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Physicochemical, Textural, Cooking and Sensory Properties of Traditional Turkish Homemade Noodle Enriched with Apple Fiber

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ABSTRACT

The aim of this study is to determine some physicochemical, textural, cooking and sensory characteristics of traditional Turkish homemade noodles enriched with apple fiber. Apple fiber was incorporated into the noodle dough formulation at three different concentrations (5, 10 and 20%). Dry matter contents of the samples were in the range of 91.80-92.93% and an increase in dry matter with the addition of apple fiber was determined. Protein contents of the samples were in the range of 8.817-9.909 % and decreased significantly ($p<0.05$) with the addition of apple fiber. Firmness value was determined to be 33.81 kg in the noodle sample enriched with 20% apple fiber while the firmness value of un-enriched one was 23.09 kg. Color characteristics were significantly affected from the apple fiber concentration ($p<0.05$). Generally, cooking properties of the samples increased significantly in the noodles with the enrichment of apple fiber ($p<0.05$). No significant difference was determined for the overall acceptability of samples ($p>0.05$). Results indicated that innovative noodles could be produced by using apple fiber.

Keywords: Turkish homemade noodle, Apple fiber, Texture, Sensory and cooking properties

Elma Lifi ile Zenginleştirilmiş Geleneksel Türk Ev Yapımı Eriştelerin Fizikokimyasal, Tekstürel, Pişme ve Duyusal Özellikleri

ÖZ

Bu çalışmanın amacı, elma lifi ile zenginleştirilmiş geleneksel Türk ev tipi eriştelerin bazı fizikokimyasal, tekstürel, pişme ve duyusal karakteristiklerini araştırmaktır. Elma lifi üç farklı konsantrasyonlarda (%5, 10 ve 20) erişte hamuruna ilave edilmiştir. Örneklerin kuru madde içerikleri %91.80-92.93 arasında olup, elma lifi ilavesinin örneklerin kuru madde içeriklerini artırdığı tespit edilmiştir. Örneklerin protein içeriği %8.817-9.909 aralığında değişmiş ve elma lifi ilavesiyle önemli bir azalma bulunmuştur ($p<0.05$). % 20 elma lifi ile zenginleştirilmiş eriştenin sertlik değeri 33.81 kg iken kontrol (zenginleştirilmemiş) örneğinin sertlik değeri 23.09 kg olarak belirlenmiştir. Elma lifi ilavesi renk karakteristiklerini önemli oranda etkilemiştir ($p<0.05$). Genellikle, eriştelerin elma lifi ile zenginleştirilmesi örneklerin pişme özellikleri önemli oranda artmıştır ($p<0.05$). Örneklerin genel kabul edilebilirlik parametrelerinde anlamlı bir farklılık tespit edilmemiştir ($p>0.05$). Bu çalışmada elma lifi kullanılarak alternatif erişte üretilmiştir.

Anahtar Kelimeler: Türk ev yapımı erişte, Elma lifi, Tekstür, Duyusal ve pişme özellikleri

INTRODUCTION

Noodles are important food products in Turkey and Asia countries because they frequently and lovely consumed this product in the meals. Noodles are semi ready food, delicious and low cost products. In Turkey, the traditional homemade noodle products were produced with flour, salt, egg, other ingredients (whey protein, hydrocolloids, etc.) and water and then they were dried. Noodles include carbohydrates in high quantities and so these products provide high energy for the body. So this product may be prepared with different fiber, flour (for example: oat flour, barley flour etc.), hydrocolloids and gums etc. Thus, the enriched noodles products will provide better digestion than noodles product having no fiber for the human body [1–7].

In recent years, food industry is trying to produce a new product to enrich with dietary fiber because of their some positive health effect. The new products provide positive health effect on human body on the diseases, for example; cardiovascular, some forms of diabetes, obesities, diverticular and coronary heart diseases and suboptimal health [7–10]. There are two types of dietary fiber that name is soluble and insoluble dietary fibers. The two types of dietary fibers are very important for both physiological and functional characteristics. Generally, fibers that suitable ratio for use as a food ingredient are 1:2 soluble dietary fiber/insoluble dietary fibers and they are obtained from fruits and vegetables because there are high amount of fibers in those biomaterials [10–13].

There is high amount of fiber and bioactive compounds in apple and so apple may be used as a source of dietary fibers and bioactive compounds [8, 10, 14]. The apple fiber has 40% cellulose, 19% water-soluble hemicellulose, 15% lignin, 9% water-insoluble pectin and 4% water-insoluble hemicellulose. In this regard, apple may be used for a good source of dietary fibers and then those can be used in food industry in order to take advantages of dietary and functional properties of fiber [15–18]. The objectives of this research were to produce a new functional Turkish homemade noodle product produced using wheat flour and apple fiber (0-5-10-20%) and investigate some physicochemical, textural, cooking and sensory properties of final noodles.

MATERIAL AND METHODS

Materials

Wheat flour (moisture 13.7%, protein 11.4%, 0.55% ash in dry matter, 35% gluten) was provided by a seller in Degirmencilik Flour Co. Kayseri (Turkey). Apple fiber (10% moisture, 60% total dietary fiber (20% soluble fiber), 5% glucose, 6% sucrose, 12% fructose, water holding capacity 4 mL/g, 66.62 L*, 13.27 a* and 27.11 b*) was obtained by Herbafoods Ingredients GmbH (Werder (Havel) Germany). Salt (Kristal, Izmir, Turkey) is purchased from a local market.

Methods

Preparation of Traditional Turkish Homemade Noodle Enriched with Apple Fiber

Figure 1 illustrates the process flow chart of traditional Turkish homemade noodle. At first, wheat flour and apple fiber at different proportions were mixed (100:0, 95:5, 90:10, 80:20 w/w) and then salt was added to the mixture (2 g). After homogenization of dry mixture using a dough mixer (Kitchen Aid Professional 600, MI, USA) for 4 min and 30-40 mL water was incorporated into the mix and it was kneaded for 20 min. Thereafter, the spreading of dough was adjusted to 1 mm using a dough roller. At the end of the spreading, the dough was matured for 30 min at room conditions. Afterwards, the 1 mm dough was shaped using a household type noodle machine (Ampia 150, Marcato, Italy). Finally, traditional Turkish homemade noodle enriched with apple fiber was matured for 5 days at room conditions.

Proximate Composition of Traditional Turkish Homemade Noodle Enriched with Apple Fiber

Dry matter content, water activity, protein and ash contents of the samples were carried out according to procedures outlined by the method of AOAC (2000) [19]. Dry matter content of the samples was measured by drying of samples at 105°C for 4 hours in a drying oven (Nüve FN 120, Ankara, Turkey). Ash content was determined by incineration of the samples at 550°C for 2 hours. Color of noodle samples were determined using a colorimeter (Lovibond RT Series Reflectance Tintometer, England) and were recorded using L*, a* and b*. For the protein analysis, Dumas methodology was used for the determination of nitrogen content of the samples. An automatic water activity meter was used for the measurement of the water activity content of the samples at 20ºC.

Textural Analysis

Textural properties of noodle samples were determined using Texture Analyzer (TA.XT Plus, Stable Micro System Ltd., Surrey, England) equipped with a Kramer shear cell attachment (HDP/KS-5) using a 30 kg of load cell for the analysis. Four pieces of noodles (each approximately 1 g) were inserted in the Kramer shear cell and samples were located as vertical to Kramer shear blades. The blades on the samples travelled at 5 cm/min. The fracture force (kg) which is the maximum force required to break the sample was determined from the time-deformation curve.

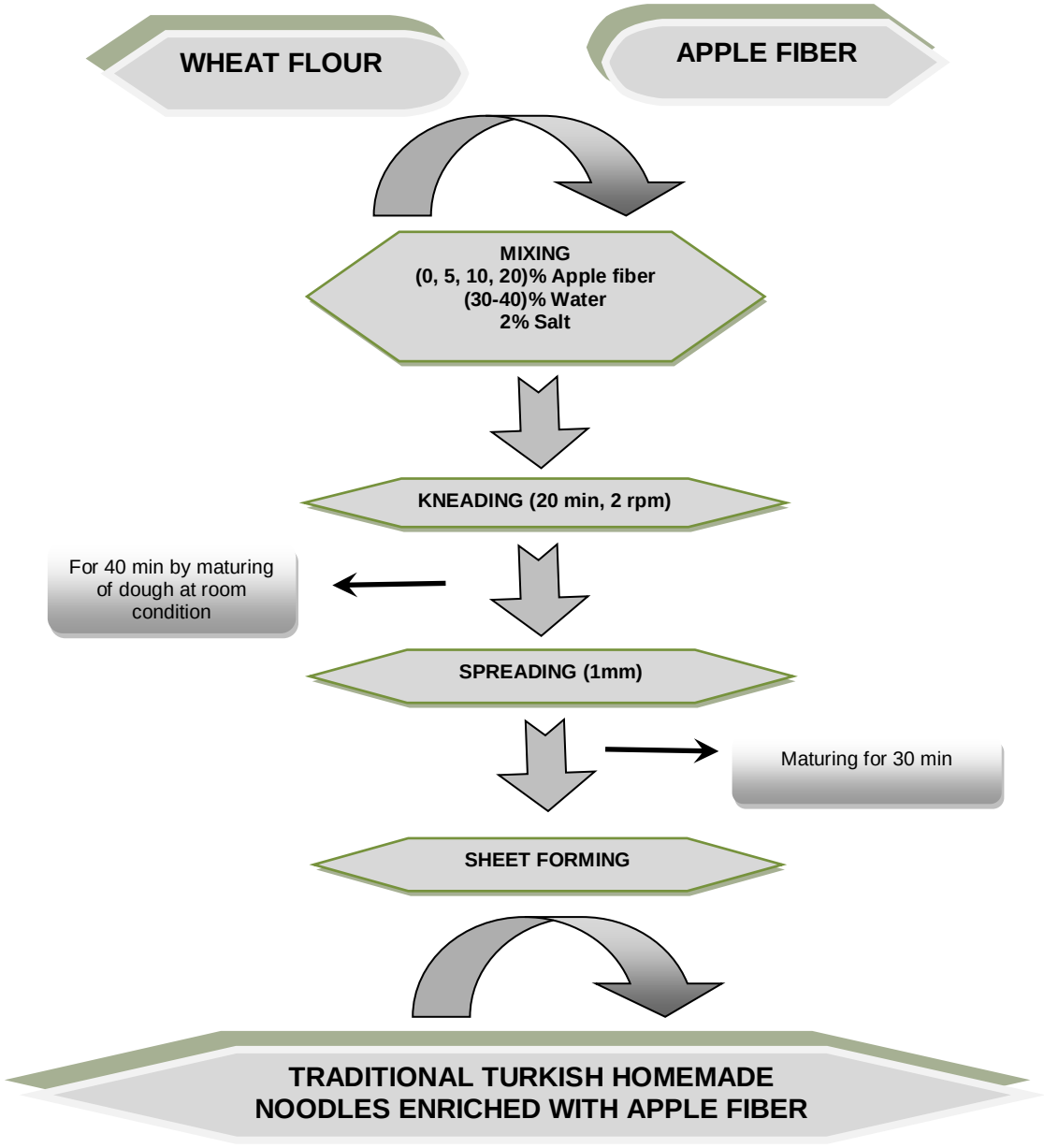

Figure 1. Process flow chart for the production of traditional Turkish homemade noodle enriched with apple fiber

Cooking Properties of Traditional Turkish Homemade Noodle Enrichment with Apple Fiber

Cooking properties analysis of noodles was carried out according to procedures outlined by Kawaljit Singh Sandhu et al. [20] with some modifications. Noodles (10g) were cooked in 200 mL of boiling water for 5 min. The boiling water was filtered and the samples were relaxed for 5 min. Water holding capacity was calculated as follows (Eq.1):

Water holding capacity= The weight of noodles after cooking – The weight of noodles before cooking×100/ The weight of cooking noodles

$$\text{Water holding capacity} = \frac{\text{The weight of noodles after cooking} - \text{The weight of noodles before cooking} \times 100}{\text{The weight of cooking noodles}} \quad \text{(Eq.1)}$$

The supernatant after boiling of water was collected in 200 mL cup and 10 mL the supernatant was dried at 105°C. Cooking loss was calculated as follows (Eq.2). Brix degree after boiling water was measured with an automatic refractometer (Reichart AR 700) [19].

$$\text{Cooking loss} = \frac{\text{The weight of dry matter}}{\text{The weight of noodles before cooking} \times [1 - \text{The moisture content of noodles before cooking}]} \quad \text{(Eq.2)}$$

Sensory Analysis

The panelist groups (ten members) were selected from faculty and graduate students in the Department of Food Engineering at Erciyes University and then the noodles were served to trained panel groups. Panelists were placed randomly at room temperatures and water was serviced to clean their palates former to proceeding to the next sample. The noodles were evaluated using a scaling method of descriptive attributes for color (1=very brown, 9= desired yellowness), odour (1=undesired, 9=desired), taste (1=undesired texture, 9=desired texture), firmness (1=dislike, 9=like), cohesiveness (1=dislike, 9=like) and overall acceptability (1=dislike, 9=like).

Statistical Analysis

Data were expressed using the general linear model procedure with SAS version 8.2 software packages (SAS 2002, SAS Institute Inc., Cary, NC, USA). Means were divided by ANOVA analysis and statistical significance was denoted at the 0.05 p value.

RESULTS and DISCUSSION

Proximate Composition and Textural Analysis

Some physiochemical analysis results of uncooked noodles enriched with apple fiber were indicated in Table 1. The dry matter content of samples increased significantly with increasing of apple fiber concentration ($p<0.05$). The highest dry matter content was determined in the samples containing 20% apple fiber and the lowest value was in the sample added with 5% apple fiber concentration (92.933-91.773%). Choo and Aziz [2] have reported a significant increase in the content of dry matter content of the sample. Toyokawa et al. [21] found dry matter values of noodles prepared with four different flours. The contents of dry matter were determined to be as 86.5, 87.6, 87.7 and 88.6%, respectively. These results were similar to our results. Ash content of noodle enriched with apple fiber increased significantly ($p<0.05$, Table 1). This increase was expected because apple fibers contain enormously dietary fiber. Lee et al. [22] have reported a significant increase in the protein and ash content. Table 1 shows the water activity of uncooked homemade noodles enriched with apple fiber. Water activity levels of the samples decreased significantly ($p<0.05$, Table 1). Dry matter and water activity levels of samples increased and decreased, respectively because apple fiber amount increased in the samples and apple fiber provided soluble and insoluble fiber to noodles. Consequently, these fibers provided to retire of water from the samples with cooking and drying. Man Li et al. [23] have reported a significant decrease in the water activity in the fresh noodles. Protein content of uncooked samples were determined to be significant ($p<0.05$). Protein value of control noodle samples was measured to be 9.909%. Otherwise, when the apple fiber concentration increased from 5, 10 and 20%, the protein content of samples decreased to 9.667-9.271-8.817% respectively. Collins and Pangloli [24] found that the addition of sweet potato and soy flour into the noodle formulation decreased and increased protein values of final product, respectively. No significant difference was determined for the firmness content of the samples containing apple fiber ($p> 0.05$) while there was significant difference between control sample and others ($p<0.05$, Table 1). According to control uncooked noodle samples firmness values increased from %0 apple fiber concentrations (23.089 kg) to 10% apple fiber concentration (33.943 kg) significantly. Following % 20 apple fiber concentration (33.815 kg) firmness values decreased. The firmness content of uncooked noodles increased from control to the 10% apple fiber concentration and so it could be speculated that the elasticity of samples were increased due to the moisture content of uncooked noodles.

Table 1. Mean values for the physicochemical and textural of uncooked noodles enriched with apple fiber*

Apple Fiber Concentration (%)	Dry Matter (%)	Ash (%)	Water Activity (aw)	Protein (%)	Firmness (kg)
0	91.803^{c}	2.277^{b}	0.335^{a}	9.909^{a}	23.089^{b}
5	91.773^{c}	2.326^{b}	0.321^{b}	9.667^{b}	28.532^{ab}
10	92.100^{b}	2.462^{ab}	0.315^{c}	9.271^{c}	33.943^{a}
20	92.933^{a}	2.611^{a}	0.312^{c}	8.817^{d}	33.815^{a}

*: Different superscript letters in the same column are statistically different ($p<0.05$)

Man Li et al. [23] found that addition of purple yum flour to noodles increased the firmness values of samples. Similar results were observed by Song [25] who reported a noodle prepared by using different concentrations of wheat bran. The firmness values of

noodles enriched with different wheat bran levels increased significantly ($p<0.05$).

Cooking Properties

Cooking performance of noodles is very important for deciding the product quality characteristics [26]. The results of cooking of traditional Turkish homemade noodles enriched with apple fiber are presented in Table 3. Water holding capacities levels of samples increased significantly with the increasing of apple fiber concentration ($p< 0.05$). Water holding capacity values of control noodle samples were measured as 50.487%. Otherwise, when the apple fiber concentrations increased from 5, 10 and to 20%, water holding capacities of the samples increased to 56.077-58.727-60.457% respectively. The water holding capacities slightly increased from beginning to the 20% apple fiber concentration and so it could be speculated that the water holding capacities of the noodles were increased due to the water holding capacities (4 mL/g) of apple fiber. Also, there is a nonlinear interaction between water holding capacities and gluten and so it could be speculated that the baking performance of the noodles were decreased with addition of apple fiber concentration [27]. Xiaoyan et al. [28] determined similar results in the noodles enriched with oat cereal hydrocolloid. Cooking yield levels of the samples increased with the increment of oat cereal hydrocolloid. Man Li et al. [1] found that the addition of green tea to noodles increased the water holding capacity values of final products. The cooking loss parameters increased significantly with the increase of apple fiber from 0 to 20% in the formulation ($p<0.05$). On the other hand, statistical analysis revealed that there was no significant difference in terms of cooking loss parameters for samples containing 0-5% and 10-20 % apple fiber. The cooking losses values of the samples were determined in the range of 0.320-0.626. Similar results were observed by George et al. [29] who reported a noodle prepared by using oat cereal hydrocolloid. The cooking loss values of noodles enriched with different wheat bran increased significantly. Chung et al. [30] obtained that utilization effect of heat-moisture treatment for utilization of germinated brown rice in wheat noodle increased cooking loss values Brix degree level of water immediately after boiling increased significantly with the increase of apple fiber concentration ($p<0.05$, Table 1). This increase was caused by apple fiber in the samples. There are high water holding capacities in apple fiber and so the capacity was associated with dietary fiber in apple fiber. The highest Brix degree content was determined in the samples containing 20% apple fiber and the lowest one was in 0% apple fiber concentration (1.347-0.657 Brix, respectively).

Table 2. Mean values for the cooking properties of noodles enriched with apple fiber*

Apple Fiber Concentration (%)	Water Holding Capacity (%)	Cooking Loss (%)	Brix Degree (Bx) (Boiling Water)
0	50.487^{b}	0.320^{b}	0.657^{d}
5	56.077^{ab}	0.376^{b}	0.795^{c}
10	58.727^{a}	0.626^{a}	0.900^{b}
20	60.457^{a}	0.586^{a}	1.347^{a}

*: Different superscript letters in the same column are statistically different ($p<0.05$)

Color Values

Color is one of the most important quality factor which is an indicative of noodle commercialize [30, 31]. The lightness (L*), redness (a*), and yellowness (b*) values of uncooked traditional Turkish homemade noodle enriched with apple fiber were shown in Table 2. Compared with the control noodle, apple fiber addition significantly decreased the lightness and increased the redness and yellowness of noodle ($p<0.05$, Table 2). Maximum and minimum values of lightness, redness and yellowness were recorded as 84.130 and 73.571-1.343 and 5.233- 14.230 and 18.921, respectively. Similar results were observed by Man Li et al. [1] who reported a noodle prepared by using superfine green tea. The lightness values of samples according to control of samples decreased significantly. Kayacier et al. [11] found that addition of apple fiber to wheat chip decreased the lightness values of final products. Staffolo et al. [31] investigated the effect of apple fiber addition on sensory and rheological properties of yogurt and reported that the increase of apple fiber in the yogurt formulation decreased the content of lightness while increase of brownish color. The browning color properties of sample increased from beginning to the 20% apple fiber concentration and so it could be speculated that the noodles were affected due to the redness (13.27) and yellowness (27.11) content of apple fiber.

Table 3. Mean values for the color of uncooked noodles enriched with apple fiber*

Apple Fiber Concentration (%)	L*	a*	b*
0	84.130^{a}	1.343^{d}	14.230^{d}
5	77.073^{b}	3.536^{c}	15.543^{c}
10	74.608^{c}	4.501^{b}	17.110^{b}
20	73.571^{d}	5.233^{a}	18.921^{a}

*: Different superscript letters in the same column are statistically different ($p<0.05$)

Sensory Evaluation

Sensory score values of samples of the cooked were recorded the quality properties like color, odour, taste, firmness, cohesiveness and overall acceptability and they were tabulated in Table 4. Small, taste, firmness, cohesiveness and overall acceptability were not significant, while there are significant differences ($p<0.05$, Table 4) between the control noodle and enriched noodles in terms of color scores. According to sensory analysis of noodle samples, color values were recorded as 6.85 for control and it was 5.00 in the noodle containing 20% apple fiber. This decrease was evaluated with the high dietary fiber content of apple fiber included and color properties of apple fiber having high level redness (a*) and yellowness (b*). Therefore, increasing the apple fiber level in the noodle formulation caused lower color scores for the final products. Otherwise, the panelists evaluated all of the samples as a similarly in terms of overall acceptability. Apple fiber was not effective for the sensory profile of samples because there are not any difference between samples as a statistically. Similar results were observed by Li et al. [32] who reported a noodle prepared by using superfine green tea. The overall acceptability values of samples were not different significantly compared to control of samples. Po-Hsien Li et al. [25] reported that the scores of noodles enriched with purple yam flour showed no significantly different cohesiveness values. George et al. [29] found no difference in terms of color, odour, flavor, texture and acceptance in noodles enriched with oat cereal hydrocolloid as similar to our findings

Table 4. Mean values for the sensory of cooked noodles enriched with apple fiber*

Apple Fiber Concentration (%)	Color	Odor	Taste	Firmness	Cohesiveness	Overall Acceptability
0	6.85^{a}	6.71^{a}	6.28^{a}	7.00^{a}	6.00^{a}	6.71^{a}
5	6.28^{ab}	6.57^{a}	6.28^{a}	7.14^{a}	6.14^{a}	6.71^{a}
10	5.71^{ab}	5.85^{a}	5.57^{a}	6.28^{a}	5.00^{a}	5.28^{a}
20	5.00^{b}	5.50^{a}	5.42^{a}	6.14^{a}	4.85^{a}	5.14^{a}

*: Different superscript letters in the same column are statistically different ($p<0.05$)

CONCLUSION

Our result showed that the apple fiber incorporation to wheat flour can be used for the production of traditional Turkish homemade noodles. The increment in apple fiber level of the samples increased the dry matter, firmness, water holding capacity, cooking loss, brix degree and ash content levels of final products significantly ($p<0.05$). Lightness (L*) score decreased while redness (a*) and yellowness (b*) values increased in the samples enriched with apple fiber concentration. It was determined that the scores for the parameters did not change significantly and panelists evaluated all the samples as similar in terms of odour, taste, firmness, cohesiveness and overall acceptance parameters. The results showed that the traditional Turkish homemade noodles enriched with apple fiber could be acceptable until the apple fiber concentration reached to 20% in the formulation.

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