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Quality characteristics of Trabzon persimmon dried at several temperatures and pretreated by different methods

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Abstract: Although Trabzon persimmon (*Diospyros kaki* L.) is a beneficial fruit for both human health and industrial use, it is generally used seasonally, and inadequate attention has been given to its off-season use. This study was designed to determine the best drying method for optimizing the quality of dried Trabzon persimmon (*Diospyros kaki* 'Fuyu'). Samples treated with sodium metabisulfite prior to drying and dried at 65 °C had the highest L* value ($P < 0.05$). Rehydration value and ascorbic acid content of samples dried at 50 °C were the highest. Nevertheless, these samples had lower total phenolic content than samples dried at 65 °C and 90 °C. Samples treated with sodium metabisulfite before drying had the highest appearance score; however, these samples were the least liked and had the lowest flavor score. Control samples were the most popular samples in terms of flavor ($P < 0.05$). During storage, control group samples had the highest increase in total mesophilic aerobic bacteria, while samples treated with sodium metabisulfite prior to drying had the lowest increase in total mesophilic aerobic bacteria, owing largely to the antimicrobial effect of sodium metabisulfite. Although sodium metabisulfite treatment gave the best physical, chemical, and microbiological results, these dried persimmons were given the lowest sensory scores.

Key words: *Diospyros kaki* L., tray dryer, drying, Trabzon persimmon

1. Introduction

Drying is one of the oldest methods of food preservation. Fruits can be dried to extend their shelf life, and this gives us the opportunity to benefit from these fruits off season. Persimmon (*Diospyros kaki* L.) is not marketed efficiently because it stays in the markets for a short period of time, and therefore consumers and producers cannot benefit from it adequately. Drying can allow us to use the persimmon off season, and drying also removes the astringency that comes from the phenolic compounds of some varieties. Astringency and color have been reported in the literature as the most important quality characteristics of dried persimmon (Akyıldız et al., 2004)

Persimmon has a therapeutic effect on cardiovascular system disease. Recently, studies have determined that persimmon reduces cholesterol and blood pressure, strengthens the immune system, remedies digestive system diseases, and helps to prevent cancer. Generally, persimmon has a therapeutic effect on weakness, anemia, vitamin deficiency, and gastrointestinal diseases (Yönel et al., 2008).

Park et al. (2006) sun-dried or oven-dried fresh persimmons and investigated the effect of drying on dietary fiber, minerals, total phenolic content, and antioxidant activities and reported that there was no significant difference between dietary fiber and mineral content of fresh and dried persimmon. Baltacıoğlu and Artık (2013) investigated the changes in total phenolic content and total phenolic composition of 6 different persimmon cultivars during postharvest storage. They also determined the chemical composition and distribution of sugars and L-ascorbic acid content and reported that persimmons were a good source of polyphenolic compounds, L-ascorbic acid, and sugars, especially glucose and fructose. Jung et al. (2005) studied the soluble and insoluble dietary fiber, mineral content, total phenol, phenolic acid, and antioxidant potential of the fresh and dried persimmons. They did not report any statistical difference in dietary fiber, minerals, total phenolic content, or antioxidant potential between fresh persimmons and dried persimmons. Akyıldız et al. (2004) dipped Türkay variety astringent sliced persimmons into 8% sodium metabisulfite solution and into water and then dried them in a cabinet dryer at 60 °C, 75 °C, and 90 °C. During the drying process, they investigated changes in sulfur, total phenolic content, and color and reported that total

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phenolic content was highest in the samples immersed in a solution of sodium metabisulfite. Most research related to persimmon has been on storage conditions, and a limited number of studies exist on persimmon drying. Therefore, the objective of our study was to determine the optimum drying method for protecting the nutritional value and overall eating quality of dried persimmon (*Diospyros kaki* 'Fuyu').

2. Materials and methods

In this study, the Fuyu persimmon variety was used. Persimmons were obtained from the Karadeniz Agricultural Research Institute (Samsun, Turkey). Fruits were harvested when they were firm and not fully ripened since they were not an astringent variety. Fruits were preserved at 4 °C until further analysis.

2.1. Preparation of the samples

Fruits were washed and peeled with a knife and then sliced into 0.5-cm-thick rings from the pulp since cores could affect the results. Internal parts containing core were not used in the analysis.

Sliced fruits were divided into 3 groups. The first group was the control and was not subjected to any chemical treatment. However, control samples were not easily oxidized since persimmon is known to have high natural antioxidant capacity (Del Bubba et al., 2009). The second group was immersed in 3% ascorbic acid solution for 5 s, and the third group was immersed in 3% sodium metabisulfite solution for 5 s prior to dehydration.

2.2. Drying process

After pretreatments (washing, peeling, slicing, and dipping in different solutions), the persimmon slices were dried in a tray dryer that was 130 cm wide, 130 cm deep, and 130 cm high (with exhaust fan) with a capacity of 10 trays (50 cm × 50 cm × 3 cm). The dryer has an electrical heating system (380 V) and a speed-controlled rotating system that can be set at 0 to 20 cycles/min (Figure 1). The drying process was performed at 50 °C for 6 h, 65 °C for 4 h, and 80 °C for 3 h using 20 cycles/min until the dry matter content reached 81%. After drying, total solid contents of the samples were measured by determining total dry matter.

In order to compare physical, chemical, and sensory characteristics of the dried persimmon slices, color, rehydration ability, total phenolic content, and ascorbic acid content analyses were performed. Microbial quality of the samples was determined by counting total aerobic mesophilic bacteria and yeast and mold. Moreover, correlation coefficients (Pearson correlation coefficient) were calculated between texture profile analysis (TPA) values and sensory panel values using the PROC CORR procedure of SAS (SAS, 2001).

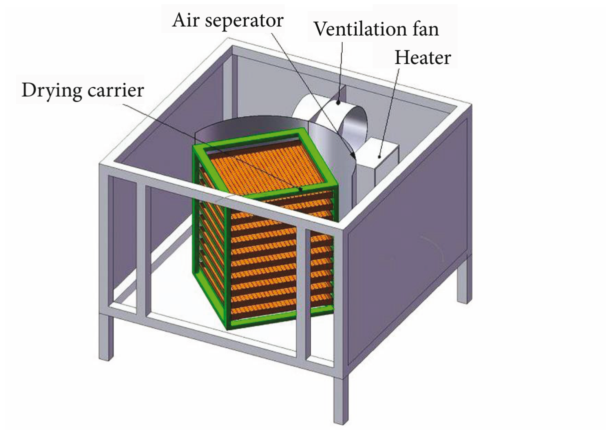

Figure 1. Tray dryer used in drying process.

2.3. Determination of physical characteristics of the dried persimmon slices

Total dry matter was determined using a method that includes drying samples at 65 °C until they reach constant weight by using a vacuum oven (AOAC, 2000). To measure the surface colors of samples, a Minolta DP-301 (Osaka, Japan) model colorimeter was used. A white tile (L* = 93.3, a* = 0.3162, and b* = 0.3321) was used as a reference for calibration. Rehydration ability was determined by making slight modifications to the procedure described by Quintero et al. (2004). Pure water was added to dried samples at a fruit-to-water ratio of 1:30 (w/w), and the samples were kept at 4 °C for 24 h. The fruits were blotted with paper towels after drying. The rehydration ratio was calculated by dividing the weight of the dried product by the weight of the wet product.

2.4. Determination of chemical characteristics of the dried persimmon slices

Total phenolic content was determined using a slight modification of the procedure described by Cemeroğlu (2009). Briefly, 5-g samples were homogenized by beating in a mortar with 50 mL of 80% methanol for 5 min. The homogenate was boiled for 5 min in a beaker. The extract was filtered by Whatman 4 filter. The residue in the beaker was reboiled for 10 min by adding 50 mL of 80% methanol. The 2 extracts were combined in 100-mL volumetric flasks and allowed to cool. After cooling, the flask was completed with distilled water, 5 mL of the extract was taken into a 50-mL volumetric flask, and 5 mL of distilled water was added to it. Then 0.5 mL of Folin–Ciocalteu reagent was added, and the container was shaken vigorously. After waiting for 3 min, 1 mL of 36% sodium carbonate solution was added. The container was then filled with distilled water and shaken strongly. The container was left in a dark environment for 1 h. The absorbance at 725 nm was measured afterwards.

Absorbance values against the concentration for each sample were determined from the calibration graph. The results were calculated taking into account the dilution factors in terms of gallic acid mg/100 g.

Ascorbic acid content was determined according to the method described by the Strengthening the Vocational Education and Training System Project (MEGEP, 2008). Ascorbic acid content was calculated by titrating the sample with 2,6-dichlorophenolindophenol solution.

2.5. Sensory and texture profile analysis

A panel of 9 judges carried out a sensory evaluation using a hedonic scale (Altuğ-Onoğur and Elmacı, 2011). Three attributes of the samples (appearance, texture, and flavor) were evaluated. Samples were tested in 2 replications. Panel members were faculty of the Food Engineering Department of Celal Bayar University, and they were informed of the persimmon characteristics to be evaluated and the scale to be used. Panelists had experience in evaluating different food products.

A texture analyzer with a 5-kg load cell (TA-XT Plus, Stable Micro Systems, UK) was used to determine textural properties of dried persimmon slices. A Warner-Bratzler cutting blade was used for the test. Prior to the test, the maximum cell load was 5 kg, the pretest speed was 1 mm s^{-1}, test speed was 1 mm s^{-1}, and posttest speed was 1 mm s^{-1}.

2.6. Microbial quality of the dried persimmon slices

Total mesophilic aerobic bacteria count was performed according to the method specified by the International Commission on Microbiological Specifications for Foods (ICMSF, 1988). Plate Count Agar was used as the medium. Incubation was carried out at 30 °C for 3 days. Yeast and mold count were performed using the pour plate method. Dichloran Rose Bengal Chloramphenicol Agar was used as a medium. Incubation was performed at 25 °C for 5 days.

2.7. Statistical analysis

The experiment was conducted using a completely randomized design with 3 replications except for the sensory part, where 2 replications were used. Data were analyzed using the PROC MIXED procedure of SAS (SAS, 2001).

3. Results

The changes in L* values (lightness) of persimmons with drying are shown in Figure 2. The L* values were affected ($P < 0.05$) by drying process. Prior to drying, sodium metabisulfite treatment increased L* values of samples. Samples subjected to sodium metabisulfite treatment prior to drying and dried at 65 °C had the highest L* value ($P < 0.05$). However, control samples dried at 50 °C had the highest a* values (Figure 3). The trend in b* values was very similar to that in L* values, because samples subjected to sodium metabisulfite treatment prior to drying and dried at 65 °C had the highest b* values ($P < 0.05$), as shown in Figure 4. Rehydration value and total phenolic and ascorbic acid contents of dried persimmons are shown in Table 1. While samples treated by sodium metabisulfite prior to drying had the highest rehydration value and ascorbic acid content, samples treated by ascorbic acid before drying had the highest ascorbic acid contents ($P < 0.05$). The rehydration value and ascorbic acid contents of samples dried at 50 °C were the highest. However, these samples had lower total phenolic content than samples dried at 65 °C and 90 °C. Similarly, Ben-Arie and Sonego (1993) reported that total phenolic content was lower for samples immersed in water at 60 °C compared to those immersed in water at 80 °C.

Sensory results of dried persimmons are given in Table 2. Samples treated with sodium metabisulfite before drying had the highest appearance score. However, in terms of flavor, these samples were the least liked. Although

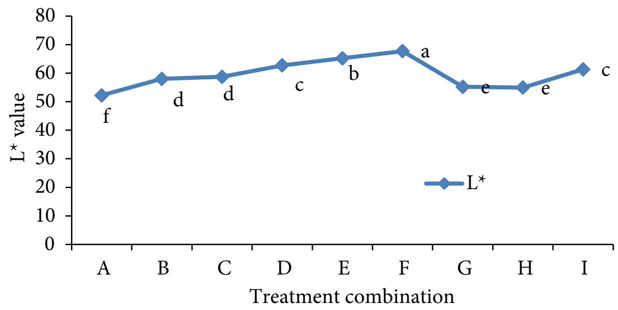

Figure 2. L* values of dried persimmons: A = 50 °C, control; B = 50 °C, ascorbic acid; C = 50 °C, sodium metabisulfite; D = 65 °C, control; E = 65 °C, ascorbic acid; F = 65 °C, sodium metabisulfite; G = 80 °C, control; H = 80 °C, ascorbic acid; I = 80 °C, sodium metabisulfite. Points marked with the same letter are not statistically different.

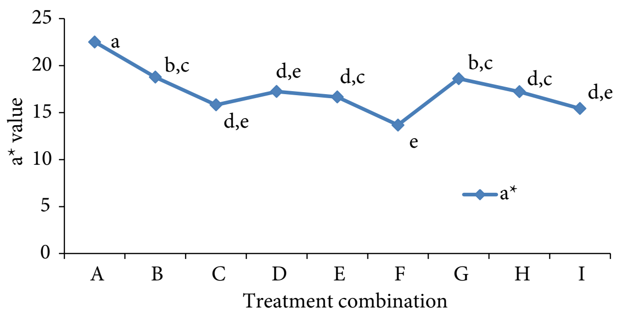

Figure 3. a* values of dried persimmons: A = 50 °C, control; B = 50 °C, ascorbic acid; C = 50 °C, sodium metabisulfite; D = 65 °C, control; E = 65 °C, ascorbic acid; F = 65 °C, sodium metabisulfite; G = 80 °C, control; H = 80 °C, ascorbic acid; I = 80 °C, sodium metabisulfite. Points marked with the same letter are not statistically different.

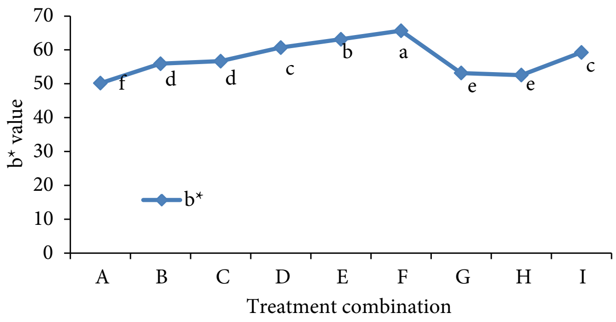

Figure 4. b* values of dried persimmons. A = 50 °C, control; B = 50 °C, ascorbic acid; C = 50 °C, sodium metabisulfite; D = 65 °C, control; E = 65 °C, ascorbic acid; F = 65 °C, sodium metabisulfite; G = 80 °C, control; H = 80 °C, ascorbic acid; I = 80 °C, sodium metabisulfite. Points marked with the same letter are not statistically different.

control samples had the lowest appearance scores, these samples were the most popular samples in terms of flavor ($P < 0.05$). Samples dried at 50 °C were the most popular in terms of flavor ($P < 0.05$). However, these samples had lower appearance scores than samples dried at 65 °C or 80 °C. Sensory analysis revealed that samples treated with sodium metabisulfite prior to drying were the least liked, which could be attributed to the preservation of phenolic compounds responsible for the astringent flavor of persimmon.

Hardness values and total aerobic mesophilic bacteria and yeast-mold counts of dried persimmons are given in Table 3. Samples subjected to ascorbic acid treatment prior to drying had the highest hardness values, whereas samples treated with sodium metabisulfite before drying had the lowest hardness values. The correlation coefficient between texture (sensory) and hardness (TPA) was negative ($r = -0.13$) but nonsignificant ($P > 0.05$).

During storage, control group samples experienced the highest increase in total mesophilic aerobic bacteria; conversely, samples treated with sodium metabisulfite prior to drying had the lowest increase in total mesophilic aerobic bacteria (Table 4), which could be attributed to the antimicrobial effect of sodium metabisulfite. Total yeast and mold counts of samples treated with ascorbic acid or sodium metabisulfite before drying was less than 1 log cfu/g over a 90-day period of storage. However, control group samples had yeast and mold counts exceeding 1 log cfu/g on the 60th and 90th days of storage (Table 4), proving that ascorbic acid or metabisulfite limits yeast and mold growth in dried products.

On day 0 of storage, samples treated with sodium metabisulfite and dried at 80 °C had higher ($P < 0.05$) total phenolic content than any other samples, and the same trend was seen on day 90 of storage (Table 5), which can be attributed to the powerful antioxidant action of sodium metabisulfite, as reported in other studies (Akyıldız et al., 2004; Carcel et al., 2010). As far as nutritional value was concerned, samples treated with sodium metabisulfite prior to drying preserved ascorbic acid content better than other samples (Table 5). Samples treated with sodium metabisulfite prior to drying had higher ($P < 0.05$) L* values than any other samples after drying and during storage (Table 5), indicating that sodium metabisulfite had a preservative effect on lightness. The same can also be said for a* and b* values (Table 5). Hardness of samples decreased ($P < 0.05$) with increased storage time irrespective of the treatment combination applied (Table 5), which could be explained by the softening of texture over time.

4. Discussion

Determining the acceptability of a product by the consumer is crucial. Persimmons contain high amounts

Table 1. Rehydration values and total phenolic and ascorbic acid contents of dried persimmons.

Dried persimmon (drying temperature/treatment)	Rehydration value	Total phenolics (mg/100 g)	Ascorbic acid (mg/100 g)
50 °C, control	3.65^{d}	364.95^{i}	9.63^{c}
50 °C, ascorbic acid	3.69^{d}	406.36^{h}	10.80^{a}
50 °C, sodium metabisulfite	4.19^{a}	444.08^{g}	10.12^{b}
65 °C, control	3.46^{e}	556.66^{f}	7.62^{f}
65 °C, ascorbic acid	3.50^{e}	570.25^{e}	8.30^{d}
65 °C, sodium metabisulfite	3.94^{b}	591.98^{d}	7.91^{e}
80 °C, control	3.27^{f}	594.70^{c}	6.23^{i}
80 °C, ascorbic acid	3.26^{f}	610.87^{b}	7.14^{g}
80 °C, sodium metabisulfite	3.84^{c}	644.81^{a}	6.81^{h}

a–i: Means having a different subscript within a column differ ($P < 0.05$).

Table 2. Sensory properties of dried persimmons.

Dried persimmon (drying temperature/treatment)	Appearance	Texture	Flavor
50 °C, control	3.65^{f}	$4.04^{d,e}$	4.61^{a}
50 °C, ascorbic acid	3.98^{d}	$4.28^{b,c}$	4.39^{b}
50 °C, sodium metabisulfite	4.24^{c}	3.50^{f}	2.11^{i}
65 °C, control	3.99^{d}	$4.11^{d,c,e}$	4.24^{c}
65 °C, ascorbic acid	4.24^{c}	$4.48^{b,a}$	4.06^{d}
65 °C, sodium metabisulfite	4.78^{a}	3.62^{f}	2.41^{h}
80 °C, control	3.77^{e}	$4.22^{d,c}$	3.81^{e}
80 °C, ascorbic acid	4.15^{c}	4.69^{a}	3.59^{f}
80 °C, sodium metabisulfite	4.37^{b}	3.89^{e}	2.59^{g}

a–i: Means having a different subscript within a column differ ($P < 0.05$).
Appearance: 5- Bright yellow and homogeneous color distribution, smooth surface; 4- light brownish-yellow and homogeneous distribution of color, smooth surface; 3- brownish yellow, nonhomogeneous distribution of color, deviates from the surface smoothness slightly; 2- prominent brown color, nonuniform surface; 1- unacceptable dark color, fragmented section.
Texture: 5- Normal hardness, normal stickiness, easy to chew, ordered structure; 4- acceptable hardness, light stickiness, not easy to chew, acceptable structure; 3- medium hardness or softness, sticks to the mouth, difficult to chew, deviation from acceptable structure; 2- defined hardness or softness, very sticky, very difficult to chew, disordered structure; 1- too tough or soft, too sticky, cannot be chewed, unacceptable structure.
Flavor: 5- Typical dried fruit flavor, ideal taste, not astringent; 4- typical dried fruit flavor and lightly astringent; 3- lightly astringent and bland flavor; 2- astringent and unacceptable flavor; 1- off flavor, too astringent.

Table 3. Hardness values and total mesophilic aerobic bacteria and yeast-mold counts of dried persimmons.

Dried persimmon (drying temperature/treatment)	Hardness (kg)	Total mesophilic aerobic bacteria (CFU)	Mold and yeast counts
50 °C, control	$2.89^{e,d}$	1.89^{b}	<1
50 °C, ascorbic acid	$3.95^{c,b}$	1.63^{c}	<1
50 °C, sodium metabisulfite	1.83^{f}	2.57^{a}	<1
65 °C, control	$3.40^{c,d}$	1.90^{b}	<1
65 °C, ascorbic acid	4.57^{b}	1.38^{d}	<1
65 °C, sodium metabisulfite	2.07^{f}	1.24^{e}	<1
80 °C, control	$3.96^{c,b}$	1.10^{f}	<1
80 °C, ascorbic acid	5.51a	1.95^{b}	<1
80 °C, sodium metabisulfite	$2.17^{e,f}$	1.65^{c}	<1

a–f: Means having a different subscript within a column differ ($P < 0.05$).

of phenolic compounds, and these compounds render astringency more noticeable by interacting with sulfur when persimmons are treated with sodium metabisulfite prior to drying. Therefore, Akyıldız et al. (2004) did not include dried persimmons pretreated with sodium metabisulfite in their sensory evaluation because of their strong astringency. Although sodium metabisulfite treatment gave the best final product in terms of physical, chemical, and microbiological quality in our study, this treatment cannot be considered optimum due to the undesirable flavor of the dried persimmons. However, lower concentrations of sodium metabisulfite may be tried to prevent adverse effects on flavor.

Irrespective of treatment combination used, total phenolic content decreased with storage time in our study (Table 5). Similarly, several studies reported a decrease

Table 4. LS mean values for total mesophilic aerobic bacteria (TMAB) and mold-yeast counts of dried persimmon after storage.

Temp. (°C)	Treatment	Storage day	TMAB (CFU)	Mold- yeast
50	Control	0	1.87	<1
		30	2.34	<1
		60	2.92	1.17
		90	3.46	1.27
50	Ascorbic acid	0	1.61	<1
		30	1.94	<1
		60	2.00	<1
		90	2.46	<1
50	Sodium metabisulfite	0	2.56	<1
		30	2.62	<1
		60	2.84	<1
		90	3.00	<1
65	Control	0	1.91	<1
		30	2.28	<1
		60	3.14	1.15
		90	3.95	1.39
65	Ascorbic acid	0	1.39	<1
		30	1.57	<1
		60	1.94	<1
		90	2.13	<1
65	Sodium metabisulfite	0	1.26	<1
		30	1.32	<1
		60	1.85	<1
		90	1.99	<1
80	Control	0	1.12	<1
		30	1.63	<1
		60	2.82	1.08
		90	3.25	1.47
80	Ascorbic acid	0	1.94	<1
		30	2.05	<1
		60	2.43	<1
		90	2.91	<1
80	Sodium metabisulfite	0	1.68	<1
		30	1.69	<1
		60	2.01	<1
		90	2.42	<1
Level of significance			$P < 0.001$	$P < 0.001$
LSD (0.05)			0.06	0.08

in total phenolic content with storage time, which is in agreement with our findings (Sattar et al., 1992; Del Bubba et al., 2009; Baltacıoğlu and Artık, 2013). Based on the results of sensory analysis, the control fruits had the most desirable flavor. Samples treated with ascorbic acid prior to drying had lower flavor ($P < 0.05$) scores than the control samples. Albeit significant, this difference was very small (0.2) and may not be detected by consumers, implying that ascorbic acid treatment prior to drying persimmon may be implemented to preserve flavor.

When the effect of drying temperature was investigated, samples dried at 50 °C were most popular in terms of flavor ($P < 0.05$). Akyıldız et al. (2004) reported higher average taste scores for samples dried at 60 °C than those dried at 75 °C or 90 °C. Samples dried at 50 °C had lower appearance scores than those dried at 65

Table 5. LS means values for total phenolic, ascorbic acid, hardness, L*, a*, and b* of dried persimmon after storage.

Temp. (°C)	Treatment	Storage day	Total phenolics (mg/100 g)	Ascorbic acid (mg/100 g)	Hardness (kg)	L*	a*	b*
50	Control	0	364.95	50.17	2.89	52.22	22.52	50.17
		30	167.35	24.26	1.94	37.23	23.07	24.26
		60	61.84	21.19	1.05	37.01	24.40	21.19
		90	22.36	14.11	0.72	35.25	24.58	14.11
50	Ascorbic acid	0	406.37	55.93	3.95	57.98	18.78	55.93
		30	176.82	32.50	2.98	56.67	19.10	32.50
		60	87.60	30.51	1.96	43.07	20.73	30.51
		90	35.15	27.13	1.04	40.15	24.50	27.13
50	Sodium metabisulfite	0	444.08	56.66	1.83	58.71	15.82	56.66
		30	244.11	52.87	1.05	57.88	18.50	52.87
		60	95.33	49.95	0.72	54.56	19.31	49.95
		90	43.21	45.27	0.43	51.66	22.72	45.27
65	Control	0	556.67	60.69	2.03	62.74	17.25	60.69
		30	201.37	34.76	2.80	43.39	17.98	34.76
		60	121.84	28.31	2.03	42.41	18.39	28.31
		90	52.76	22.19	1.06	42.09	20.70	22.19
65	Ascorbic acid	0	570.25	63.15	4.57	65.20	16.36	63.15
		30	213.64	40.34	3.76	54.81	16.66	40.34
		60	134.07	34.13	2.95	47.64	17.90	34.13
		90	57.82	30.21	1.27	44.94	18.98	30.21
65	Sodium metabisulfite	0	591.99	65.67	2.07	67.71	13.68	65.67
		30	296.71	57.70	1.63	63.71	16.18	57.70
		60	148.06	49.27	0.98	61.43	17.77	49.27
		90	62.58	48.16	0.51	59.64	17.92	48.16
80	Control	0	594.70	53.16	3.96	55.21	18.62	53.16
		30	250.94	26.05	3.08	39.65	22.28	26.05
		60	142.31	18.96	2.50	36.20	22.53	18.96
		90	60.28	16.14	1.93	35.30	22.97	16.14
80	Ascorbic acid	0	610.87	52.56	5.51	54.94	17.22	52.56
		30	275.96	39.53	4.92	47.67	18.30	39.53
		60	153.38	23.90	3.81	40.75	21.16	23.90
		90	70.29	20.17	2.48	38.59	21.28	20.17
80	Sodium metabisulfite	0	644.81	59.25	2.17	61.30	15.44	59.25
		30	337.48	50.39	1.91	61.03	16.22	50.39
		60	196.06	49.88	1.02	60.35	17.25	49.88
		90	82.51	47.45	0.64	54.75	18.04	47.45
Level of significance			P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001
LSD (0.05)			3.30	0.03	0.36	1.39	2.09	1.50

°C or 80 °C. Samples dried at 80 °C had lower L* values than samples dried at 65 °C, which could be attributed to the nonenzymatic browning reaction occurring at higher drying temperatures, which agrees with the findings of Carcel et al. (2010), who reported faster color darkening at higher temperatures. Accordingly, the drying process had a positive effect on the lightness of persimmon provided that it was carried out at reasonably high temperatures. Although the drying at 50 °C preserved the flavor of persimmons most effectively, it could not inactivate polyphenol oxidase. Drying at 80 °C adversely affects both color and nutritional value of persimmons because the protecting effect of citric acid depends on temperature and is more effective at lower temperatures (Carcel et al., 2010). Therefore, it is suggested that persimmons be dried at 65 °C. Samples treated with ascorbic acid prior to drying had very high hardness; thus, ascorbic acid should be applied at lower concentrations. Treating persimmons with lower ascorbic acid concentrations and drying them at 65 °C could be an optimum combination.

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