ± 0.00^{cx}
Microwave Cooking	Plain	34.77 ± 10.38^{ax}	245.00 ± 42.43^{ax}	0.00 ± 0.00^{ax}
	2	39.06 ± 9.61^{ax}	257.50 ± 24.75^{ax}	0.20 ± 0.00^{bx}
	4	33.23 ± 0.67^{ax}	235.00 ± 21.32^{ax}	0.20 ± 0.00^{bx}
	6	36.17 ± 3.45^{ax}	245.00 ± 7.07^{ax}	0.40 ± 0.00^{cy}
	8	37.81 ± 5.96^{ax}	257.50 ± 10.61^{ax}	0.50 ± 0.14^{cy}

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

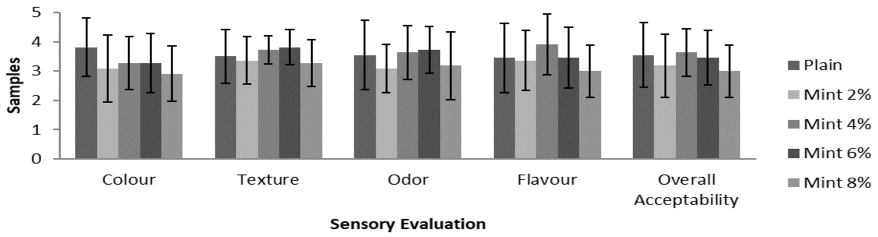

Figure 4
Sensory ratings for all samples.

CONCLUSION

The addition of the fresh mint to the Turkish Noodles did not significantly affect the moisture content, water activity values and protein content (P>0.05). On the other hand, colour values of the dough and ETN significantly decreased depending on the increase of mint concentration (P<0.05). Results of the chemical analysis showed that vitamin C, total chlorophyll and total carotene content increased depending on increasing of the mint concentration (P<0.05). The results for the cooking test showed that the traditionally cooked ETN have higher water absorption and swelling volume than microwave cooked ETN (P<0.05). Turkish noodles with 4% mint were found to be the favourable samples in terms of flavour, and overall acceptability ratings.

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