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Research Article

Effects of Roasting Process on Color and Some Industrial Properties of Hazelnuts Cultivated By Organic and Conventional Methods

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Abstract

In this study, the effects of the roasting process on the color (*L**- value, *a**-value, *b**-value, hue, chroma, total color difference- *ΔE* and browning index- *BI*) and some industrial properties (blanching percentage and full blanching percentage) of cultured hazelnuts cultivated by organic and conventional methods was investigated. The study material was collected from Turkey, the world's most important hazelnut cultivation center, and Tombul, Mincane, Çakıldak, Palaz, Foşa and Sivri cultivars that have commercial importance were selected. The roasting conditions were set at 130 °C for 40 minutes and 160 °C for 20 minutes, the most preferred conditions in the industry. The results of the study demonstrated that blanching and full blanching percentages of organic hazelnuts were high at low temperatures and the *BI* values of it were high at both temperatures. Tombul and Mincane cultivars came to the forefront with their blanching performance. With the increase in temperature, *L** and hue value decreased and *a**, *b** and chroma values increased. However, it was determined that the cultivation method and the cultivar factor did not affect these values. Considering these results, organic hazelnuts were found to be more sensitive to heat treatment. According to these results, it can be recommended to roasting organic hazelnuts at lower temperatures compared to conventional ones.

Key words: Roasting, Blanching, Color properties, Browning, Organic food, Hazelnut

Organik ve Konvansiyonel Yöntemlerle Yetiştirilen Fındıkların Renk ve Bazı Teknolojik Özelliklerine Kavurma İşleminin Etkisi

Öz

Bu çalışmada organik ve konvansiyonel yöntemlerle yetiştirilen fındıkların renk (*L**, *a**, *b**, hue, kroma, toplam renk değişimi- *ΔE* ve kahverengileşme indeksi- *BI*) ve bazı endüstriyel özelliklerine (beyazlama), kavurma işleminin etkisi araştırılmıştır. Çalışma materyali fındıklar dünyanın en önemli fındık üretim merkezi olan Türkiye'den toplanmış ve ekonomik değere sahip Tombul, Mincane, Çakıldak, Palaz, Foşa ve Sivri çeşitleri seçilmiştir. Kavurma koşulları, endüstride en fazla tercih edilen 130 °C'de 40 dakika ve 160 °C'de 20 dakika olarak ayarlanmıştır. Çalışma sonuçlarına göre organik fındıkların düşük sıcaklıkta beyazlama ve tam beyazlama oranlarının, her iki sıcaklıkta *BI* değerlerinin yüksek oldukları tespit edilmiştir. Beyazlama performansında Tombul ve Mincane çeşitleri öne çıkmıştır. Sıcaklık artışıyla *L** ve hue değeri düşmüş *a**, *b** ve chroma değerleri artış göstermiş ancak genel olarak üretim yöntemi ve çeşit faktörünün bu değerleri etkilemediği belirlenmiştir. Bu sonuçlar eşliğinde organik fındıkların konvansiyonele kıyasla daha düşük sıcaklıkta kavrulması önerilmektedir.

Anahtar kelimeler: Kavurma, Zar atma, Renk Özellikleri, Kahverengileşme, Organik gıda, Fındık

Introduction

Organic food is described as the type of food produced without the use of synthetic substances such as chemical fertilizers and drugs, veterinary medicaments, hormones and antibiotics and genetically modified organisms (Araujo et al., 2014; Yüzbaşıoğlu, 2018). Consumer evaluation studies have shown that consumers want to buy organic food because they think it is healthier, tastier and safer, even though it is more expensive. (Krause and Spicka, 2017; Chekima et al., 2017; Hansen et al., 2018; Asif et al., 2018). In recent years, organic food production has increased in parallel with the increasing demand for organic food (Krejcova et al., 2016). Today, on an area of approximately 74.9 million ha, 3.4 million producers produce around 120.6 billion euros of organic food (FiBL and IFOAM, 2022). As in all organic foods, organic hazelnut cultivation has tended to increase in recent years. Organic hazelnut cultivation in Turkey has increased by almost 100% in the last decade and reached 21 500 tons in 2020. This amount accounted for 3.5% of the total hazelnut cultivation (MAF, 2021; Karaosmanoğlu, 2022).

Hazelnut (*Corylus avellana* L.) is the second most extensive hard-shelled fruit in the world after almonds in the Betulaceae family (Karaosmanoğlu and Üstün, 2019). The most important hazelnut production territory is the Black Sea shore of Turkey (40-41° latitudes and 37-42° longitudes). Although there are 20 different varieties cultivated in Turkey, seven of them (Mincane, Foşa, Palaz, Kara, Tombul, Sivri and Çakıldak) have trading significance. (Pelvan et al., 2012).

In the food industry, the hazelnut is used in the production of cake, bakehouse products, sundae, and dairy products, confection and chocolate products. It can also be added to breakfast grain, types of bread, yogurt, soup, salad and main dishes (Simsek and Aykut, 2007; Yılmaz and Tavman, 2015). Approximately 8-10% of hazelnut is consumed as a natural snack (with skin) (Fallico et al., 2003) or roasted (without skin) (Pelvan et al., 2018).

As in all nuts, roasting is also the most important processing method in hazelnuts (Özdemir et al., 2003). With the roasting of hazelnut, the skin is separated, microorganisms and enzymes are inactivated, toxins and allergen compounds are destroyed. In addition, the aroma and flavour, the texture changes, the brightness and crispness increase (Şimşek, 2007). The main purpose of roasting is to improve the desirable flavor, color, crispy, and crunchy texture of products (Saklar et al., 2001; Moghaddam et al., 2016; Pelvan et al., 2012). Hazelnut roasting is mostly done through devices that produce hot air, such as electric ovens (Belviso et al., 2017). The roasting temperature and duration generally vary between 100 and 180 °C and 5 and 60 minutes (Özdemir and Devres, 2000a; Belviso et al., 2017). However, the optimal temperature range for the final characteristics of hazelnuts is considered to be between 130 and 160 °C (Marzocchi et al., 2017).

For consumers, color is one of the most important quality parameters in dried foods (Özdemir and Devres, 2000b; Özdemir et al., 2001). Therefore, knowing the color values of foods affects consumer preferences. The pellicle removal percentage is one of the most important quality criteria in hazelnut technology. Many studies have examined the color change and pellicle removal properties that occurred after the roasting of the hazelnuts cultivated by the conventional method (Saklar et al., 2001; Özdemir et al., 2001; Şimşek, 2007; Donno et al., 2013; Marzocchi et al., 2017). Few studies have been conducted to examine the heat treatment sensitivities of organic and conventional foods. In a study conducted by Faller and Fialho (2009), they found that organic vegetables (potato, carrot, onion, broccoli, nad white cabbage) showed higher sensitivity than conventional ones. In another study, no difference was found between organic and conventional eggplants (Zambrano-Moreno et al., 2015). Although there are studies on the color and physically characteristics of natural organic hazelnuts in the literature (Karaosmanoğlu and Üstün, 2017; Karaosmanoğlu and Üstün, 2022), no study has been found on the effect of roasting. In the present study, color and pellicle removal properties of six different hazelnut cultivars, which were cultivated by organic and conventional methods and roasted in two different processing conditions most preferred in the industry, were investigated.

Material and Methods

Sample collection

Organic hazelnuts used in the study were collected from orchards with organic agriculture certificate in Düzce, Samsun, Ordu and Trabzon territory of the Black Sea territory, which is the most important hazelnut production territory. Conventional hazelnuts were obtained from nearby orchards. All samples were dried in the sun for 3 days in the same environment until the moisture was 6%. In organic and conventional orchards, the same cultural treatments were carried out, except for fertilization. Commercially important varieties were selected from each

territory (Trabzon: Foşa, Sivri, Mincane; Ordu and Samsun: Tombul, Palaz, Çakıldak; Düzce: Foşa, Sivri, Tombul). Each variety in each region was supplied in three kg from three different producers. The collected samples were kept in packages made of kraft paper until they were analyzed.

Roasting of hazelnuts

Before roasting, about 100 g of hazelnuts were cracked with a manual nutcracker and separated from their shells. Natural hazelnuts were sieved and calibrated. The calibrated 9-11 mm hazelnuts were roasted in a lab-scale ventilator electric oven at 130 °C for 40 minutes and 160 °C for 20 minutes (Marzocchi et al., 2017). After roasting, the hazelnuts taken out of the oven were allowed to cool and analyzed.

Colorimetric analysis

*L** (brightness), *a** (redness) and *b** (yellowness) values of hazelnuts were determined by HunterLab Color Flex EZ color measuring device. Before measurement, the device was calibrated to be X: 79.05, Y: 84.02, Z: 89.03. Twenty hazelnuts were placed in the optical cylinder. After that, hazelnuts were measured at different points and *L**, *a** and *b** values were determined according to the CIE system (Mexis and Kontominas, 2009). According to the Munsell color system, the chroma value (*C**), hue angle (*h**), total color difference (*ΔE*) (Patras, 2019) and browning index (*BI*) (Marzocchi et al., 2017) were calculated with the following equations.

$$Chroma = \sqrt{(a)^2 + (b)^2} \quad (1)$$

$$h\text{ue} = \arctan(b/a) \quad (2)$$

$$\Delta E = \sqrt{\Delta L^2 + \Delta a^2 + \Delta b^2}\ ,\ (\Delta L = L_{130} - L_{160},$$
$$\Delta a = a_{130} - a_{160},\ \Delta b = b_{130} - b_{160}) \quad (3)$$

$$BI = 100 \text{ x } \frac{x - 0.31}{0.17},$$
$$x = \frac{(a + 1.75\,L)}{(5.645L + a - 3.012b)} \quad (4)$$

Blanching percentage and full blanching percentage

The pellicles were removed manually from the hazelnuts which were allowed to cool after roasting. The roasted hazelnuts were counted, those with pellicles completely removed (totally blanched ones) were proportioned to the total number of hazelnuts to determine the full blanching percentage. Furthermore, the pellicle removal percentages were classified as 100%, 90%, 80%, 50%, 25% and 0% after roasting; those with pellicles completely removed were proportioned to the total number of the hazelnuts to determine the blanching percentage (Şimşek, 2004).

Statistical evaluation

The experiments were performed in triplicates in a completely randomized block design. When calculating the sample width, Power (Test Power) was determined as at least 0.80 and Type 1 Error as 0.05 for each variable. Descriptive statistics for continuous (quantitative) variables/parameters were expressed as mean and standard error. The Kolmogorov-Smirnov test (n> 50) was used to determine whether the mean values of continuous variables were normally distributed. Kruskal Wallis test was used to compare the cultivars, and Tukey's HSD was used to determine the differences. The Mann-Whitney U test was used to compare the temperatures and cultivation methods. The statistical significance level (α) was taken as 5% and SPSS (Windows SPSS for Windows, ver. 24) statistical package program was used for the calculations.

Results and Discussion

Colorimetric analysis

Color is one of the most important quality criteria in roasted hazelnuts (Fallico et al., 2003; Donno et al., 2013; Marzocchi et al., 2017). Browning is an enzymatic or nonenzymatic complex reaction. Browning in hazelnut color by the roasting process is nonenzymatic due to the loss of activation of enzymes at high temperature (Özdemir and Devres, 2000b).

Table 1 presents the *L**, *a** and *b** values of organic and conventional hazelnuts. Only the Çakıldak cultivar at 160 °C was affected by the cultivation method (P<0.05) while the other samples were not affected (P>0.05). In a study, the *L** values of organic hazelnut flours were found to be higher than conventional ones, but no difference was found in *a**, *b**, chroma and hue values (Karaosmanoğlu and Üstün, 2021). The cultivar factor was found to be effective at 130 °C (P<0.05), and the highest *L** value was found in Tombul (63.13), and the lowest was determined in Sivri (56.99). At 160 °C, it was found that the cultivar factor did not affect the brightness of the hazelnuts (P>0.05). With the increase in the roasting temperature, the *L** value of all cultivars decreased (P<0.05).

Table 1. *L*, a*, b*, hue* and *chroma* values of roasted hazelnuts cultivation by organic and conventional methods.

Parameters	Cultivar	Temperature/Time			
		130 °C/40 min.		160 °C/20 min.	
		Cultivation method			
		Conventional	Organic	Conventional	Organic
*L**	Foşa	59.27±0.93bA	54.91±4.29	50.57±1.31B	49.67±2.35
	Sivri	56.99±1.63cA	58.73±1.74A	49.89±1.69B	47.14±2.54B
	Mincane	62.60±0.84abA	61.81±2.13A	52.22±0.85B	49.51±0.63B
	Tombul	63.13±0.53aA	62.61±0.62A	51.55±1.26B	49.41±1.95B
	Palaz	61.46±0.66abA	59.96±1.58A	50.65±0.79B	50.27±1.14B
	Çakıldak	59.71±1.58abcA	61.29±0.71A	50.24±1.27Bω	44.70±1.92B#
	Cultivar means	60.57±0.55A	59.95±0.91A	50.80±0.52B	48.44±0.85B
*a**	Foşa	6.10±0.35B	9.16±1.54a	12.03±1.01A	12.49±1.25
	Sivri	7.11±0.33B	6.16±0.61bB	13.66±0.18A	14.31±0.38A
	Mincane	5.86±0.20B	7.74±0.97abB	13.02±0.30A	13.83±0.16A
	Tombul	6.39±0.28B	6.45±0.25bB	12.69±0.79A	13.86±0.68A
	Palaz	6.27±0.35B	6.70±0.48bB	13.33±0.14A	13.64±0.52A
	Çakıldak	6.31±0.38B	5.79±0.24bB	13.20±0.65A#	14.83±0.20Aω
	Cultivar means	6.38±0.14B	6.89±0.34B	12.96±0.28A	13.83±0.30A
*b**	Foşa	25.95±0.59bB	28.66±1.35	29.88±0.95A	30.21±0.68
	Sivri	26.46±0.70abB	26.36±1.28B	31.42±0.75A	30.82±1.05A
	Mincane	26.72±0.35abB#	29.14±0.82Bω	31.75±0.39A	32.10±0.32A
	Tombul	28.22±0.59aB	27.53±0.61B	31.41±0.51A	31.57±0.45A
	Palaz	27.14±0.56abB	27.52±1.24	32.07±0.56A	32.10±0.29
	Çakıldak	25.89±0.41bB	26.36±0.73B	31.60±0.31A	31.79±0.54A
	Cultivar means	26.86±0.27B	27.46±0.43B	31.32±0.27A	31.38±0.27A
Hue angle (*h**)	Foşa	76.82±0.53A	72.84±1.97b	68.25±1.15B	67.73±1.89
	Sivri	74.90±0.88A	77.02±0.77aA	66.44±0.68B	64.99±1.11B
	Mincane	77.62±0.50A	75.22±1.44abA	67.71±0.42B	66.68±0.45B
	Tombul	77.27±0.39A	76.85±0.28aA	68.14±1.03B	66.32±1.10B
	Palaz	77.04±0.46A	76.32±0.79aA	67.41±0.27B	67.00±0.73B
	Çakıldak	76.32±0.75A	77.64±0.25aA	67.37±0.93Bω	64.98±0.21B#
	Cultivar means	76.63±0.27A	76.12±0.46A	67.59±0.37B	66.25±0.48B
Chroma (*C**)	Foşa	26.67±0.64B	30.18±1.75	32.24±1.23A	32.78±0.94
	Sivri	27.42±0.66B	27.08±1.37	34.27±0.66A	34.01±0.90A
	Mincane	27.35±0.33B	30.17±1.03	34.31±0.42A	34.96±0.22A
	Tombul	28.94±0.63B	28.28±0.64	33.92±0.72A	34.53±0.48A
	Palaz	27.86±0.62B	28.33±1.28	34.73±0.55A	34.89±0.40
	Çakıldak	26.66±0.44B	26.99±0.76	34.27±0.45A	35.08±0.56A
	Cultivar means	27.62±0.28B	28.35±0.49B	33.92±0.33A	34.34±0.29A

Data are presented as mean± SE. Tombul n=9; Foşa n=6, Sivri n=6, Palaz n=6; Mincane n=3. In the same cultivation method and temperature, there is a statistically difference between the 'cultivars' indicated by different lowercase letters (a-d) (P<0.05). Kruskal Wallis test and Tukey's HSD were used. In the same cultivar and cultivation method, there is a statistically difference between the 'temperature values' indicated by different uppercase letters (A-B) (P<0.05). Mann Whitney U test was used. In the same cultivar and at the same temperature, there is a statistically difference between the 'cultivation methods' indicated by different symbols (#-ω) (P<0.05). Mann Whitney U test was used.

The cultivation method affected the *a** value of only the Çakıldak cultivar at 160 °C, and it was seen that the organics were high. The cultivar factor was effective in organic hazelnuts at 130 °C, and the highest was found in Foşa while the lowest in Sivri cultivars (P<0.05). No statistical difference was observed in other samples (P>0.05). *a** value of hazelnut samples increased with the temperature increase in all cultivars (P<0.05). While the cultivation method only affected the *b** value of Mincane, it was found to be 29.14 in the organic Mincane and 26.72 in the conventional Mincane (P<0.05). The cultivar factor affected only conventional hazelnuts at 130 °C. The cultivar with the highest *b** value was found to be Tombul while Çakıldak had the lowest b value (P<0.05). It was

observed that the *b** value of all samples increased with increasing temperature (P<0.05).

The results of the study showed that the roasting temperature is the most critical parameter affecting the color change in hazelnuts regardless of the cultivation method. Similar to the findings reported by Saklar et al. (2001) and Marzocchi et al. (2017), our findings indicate that with an increase in the roasting temperature, the *L** value decreases while *a** and *b** values increase. Although Şimşek (2007) reported that the cultivar factor affects the *L*, a** and *b** values, in our study, it was determined that the cultivar factor was only effective on the *L** and *b** values at 130 °C. Özdemir et al. (2003) reported that the cultivar factor was partially effective.

Regarding Hue angle *(h**) values, it was determined that the cultivation method was effective on the Çakıldak cultivar at 160 °C (P<0.05) and not in other temperatures and cultivars (P>0.05). The cultivar factor was only effective on organic hazelnuts at 130 °C. The highest value was found in Çakıldak and the lowest value in Foşa (P<0.05). With the increase in the roasting temperature, there was a decrease in *h** values in both cultivation methods (P<0.05). Kalkan et al. (2016) reported a similar result. Malekjani et al. (2017) showed that the *h* value decreased with the increase in the roasting temperature and duration.

Cultivation method and cultivar factor were not statistically significant on Chroma *(C*)* values (P>0.05). However, parallel to the increase in temperature, *C** values of all samples were increased (P<0.05). Chroma refers to color intensity (Kalkan et al., 2016). It was determined that hazelnuts had a more intense color with the increase in the roasting temperature. Ciemniewska-Zytkiewicz et al. (2014) reported that *C** values increased with the increase in the roasting temperature while Kalkan et al. (2016) stated that there was no change in the *C** values with the increase in the roasting temperature.

The total color difference (*ΔE*) value was calculated to determine the changes in the colors of the samples with the increase in the roasting temperature. The *ΔE* values varied between 10.86 and 13.82 in conventional hazelnuts and between 6.40 and 19.65 in organic hazelnuts (Figure 1). The *ΔE* values of the organic hazelnuts were found to be more variable than those of the conventional hazelnuts, and higher than the averages of all the samples. In other words, there was a more significant change in color in organic hazelnuts with the increase in the roasting temperature (organic:12.60, conventional: 14.00).

Browning index (*BI*), blanching percentage and full blanching percentage

In order to make a general evaluation on the color change with the roasting process, the *BI* value was calculated and the results are given in Table 2. According to Table 2, the *BI* value increased with the temperature increase in both cultivation methods (P<0.05). Marzocchi et al. (2017) reported that the increase in the roasting temperature increased *BI* values. At both temperatures, organic hazelnuts had higher *BI* values than conventional ones (P<0.05). Browning in the roasting process is caused by non-enzymatic reactions such as Maillard Reaction and caramelization. Caramelization reaction takes place by direct degradation of sugars at high temperature while the Maillard reaction is the reaction between free amino groups of proteins and peptides and reducing sugars or lipid oxidation products (Özdemir and Devres, 2000b; Özdemir et al., 2001; Şimşek, 2007; Marzocchi et al., 2017). The difference between the *BI* values of organic and conventional hazelnuts is thought to be due to the differences in the number of compounds included in the caramelization and Maillard reaction.

The blanching percentage (skin removal) in hazelnut is one of the most important industrial features. The blanching and full blanching percentages of the samples are given in Table 2. At low temperatures, the blanching percentages of organic hazelnuts were found to be 69.89% and 35.00%, while those of the conventional hazelnuts 64.38%, 33.04%. In other words, it was determined that the blanching and full blanching percentages of the organic hazelnuts were higher than the conventional hazelnuts (P<0.05). However, the effect of the cultivation method on the pellicle removal percentage with increasing temperature was not statistically significant (P>0.05). In a study on Tombul cultivar, Turan et al. (2010) reported that the cultivation method did not affect the pellicle removal percentage. In the majority of samples, an increase in blanching and full blanching percentages occurred with an increase in the roasting temperature (P<0.05). Considering both roasting conditions and cultivation methods, the highest blanching and full blanching percentages were determined in Mincane and Tombul cultivars while the lowest in Sivri cultivar. Şimşek (2004) reported an increase in the blanching percentage due to an increase in the roasting temperature and stated that the cultivar factor was also a significant factor.

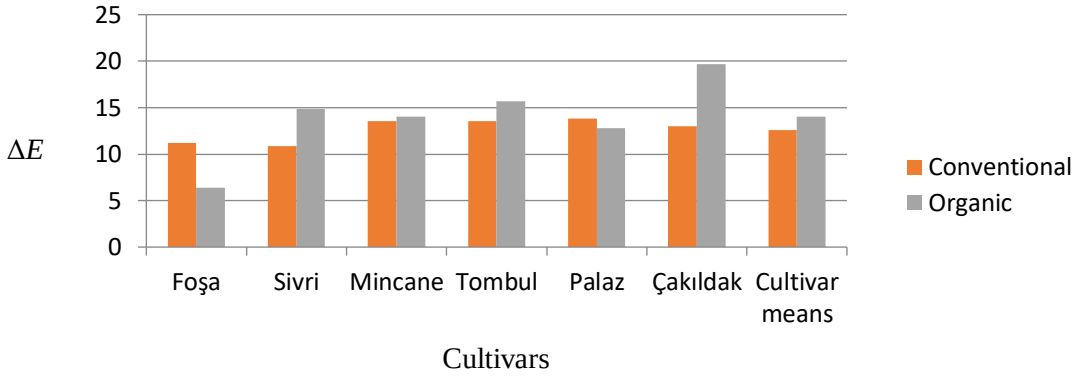

Figure 1. Δ*E* values of roasted hazelnuts grown by organic and conventional methods.

Table 2. *BI,* blanching percentage and full blanching percentage values of roasted hazelnuts grown by organic and conventional methods.

Parameters	Cultivar	Temperature/Time			
		130 °C/40 min.		160 °C/40 min.	
		Cultivation method			
		Conventional	Organic	Conventional	Organic
Browning Index (*BI*)	Foşa	63.76±2.47B	89.09±16.67	104.28±7.94A	111.75±10.08
	Sivri	69.66±2.20B	65.60±2.91B	114.33±2.78A	122.08±5.07A
	Mincane	60.63±0.61B	71.68±6.14B	108.46±2.19A#	117.63±0.59Aω
	Tombul	65.21±2.14	64.06±1.84B	110.21±6.49	118.98±7.30A
	Palaz	64.82±2.54B	68.55±3.27	113.73±1.37A	115.82±4.56A
	Çakıldak	63.63±2.69B	62.33±2.26B	114.52±4.88A#	136.38±5.86Aω
	Cultivar means	65.00±1.01B#	69.59±3.15Bω	111.07±2.26A#	120.55±3.02Aω
Blanching percentage (%)	Foşa	64.97±3.01bB#	78.23±3.21aBω	90.50±1.67abA	87.47±1.55aA
	Sivri	40.24±7.17cB	47.46±10.69c	69.96±4.69cA	72.44±5.45b
	Mincane	88.43±0.92aB	89.58±2.52a	95.73±1.06aA	93.01±2.52a
	Tombul	82.84±1.86aB	80.89±3.72aB	91.46±1.28abA	89.82±1.55aA
	Palaz	63.46±4.69bB	70.17±7.45abB	84.11±1.50bA	89.61±2.18aA
	Çakıldak	49.12±2.28cB	57.38±5.41bcB	89.25±1.44abA	88.96±2.47aA
	Cultivar means	64.38±3.16B#	69.89±3.33Bω	86.48±1.62A	86.62±1.55A
Full Blanching percentage (%)	Foşa	30.81±4.95bB#	32.93±2.26bcdBω	56.40±3.87bA	53.10±3.91aA
	Sivri	14.42±4.74c	14.08±3.34dB	31.79±7.43c	33.32±6.95bA
	Mincane	60.17±2.02aB	59.47±6.10a	75.36±5.42aA	67.07±7.96a
	Tombul	51.35±3.92aB	48.86±6.07abB	70.15±2.75aA	66.99±3.84aA
	Palaz	24.71±5.52bcB	36.08±9.29bc	55.58±3.85bA	58.97±5.63a
	Çakıldak	21.23±3.55bcB	23.91±4.31cdB	56.06±2.64bA	61.42±5.13aA
	Cultivar means	33.05±3.14B#	35.00±3.26Bω	57.12±2.79A	56.80±2.80A

Data are presented as mean± SE. Tombul n=9; Foşa n=6, Sivri n=6, Palaz n=6; Mincane n=3. In the same cultivation method and temperature, there is a statistically difference between the 'cultivars' indicated by different lowercase letters (a-d) (P<0.05). Kruskal Wallis test and Tukey's HSD were used. In the same cultivar and cultivation method, there is a statistically difference between the 'temperature values' indicated by different uppercase letters (A-B) (P<0.05). Mann Whitney U test was used. In the same cultivar and at the same temperature, there is a statistically difference between the 'cultivation methods' indicated by different symbols (#-ω) (P<0.05). Mann Whitney U test was used.

Conclusion

The present study is the first to examine the effects of the roasting process on the color *(L*, a*, b*, hue, chroma, BI)* and industrial properties (blanching and full blanching) of hazelnuts cultivated by organic cultivation methods. Furthermore, this study compared the hazelnuts grown by conventional methods with organic hazelnuts in the same regions. It can be inferred from the study results that the cultivation method did not affect the *L*, a*,* and *b** values statistically while the cultivar factor had a partial effect on the *L** and *b** values (in conventional samples at 130 °C). With the increase in the roasting temperature, the *a** and *b** values increased whereas the *L** value was decreased. Also, the cultivation method and cultivar factor did not affect the hue and chroma values, but the hue decreased while the chroma increased with the increase in the roasting temperature. Besides, there was a more significant change in color *(ΔE)* in the organic hazelnuts with the increase in the roasting temperature. While the blanching and full blanching percentages of the organic hazelnuts were high at low temperature, there was no statistical difference at high temperature. *BI* values of the organic hazelnuts were higher than those of the conventional hazelnuts at all temperatures. Based on these results, roasting organic hazelnuts at a lower temperature compared to conventional ones will be beneficial in terms of obtaining the unique color of the roasted hazelnuts.

Conflict of Interest Declaration: The authors have no conflict of interest concerned to this work.

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