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Relationship between Spaghetti Prices and Quality Parameters in Pasta Market

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ABSTRACT

Spaghetti is one of the most consumed food (pasta) products in the world. It is cheap, nutritious, delicious, and easy to prepare. Its quality is based on its raw material and is measured by its color, appearance, and primarily its cooking characteristics. The purpose of this study is to determine whether a correlation exists between spaghetti quality and price. In this context, physicochemical and cooking quality of 16 different spaghetti samples obtained from nationwide chain markets in Mersin (Turkey) were evaluated and compared with their prices. Results showed that spaghetti samples had similar values in terms of optimum cooking time, cooking loss, and water absorption capacity. The quality characteristics of spaghetti samples were found to be acceptable according to the information in the literature. At the same time, insignificant correlation existed between the quality parameters and price of spaghetti samples, with an exception for the parameters of color and elasticity. A positive correlation of 0.74 was found between the price and color characteristics (CIELAB) of samples. Samples that provide the highest elasticity values also had the highest price. Similarly, the lowest elasticity value was obtained for one of the samples with the lowest price.

Keywords: Spaghetti, Quality parameters, Consumer perception

Marketteki Spagetti Makarna Fiyatları ile Kalite Parametreleri Arasındaki İlişki

ÖZ

Spagetti makarna dünyanın en çok tüketilen gıda ürünlerinden biridir. Ekonomik, besleyici, lezzetli ve hazırlanması kolaydır. Kalite özellikleri hammadde ile yakından ilişkilidir ve kaliteyi belirleyen temel parametreler, rengi, görünümü ve pişirme özellikleridir. Bu çalışmanın amacı, spagetti makarna kalitesi ve fiyatı arasında bir ilişki olup olmadığını belirlemektir. Bu kapsamda, Mersin ilinde bulunan marketlerden seçilmiş 16 farklı ulusal markaya ait spagetti makarnanın, fizikokimyasal ve pişirme kalitesi özellikleri değerlendirilerek fiyatları ile karşılaştırılmıştır. Sonuçlar, spagetti makarna örneklerinin optimum pişirme süresi, pişirme kaybı ve su absorplama kapasitesi açısından benzer değerlere sahip olduğunu göstermiştir. Spagetti makarna örneklerinin kalite özellikleri literatürdeki bilgilere göre kabul edilebilir bulunmuştur. Aynı zamanda, spagetti makarna örneklerinin kalite parametreleri ile fiyatı karşılaştırıldığında sadece renk ve elastik özelliklerinin, ürünlerin fiyatı ile pozitif bir korelasyon gösterdiği bulunmuştur. Örneklerin fiyatı ve renk özellikleri (L*, a*, b*) arasında 0.74 değerinde bir korelasyon bulunmuştur. Tekstürel olarak en yüksek elastikiyet değerlerini sağlayan örneklerin, aynı zamanda en yüksek fiyata da sahip olan örnekler olduğu görülmüştür. Benzer şekilde, en düşük elastikiyet değeri ise en düşük fiyata sahip olan örneklerden biri olduğu görülmüştür.

Anahtar Kelimeler: Spagetti, Kalite parametreleri, Tüketici algısı

INTRODUCTION

Social life in societies has experienced certain changes due to fast technological and economic developments. These changes have increased the tendency toward foods that have a long shelf life, are economical, and easy to prepare. The increase in pasta consumption in recent years around the world is one of the salient behavioral tendencies [1]. According to the report by the International Pasta Organization, 14.3 million tons of pasta is consumed in the world. Turkey is the fourth-highest pasta producer in the world, producing 1,202,440 tons per year, and ranks as the sixth-highest consumer, with 506,107 tons per year [2]. Pasta's nutritional value, low prices, various preparation methods, and easy and fast preparation contribute to this increase. In particular, the preparation of pasta with various ingredients is accepted in societies with different food cultures because each society can prepare pasta according to its own taste. A study has shown that spaghetti is the most consumed pasta type, accounting for 25% of Turkey's pasta consumption. On the other hand, the recent increase in pasta consumption in the salad category is interesting [3].

Spaghetti is a complex carbohydrate source with no cholesterol and low fat and sodium levels [4]. Good-quality pasta production cannot be achieved only with high-quality semolina. Providing optimum process conditions is also necessary. The effects of the characteristics of semolina and the process conditions on the pasta quality are known [5]. Pasta dough made from durum wheat has ideal rheological characteristics for the pasta production process. Durum wheat pasta is resistant to degradation during cooking, and the hard structure of durum wheat also protects the pasta from breakage. However, differences between durum wheat may be seen due to the protein ingredient and gluten resistance. Gluten being higher than gliadin ratio, compared to durum wheat that has the lower gluten ratio levels of proteins, have a better cooking quality [6]. There are different studies in the literature about the evaluation of spaghetti quality, cooking time, cooking loss CL, water absorption capacity (WAC), and color parameters [7,8]. On the other hand, when consumer perception of product quality is examined, consumers mostly think that the product price is the first indicator of product quality. There is a strong and directly proportional relationship between quality and value [9]. Consumers believe that the more expensive a product, the better its quality. Based on this perception, they agree to pay more to buy higher quality products, and price is an important metric for determining quality products [10]. The relationship between price and quality depends on the suitability of the food product category. Therefore, higher-priced products should have higher costs, resulting from better design, superior workmanship, better content, longer durability, or other aspects of product quality [9]. Numerous studies have shown that the relationship between the price and quality of nondurable products is inconsistent [11]. Additionally, the relationship between these two variables significantly varies from country to country [12].

Jood et al. [13], examined thirty-two food product categories in terms of the quality and price relationship. According to their findings, none of the food product showed a strong positive correlation between price and quality, and only two showed a moderate positive correlation. They concluded that the higher the price, the higher the quality is not supported regarding food product categories [13].

Therefore, the purpose of this study is to examine the quality of spaghetti in different price ranges and to determine if any relationship exists between price and quality parameters.

MATERIALS AND METHODS

Materials

In this research, 16 different spaghetti samples of different brands were obtained from nationwide chain supermarkets in Mersin, Turkey. They were bought with no special discount. The details about the samples used in the study are presented in Table 1.

All experiments were conducted as three parallels and three repetitions, except the cooking time experiments, which were conducted as two parallels and three repetitions.

Table 1. Price of spaghetti samples

Sample code[1]	Price, TL[2]
SPG-1	0.8
SPG-2	0.8
SPG-3	0.9
SPG-4	0.9
SPG-5	0.9
SPG-6	1.0
SPG-7	1.0
SPG-8	1.0
SPG-9	1.0
SPG-10	1.4
SPG-11	1.5
SPG-12	1.6
SPG-13	1.6
SPG-14	1.8
SPG-15	2.0
SPG-16	2.0

[1]SPG: spaghetti sample code, [2]Price for 500 g package

Methods

Diameter of Spaghetti Samples

The diameters of dry and cooked spaghetti samples were measured with an electronic micrometer (Mitutoyo Digital Vernier Caliper, Tokyo, Japan). Four strands were randomly selected from each spaghetti package and measurements were made from three different locations of each strand. The average of these 12 measurements was taken for each data.

Color Analysis of Raw Spaghetti

A machine vision system [14] was used for the color analysis of the raw spaghetti samples. This device is a specially designed color measuring cabinet with a digital camera with predefined light/darkness (lumen value) conditions. The results are obtained by averaging the L*, a*, and b* values of each pixel of the sample photo taken with the digital camera in the cabin. Then, the average L*, a*, and b* values of the sample are calculated with a specially designed software on the computer connected to the device. In addition to these values, a color score obtained from these values was calculated. This equation was used in several studies [21, 24] in the literature, and the score obtained was defined as a numerical expression of the color quality of the pasta. The equation is described below.

Color score = (L*+ (b*X2)/20) [21]

Hareland et al. [24] stated that, the color of spaghetti or semolina is generally considered to be the most important single factor where deep amber or gold is most preferred. The degree of yellow pigmentation determines the amount of color [24]. In this study, the color scoring equation is used together with the evaluation of the L*, and b* values.

Optimum Cooking Time

The cooking times for spaghetti samples were determined according to the AACC 66-50 method [15]. In this method, the time required for the disappearance of the white core in the center of the spaghetti strips when they are squeezed between two glass plates was taken as the optimum cooking time (OCT).

Water Absorption Capacity and the Cooking Loss

The WAC was determined from the weight difference between the weights of the uncooked and the cooked 25 g spaghetti according to Eq. (1). The amount of dry matter passing into water (cooking loss, CL) was determined by drying the boiling water of samples until the samples reached a constant weight in a 100 C incubator and calculating according to Eq. (2) [15].

WAC (%) = {[(weight of cooked pasta) − (weight of raw pasta)]/(weight of raw pasta)} × 100 (1)

CL (%) = [weight of drained residue in cooking water/weight of uncooked spaghetti] × 100 (2).

Sensory Analysis of Raw Spaghetti

Sensory analyses of the raw spaghetti samples were conducted with semi-trained panelists (n=15, 9 males, 6 females, aged 20-51). The panelists were asked to evaluate the raw spaghetti samples based on their color, breaking strength, and overall acceptability. To examine each feature, a nine-point hedonic scale was used, with categories of “extremely unpleasant” (1), “neither good nor bad” (5), and “extremely pleasant” (9) [16].

Texture Analysis

Texture analyses of the spaghetti samples cooked according to the OCT were conducted using a TA-XT2 Texture Analyzer (Stable Micro System, Surrey, UK) equipped with a 5 kg load cell. The firmness (the maximum cutting force, N, required to cut the cooked spaghetti) test was conducted as three parallels with repeated cooking. For each parallel, five spaghetti pieces were placed adjacent to each other on an aluminum platform. The samples were placed under the test probe in a position to allow cutting from the center point. Then the samples were compressed with a stainless steel blade (TA-43 Warner-Bratzler Blade) moving at a speed of 1 mm/s, according to the method of Joyner et al. [17]. The average of the values from the three repetitions was taken as the firmness value.

Tension test was conducted with an A/SPR spaghetti/noodle rig probe (settings: pre-test speed: 3 mm/s; test speed: 3 mm/s; post test speed:5 mm/s; initial distance: 10 mm and final distance: 100 mm) to determine the tension resistance of the cooked spaghetti samples, according to the method of Foscia et al. [18]. The results, stated as the maximum breaking strength, were evaluated by averaging the nine measurements from three different cooking replications.

Statistical Analysis

Each analysis for each sample was performed at least in triplicate. The results were statistically analyzed with one-way analysis of variance (ANOVA), followed by Duncan’s test, using SPSS, Version 16.0 (SPSS Inc., Chicago, IL). Statistical analyses were performed at a significance level of α=0.05.

RESULTS AND DISCUSSION

Diameters Changes in Spaghetti Samples during Cooking

The increase in the diameter of the samples after cooking was statistically similar. The average diameter value of all raw samples was found to be 1.6±0.1. The diameter values of all samples were close to each other, the highest 1.8 and the lowest 1.4. The average diameter value of all cooked samples was found to be 2.3±0.1. The diameter values of all samples were close to each other, the highest 2.6 and the lowest 2.1. Spaghetti 2 had the highest diameter for both the raw and cooked samples. At the same time, this sample had the lowest CL value. However, no correlation existed between the CL value of the samples and the diameter changes during cooking. In addition, a correlation between the diameter change and WAC is expected; however, no such correlation was found in the results. This may be because the properties of the samples affecting these parameters were very similar. Manthey et al. [19] added different buckwheat bran flours to the spaghetti at different levels and found the samples to have an average diameter of 1.63 mm. Hernandez et al. [20] added different amounts of resistant starch to the spaghetti and found the average diameter of the samples to be between 1.61 and 1.55 mm. According to this data, the raw diameter value is not affected much even if the components change.

Color Analyses

The color of raw spaghetti is an important quality factor in terms of consumer preferences. The first two of the parameters L* (lightness), a* (redness), and b* (yellowness) are considered to be more important in terms of color properties. The color values of the spaghetti samples were categorized as high brightness (L*) and low chromatic index according to previous studies in the literature [21, 22, 23]. Martinez et al. [21], used color scoring equation (L*+ (b*X2)/20) suggested by Hareland et al. [24] to evaluate the color of the spaghetti samples in their studies.

As a result of the color analysis, SPG-13 sample had the highest brightness value. According to the sensory test results, the samples with the highest score statistically are SPG-12, SPG-13, SPG-14 and SPG15. Accordingly, the results of the sensory analysis and color analysis are consistent with respect to brightness. These four samples are present in the high-price group, and thus, price and quality can be linked as two parameters that change proportionally. In general, although a statistically significant difference exists between the L*, a*, and b* values of the samples cannot be correlated with their prices (Table 2).

Table 2. Color of spaghetti samples[1]

Sample	L^*	a^*	b^*	Color score
SPG-1	$62.79^{b,c}$	$24.85^{f,g}$	$52.12^{d,e}$	8.4
SPG-2	60.15^{d}	$26.72^{d,e}$	$50.99^{e,f,g}$	8.1
SPG-3	$58.16^{e,f,g}$	$25.98^{e,f}$	$49.70^{g,h,i,j}$	7.9
SPG-4	$59.34^{d,e}$	$25.82^{e,f,g}$	$50.73^{e,f,g,h}$	8.0
SPG-5	$57.59^{f,g}$	$25.87^{e,f,g}$	48.25^{j}	7.7
SPG-6	61.59^{c}	$27.52^{c,d}$	$51.43^{d,e,f}$	8.2
SPG-7	$58.47^{e,f}$	29.40^{b}	$51.37^{d,e,f}$	8.1
SPG-8	$57.55^{f,g}$	20.34^{h}	44.82^{k}	7.4
SPG-9	$58.00^{e,f,g}$	$28.95^{b,c}$	$48.99^{i,j}$	7.8
SPG-10	$62.69^{b,c}$	$25.38^{e,f,g}$	53.73^{c}	8.5
SPG-11	56.75^{g}	20.90^{h}	41.30^{l}	7.0
SPG-12	62.25^{c}	24.42^{g}	$49.37^{h,i,j}$	8.0
SPG-13	66.80^{a}	31.55^{a}	60.64^{a}	9.4
SPG-14	63.94^{b}	$28.55^{b,c}$	58.30^{b}	9.0
SPG-15	61.83^{c}	21.02^{h}	$50.36^{f,g,h,i}$	8.1
SPG-16	$58.87^{d,e,f}$	$28.88^{b,c}$	$52.61^{c,d}$	8.2

[1]Values within a column followed by a common letter are not significantly different ($p>0.05$).

Optimum Cooking Time

No correlation existed between the OCT and other cooking properties. Generally, the cooking and textural characteristics of the final product depend on the gelatinization of the hydrated starch and the interactions of the starch with the protein matrix during cooking. Long OCT and high WAC means that more water is diffused into the starch and protein matrix and they interact with each other [22].

Water Absorption Capacity and Cooking Loss

The CL is an indicator of the overall cooking performance, and it is considered as a sign of resistance to fragmentation during cooking. Low amount of residue shows high quality [25]. Larrosa et al. [25] reported that the CL should be <12g /100g. According to Martinez et al. [21], in the spaghetti made from semolina, the CL should not exceed 7% – 8%. The CL of the spaghetti samples in the current study varied from 4.59% to 6.50% (Table 3). According to both findings, it can be concluded that all analyzed samples had acceptable values of CL. The CL is inversely proportional to the elastic properties of spaghetti. In other words, the excess of solid matter in the cooking water means that the spaghetti loses its elastic properties [25].

Simply, the weight gain of cooked spaghetti is due to the water absorbed during cooking [25]. The WAC is expected to be in the range of 254%–267% [21]. Additionally, differences in WAC may be related to particle size. As the particle size gets smaller, the surface area will increase, and the WAC will increase at the same rate. Differences in the WAC may also be related to the chemical and protein compositions. The increase in the WAC has always been associated with increased solubility in amylose and loss of the crystal structure of starch. Flours with high WAC have more hydrophilic components. The flour with low WAC may have a less amount of polar amino acids [23].

In this study, spaghetti samples had similar values in terms of CT, CL, and WAC, and no correlation existed between them (Table 4). When these values are compared with the price of the samples, it is seen that no correlation exists between price and these parameters (Table 4).

Table 3. Optimum cooking time (OCT, min), cooking loss (CL, %), water absorption capacity (WAC, %), dry diameter (DD, mm) and cooked diameter (CD, mm) values of spaghetti samples[1]

Sample code	DD (mm)	CD (mm)	WAC* (%)	OCT (min)	CL (%)
SPG-1	1.580^{c,d,e}	2.177^{d,e,f}	142.8^{c,d}	9.3^{c}	6.4^{a,b}
SPG-2	1.803^{a}	2.603^{a}	136.5^{d}	9.5^{b,c}	4.6^{d}
SPG-3	1.600^{c,d}	2.247^{c,d,e}	177.4^{a,b}	10.2^{b}	5.4^{b,c,d}
SPG-4	1.600^{c,d}	2.317^{b,c,d}	159.8^{b,c}	11.2^{a}	5.7^{a,b,c}
SPG-5	1.473^{g}	2.260^{c,d,e}	175.2^{a,b}	9.5^{b,c}	5.2^{c,d}
SPG-6	1.597^{c,d}	2.327^{b,c,d}	169.2^{a,b}	9.5^{b,c}	5.0^{c,d}
SPG-7	1.527^{f}	2.197^{d,e,f}	182.4^{a}	10.5^{a,b}	5.5^{a,b,c,d}
SPG-8	1.540^{e,f}	2.407^{b,c}	185.7^{a}	10.6^{a,b}	5.0^{c,d}
SPG-9	1.403^{h}	2.200^{d,e,f}	176.0^{a,b}	8.5^{d}	6.5^{a}
SPG-10	1.583^{c,d,e}	2.263^{c,d,e}	158.5^{b,c}	9.1^{c}	5.4^{b,c,d}
SPG-11	1.680^{b}	2.447^{b}	146.0^{c,d}	10.5^{a,b}	5.9^{a,b,c}
SPG-12	1.623^{c}	2.217^{d,e,f}	159.6^{b,c}	11.0^{a}	6.0^{a,b,c}
SPG-13	1.603^{c,d}	2.343^{b,c,d}	160.0^{b,c}	9.5^{b,c}	5.1^{c,d}
SPG-14	1.623^{c}	2.393^{b,c}	138.1^{d}	9.3^{c}	5.6^{a,b,c,d}
SPG-15	1.466^{g}	2.137^{e,f}	175.6^{a,b}	9.4^{c}	5.1^{c,d}
SPG-16	1.557^{d,e,f}	2.067^{f}	159.8^{b,c}	9.2^{c}	4.6^{d}

*Weight basis. [1] Values within a column followed by a common letter are not significantly different ($p>0.05$).

Table 4. Pearson correlation coefficients (r values) between cooking quality of samples

	Instrumental & chemical analyses								Sensory analyses		
	OCT, min	WAC, %	DD	CL, %	Color	MBS, N	BD, mm	Firmness, N	Color	BS	OA
WAC, %	0.12										
RD	0.30	0.09									
CL, %	-0.03	-0.13	0.03								
Color Score	-0.24	-0.31	-0.22	-0.17							
MBS, N	-0.03	-0.14	0.15	-0.16	0.18						
BD, mm	0.29	0.15	-0.01	-0.24	-0.12	0.04					
Firmness, N	0.07	-0.72**	0.13	-0.40	0.39	0.48	-0.01				
Color	0.01	-0.38	-0.46	-0.19	0.64**	0.11	0.15	0.36			
BS	0.04	-0.36	-0.41	-0.23	0.70*	0.21	0.16	0.25	0.82**		
OA	-0.02	-0.26	-0.49	-0.30	0.72**	0.09	0.17	0.27	0.96**	0.88**	
Price, TL	-0.13	-0.16	-0.41	-0.33	0.30	0.36	-0.04	0.26	0.74**	0.54*	0.71**

* and ** mean that the correlations are significant at $p<0.05$, $p<0.01$ levels, respectively. WAC, Water absorbance capacity; DD, dry diameter; CL, cooking loss; MBS, maximum breaking strength; BD, breaking distance; BS, breaking strength; OA, overall acceptability.

Sensory Analyses

Sensory analysis was performed to compare the customer perception of the spaghetti samples on the market shelf. The obtained data are presented in Table 5. The table shows that the score of sensory parameters, color, and overall acceptability from the panelists increased linearly according to the price, except for SPG-16. When the breaking strength scores of the samples were compared, no statistically significant difference existed between the values.

On the other hand, the color and overall acceptability scores of the samples followed almost the same trend. According to this result, it can be said that the color of samples directly affects the overall consumer acceptability. According to the data in Table 4, sensory analysis parameters showed a high correlation with each other. In addition, overall acceptability, breaking strength, and color, which are sensory analysis parameters, have the highest correlation with price among all the parameters in Table 4.

Texture Analyses

Textural parameters are important characteristics for the baking quality of spaghetti. In addition, the textural characteristics of spaghetti are relatively more important for the consumer. The textural properties of spaghetti are generally influenced by the matrix network of starch, gluten, and other components [23, 26]. However, the protein content and quality are considered to be more important than all wheat grain components that affect cooking and texture qualities. As the gluten content increases in the wheat flour, the cooked spaghetti becomes harder and less sticky [27]. Textural properties are difficult to compare with the literature because they are closely related to the starch source, the components used, the processing conditions used in pasta production, and the structural characteristics of the pasta [22].

Elasticity and breaking strength were investigated as the breaking distance and maximum stress to the spaghetti breaking point [26]. Elasticity is defined as the distance from the start of the pull to sample rupture and the breaking strength is the maximum peak force. The elastic properties of spaghetti are thought to be inversely proportional to the amount of the excess of solid matter in the cooking water, as mentioned by Larrosa et al. [25]. In this context, the excess amount of the solid matter passing the water increases the undesired stickiness of spaghetti. And this may reduce the spaghetti elasticity. When the results of the maximum breaking strength in Table 6 are considered, statistical differences exist between the samples, but these values compared to the price of the samples; low-priced and high-priced samples have statistically similar maximum breaking strength values. Numerically, it is seen that the low-priced samples have the lowest maximum breaking strength. At the same time, it appears that the samples with a price of 1.6 and above have the highest maximum breaking strength (0.363 and above).

The cutting force is directly related to the firmness of cooked spaghetti [25]. The spaghetti firmness is defined as the maximum (peak) force required to completely cut the spaghetti strand [17].

The samples have statistically different firmness values, and no correlation exists between the firmness value and the samples price, according to Table 6.

Table 5. Sensorial characteristics of raw spaghetti samples[1]

Sample code	Color[2]	Breaking strength[2]	Overall acceptability[2]
SPG-1	$4.44^{d,e}$	$6.00^{a,b}$	$5.08^{d,e,f}$
SPG-2	$4.78^{c,d}$	$5.64^{a,b}$	$4.90^{f,g}$
SPG-3	$4.82^{c,d}$	$5.21^{a,b}$	$5.40^{d,e,f}$
SPG-4	$5.30^{c,d}$	$5.57^{a,b}$	$5.43^{d,e,f}$
SPG-5	$4.58^{d,e}$	$5.14^{a,b}$	$4.85^{e,f,g}$
SPG-6	$4.27^{d,e}$	$5.93^{a,b}$	$5.00^{e,f}$
SPG-7	$4.23^{d,e}$	$5.36^{a,b}$	$4.84^{e,f,g}$
SPG-8	2.50^{f}	$5.00^{a,b}$	3.61^{g}
SPG-9	$3.50^{e,f}$	4.57^{b}	$3.71^{f,g}$
SPG-10	$6.67^{a,b}$	$5.93^{a,b}$	$6.29^{a,b,c}$
SPG-11	$4.56^{d,e}$	$5.14^{a,b}$	$4.18^{e,f,g}$
SPG-12	7.58^{a}	6.29^{a}	$6.64^{a,b}$
SPG-13	7.36^{a}	6.57^{a}	$7.29^{a,b}$
SPG-14	7.47^{a}	$6.07^{a,b}$	$7.00^{a,b}$
SPG-15	7.27^{a}	6.57^{a}	7.43^{a}
SPG-16	$5.92^{b,c}$	$5.64^{a,b}$	$6.17^{b,c,d}$

[1] Values within a column followed by a common letter are not significantly different ($p>0.05$). [2] 9 point hedonic scale with the degree of liking: 1=extremely dislike to 9=extremely like

Table 6. Mechanical behaviors of cooked spaghetti samples[1]

	Elastic properties		Firmness
Sample code	Maximal breaking strength, N	Distance, mm	Max. cutting force, N
SPG-1	$0.330^{d,e}$	$20.94^{f,g}$	$3.90^{f,g,h}$
SPG-2	$0.348^{c,d,e}$	$38.44^{c,d,e}$	6.57^{a}
SPG-3	0.297^{e}	$34.36^{c,d,e,f}$	$3.76^{g,h,i}$
SPG-4	$0.336^{d,e}$	$54.09^{a,b}$	$5.00^{c,d}$
SPG-5	$0.327^{d,e}$	65.87^{a}	$3.88^{g,h}$
SPG-6	0.440^{a}	$48.87^{b,c}$	$4.21^{f,g}$
SPG-7	0.308^{e}	$22.02^{f,g}$	$3.66^{h,i}$
SPG-8	$0.433^{a,b}$	$33.19^{c,d,e,f}$	$4.42^{e,f}$
SPG-9	$0.357^{b,c,d,e}$	13.35^{g}	$3.91^{f,g,h}$
SPG-10	$0.351^{c,d,e}$	$37.76^{c,d,e}$	$4.26^{f,g}$
SPG-11	$0.363^{a,b,c,d,e}$	$25.34^{e,f,g}$	$4.87^{d,e}$
SPG-12	$0.403^{a,b,c,d}$	$47.76^{b,c}$	$5.02^{c,d}$
SPG-13	$0.394^{a,b,c,d}$	$31.68^{d,e,f}$	5.72^{b}
SPG-14	$0.424^{a,b,c}$	$22.20^{f,g}$	6.55^{a}
SPG-15	$0.331^{d,e}$	$38.71^{c,d,e}$	3.32^{i}
SPG-16	$0.400^{a,b,c,d}$	$43.38^{b,c,d}$	$5.44^{b,c}$

[1] Values within a column followed by a common letter are not significantly different ($p>0.05$).

CONCLUSION

The quality parameters of 16 different spaghetti samples with different prices were evaluated. The quality characteristics of all the samples were in the range of the findings in the literature. However no significant correlation was found between the price and the cooking and physicochemical characteristics of the samples. But significant correlations were found only between price and sensory parameters. Correlation coefficients of color and OA (overall acceptability) characteristics are between price and 0.74 and 0.71, respectively. At the same time, positive correlation was found between the price and color properties of the samples (L*, a*, b*) with 0.74. Thus, both sensory color assessment results and color analysis test results confirm a strong relationship between their color and price. Besides, although there is no linear relationship between the elastic properties of the samples and their prices, the samples that provide the highest elasticity values are SPG12 (0.403 N), SPG14 (0.424 N) and SPG16 (0.400 N), which are also the highest in price (1.6, 1.8 and 2.0₺). Similarly, the lowest elasticity value is SPG3 (0.297 N), which is one of the lowest prices (0.9₺).

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