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Research Article/Araştırma Makalesi

The effects of canning process on the properties of Marathon and Sultan varieties of broccoli

Konserve işleminin Marathon ve Sultan çeşidi brokolilerin özelliklerine etkileri

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ABSTRACT

In this study, the suitability of broccoli which cultivated within the scope of Southeastern Anatolia Project for canning was aimed. For this purpose, the effects of different boiling liquids and storage time on broccoli canned foods were investigated. Marathon and Sultan broccoli varieties were used as plant materials. The broccolis were boiled in cooking liquid including 0.1% (w/v) citric acid, 1.7% (w/v) salt and 0.1% (w/v) citric acid + 1.7% (w/v) salt. As the filling liquid, a solution containing 0.1% (w/v) citric acid and 1.7% (w/v) salt was used. The filled glass jars were autoclaved at 116°C for 25 minutes. The canned broccolis were stored at room temperature for 9 months and taken into analyses with 3 months increments. According to the results obtained, it was concluded that sterilization caused the formation of a soft texture in broccoli, throughout storage. However, the values of drained weight, net weight, ratio of drained weight to net weight, top space of jars as well as the rate of filling did not change significantly as statistically. During the storage, the rate of ascorbic acid has decreased. As a result of the sensory evaluation, both varieties were preferred by panelists.

Key Words: Broccoli, Canning, Citric, Ascorbic, Sensory.

ÖZ

Bu çalışmada, Güneydoğu Anadolu Projesi kapsamında yetiştirilen brokolilerin konserveye uygunluğu araştırılmıştır. Bu amaçla, farklı haşlama sıvılarının ve depolama süresinin brokkoli konservesi üzerine etkisi incelenmiştir. Materyal olarak Marathon ve Sultan çeşitleri kullanılmıştır. Brokolilerin haşlanmasında % 0.1 (w/v) sitrik asit, % 1.7 (w/v) tuz ve % 0.1 (w/v) sitrik asit + % 1.7 (w/v) tuz içeren üç farklı haşlama sıvısı kullanılmıştır. Dolgu sıvısı olarak % 0.1 (w/v) sitrik asit ve % 1.7 (w/v) tuz içeren çözelti kullanılmıştır. Dolu cam kavanozlar 116°C'de 25 dakika süreyle otoklavda sterilize edilmiştir. Konserve edilen brokoliler 9 ay süreyle oda sıcaklığında depo edilirken, her 3 ayda bir analize alınmıştır. Elde edilen sonuçlara göre sterilizasyonun, depolama boyunca brokolilerin dokusunda yumuşamaya neden olduğu belirlenmiştir. Depolama süresince süzme ağırlık, net ağırlık, süzme ağırlığının net ağırlığa oranı, tepe boşluğu ve dolum oranı değerlerinde istatistiksel olarak önemli bir değişim bulgulanmamıştır. Depolama süresince askorbik asit

oranında azalma olmuştur. Duyusal değerlendirme sonucunda her iki çeşidin de panelistler tarafından beğenildiği saptanmıştır.

Anahtar Kelimeler: Brokoli, Konserve, Sitrik, Askorbik, Duyusal.

Introduction

Broccoli is a type of vegetable, which is not very well known in Turkey, although, it has a wide area of use in southern Europe and the United States of America (Boadu and Wise, 1993). It is actively being cultivated in Bursa, Bartın, Çukurova and the Harran Plains in Turkey (Anonymous, 1996).

During the initial test cultivations with the Sultan and the Marathon varieties, taking into consideration that with an appropriate selection of the cultivation time, approximately 4 tons of products per 1000 m^2 can be obtained with a rough estimate of 1 kg of product per plant and 4 plants per 1 m^2 and that a specific purpose of cultivation for industrial applications would be taken into consideration. The broccoli is reported to be a promising vegetable under the conditions of the Harran Plains (Anonymous, 1996).

The green sprouts of broccoli might be put into market for consumption as frozen and canned food in addition to being freshly consumed. The remains that are left in the field are used for feeding the livestock (Desouzas and Eitenmiller, 1986; Cheng and Eitenmiller, 1988).

The broccoli plant is quite rich in bioactive compounds such as flavonoids and glucosinolates (Bhandari and Kwak, 2014; Chen et al., 2016). In a study conducted by Dominguez-Perles et al. (2010) on the Marathon, Nubia and Viola type broccoli, they have reported positive effects of by-products such as the leaves and the stems of the plant on the bioactive compounds and nutritional components. For this reason, they have stated the added value of the agricultural by-products of the plant as a useful source in food and pharmaceutical sectors in addition to its own product value (Dominguez-Perles et al., 2010).

The green sprouts of broccoli are very rich in vitamin C. In a 100 g fresh weight, it is reported that approximately 113-118 mg of vitamin C and plenty of vitamin A are present (Fennema, 1977; Günay, 1984). In a study conducted by Gençdağ (2017), blanching process caused a significant decrease in the amount of ascorbic acid. Rickman et al. (2017) reported that the initial thermal treatment of processed products can cause loss of water-soluble and oxygen-labile nutrients such as vitamin C and the B vitamins.

Spinach and broccoli of the leafy-greens contain carotenoids such as the alpha-beta carotene, lycopene, lutein and zeaxanthin, which have preventive action against cancer, coronary and visual diseases, in their structures in abundant amounts. Consumption of these vegetables is suggested to be significant in terms of a healthy diet (Kyung, 1996).

In a study conducted by Cheng and Eitenmiller (1988), the total amount of pantothenic acid in fresh broccoli was determined as 4.92-9.34 ppm and the amount of pantothenic acid in the steam cooked broccoli samples was determined to be higher than that in the boiled samples.

Kramer (1979) and Kramer et al. (1979) have reported frozen broccoli to score higher values in terms of thiamine and ascorbic acid content as well as sensory properties than the canned broccoli. Sweeney and Marsh (1971) have reported a 15-20% loss in the vitamin A

content of leafy-greens as a result of boiling and can processing. In a study by Howard et al. (1996), a 30% loss in the ascorbic acid content and a 15% loss in beta carotene content have been reported in steam cooked broccoli. Fennema (1977) has reported a more significant loss in especially the water soluble vitamins (vitamin A, thiamine, riboflavin, niacin and vitamin C) during the canning process in comparison to freeze storing as shown in their study on the vitamin loss in canned and frozen vegetables.

Laing et al. (1995) have used Korean and Australian panel groups in the determination of the effect of consumer habits on the products in the sensory evaluation of raw and canned broccoli. As a result of this study, it has been concluded that the Korean panelists have enjoyed the canned broccoli more than the Australian panelists and the local habituations were concluded to be effective in this result.

A study on the loss of folic acid in canned broccoli, showed that there was 17% loss by boiling, which has been reported as 17% and 4% loss by steam cooking and at the end of 3 months, this loss has been reported to exceed 50% in stored cans (Desouzas and Eitenmiller, 1986) .

Wyatt and Ronan (1983) have investigated the effect of can processing on Na/K and Ca/P ratios in various vegetables and broccoli. In addition, a loss in the amount of phosphorous has been detected during processing and as a result of the added salt an increase in the Na/K ratio has been detected.

Huarte et al. (1997) have reported a loss of 22-79% in the amount of nitrate (KNO_3) following 10 minutes of boiling, which was reported to be in the range of 48-97 ppm in fresh broccoli, in their study.

In the studies regarding the shelf life of the broccoli, the packed broccoli have possessed the best texture and endured the least amount of loss in moisture content following 17 days of storage. Furthermore, yellowing has been observed in the broccoli that was stored at 13°C for 5 days. It has been reported that the broccoli might be stored for 20-40 days at 0°C. However, the sprouts might be yellow and flagged if that duration were extended (Toivonen, 1997).

In a study conducted by Zhuang et al. (1995) a direct correlation has been reported between the loss in chlorophylls and ascorbic acid and the increase in the peroxidase activity during the storage of the broccoli following the harvest.

Toivonen (1992) has reported a significant correlation between the chlorophyll fluorescence and respiration and that this might be used as an indicator of the freshness of the broccoli following harvest.

In a study conducted by Çolak et al. (2006), Broccoli was processed into canned pickles with 4 different pre-treatments. As a result, it was seen that this kind of product could be consumed easily.

In this study, the suitability of broccoli which cultivated within the scope of Southeastern Anatolia Project for canning was aimed. For this purpose, the effects of different boiling liquids and storage time on broccoli canned foods were investigated.

Materials and Methods

Materials

Sultan and Marathon broccoli varieties have been used as the material in this study.

Methods

The broccoli varieties have been canned as

indicated in Figure 1. The harvested broccoli varieties have been washed in laboratory following separation from their leaves and stems. The washed broccoli has been boiled for 3 minutes at 97 ± 1 ºC following the downsizing. Boiling broths of three different compositions; 0.1% (w/v) citric acid, 1.7% (w/v) salt and 1.7% (w/v) salt + 0.1% (w/v) citric acid, have been used. After boiling, the broccoli has been cooled down under the cold shower and the excess water has been drained, further, they have been transferred into jars of 500 ml volume to present at amounts of 250 ± 5 g. The filling liquid that has been used in the jars was the 1.7% (w/v) salt + 0.1% (w/v) citric acid containing brine at 95-97 ºC. The stuffed jars have been exhausted for 2 minutes and they have been vacuum-sealed. The sealed jars have been sterilized at 116 ºC for 25 minutes (Cruess, 1958; Lopez, 1981) . The jars have been stored for 9 months at room temperature (25ºC) after being cooled down following sterilization. The obtained canned broccoli has been subjected to various chemical and physical analyses prior to storage and at the 3rd, 6th and the 9th months of storage.

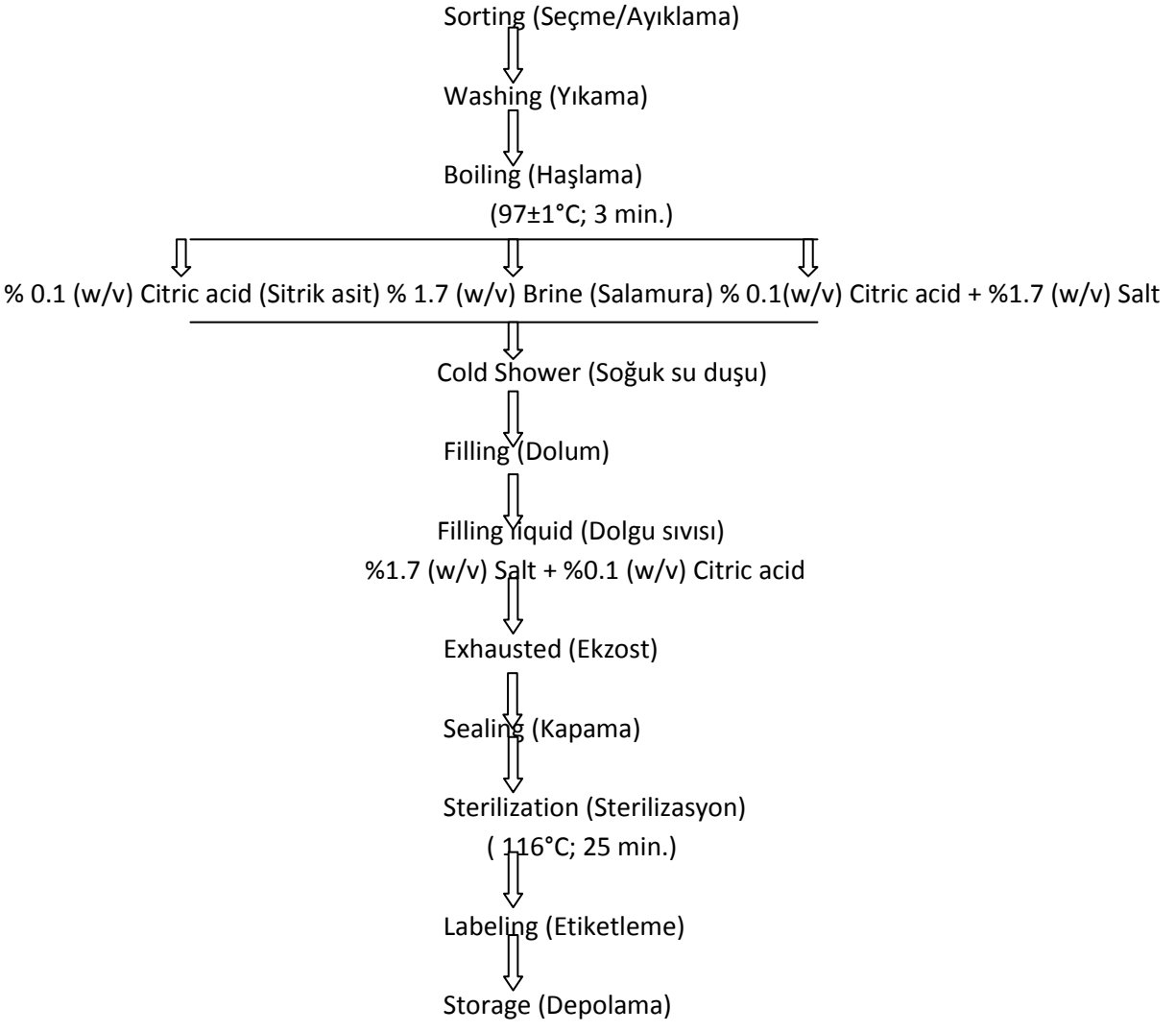

Figure 1. Schematic diagram of canning of broccoli
Şekil 1. Brokolilerin konserve yapım aşamaları

Applied analyses

The soluble dry matter is calculated directly as % with refractometer (Cemeroğlu, 2007).

Total dry matter content was determined by gravimetric method to dry basis weight and the results were expressed as percent (g / 100g) (Cemeroğlu, 2007).

The PH measurement was made with a pH meter with a combined electrode (Cemeroğlu, 2007).

For the acidity, the samples were titrated with 0.1 N NaOH until pH 8.1 and the result calculated as anhydrous citric acid (Cemeroğlu, 2007).

Determination of L-ascorbic acid in broccoli was carried out according to the titrimetric method described in AOAC (2005).

The amount of nitrogen was determined by micro-kjeldahl method and the protein amount was calculated by multiplying by the factor of 6.25 (Özkaya, 1988).

For the drained weight, after the sample was filtered, the part on the sieve (8 mesh in 20x20 cm size) was weighed (Cemeroğlu, 2007).

Net weight was calculated according to the formula "gross weight-tare weight" (Cemeroğlu, 2007).

Headspace was determined by measuring the vertical distance between the top of the mouth of the jar and the surface of the food in the jar with calipers (Cemeroğlu, 2007).

Filling ratio was calculated according to the formule “inside height of can -headspace / inside height of can” (Cemeroğlu, 2007).

Headspace, net weight, drained weight, filling ratio, pH, acidity, L-ascorbic acid content and total dry matter analyses have been carried out during the 9-month storage period at the beginning and at the end of each trimester. The data obtained from the analyses have been evaluated by the LSD (least significant difference) test using a 5% confidence level utilizing the MSTATC statistical analysis software (Bek and Efe, 1988) .

In addition, the sensory evaluations of the products have been conducted based on the appearance, taste/aroma, texture and the overall impression and the general consumer opinion has been determined the evaluation was made by a panelist group of 10 people and each feature was rated on 5 points. All of the sensory properties were calculated on a total score of 20 (Onogur and Elmacı, 2011).

Results and Discussion

Several properties of fresh broccoli

Some properties of fresh broccoli varieties are given in Table 1.

Table 1. Mean values of some chemical properties of fresh broccoli

Çizelge 1. Taze brokolilerin kimyasal özelliklerine ilişkin değerler

Component	Broccoli Variety	
	Marathon	Sultan
Soluble solid (% w/w)	8.5±0.12	8.4±0.14
Total solid (% w/w)	9.6±0.11	9.5±0.14
pH	6.98±0.01	7.01±0.02
Titrable acidity (% w/w)	0.12±0.01	0.10±0.00
L.AscorbicAcid (ppm)	975.6±38	910.8±32
Protein (% w/w)	2.8±0.06	2.8±0.09

As shown in Table 1, the soluble dry matter, total dry matter, pH and titration acidity values for the Marathon and Sultan type broccoli were found to be in close proximity to each other and they have been determined as 8.5% (w/w), 9.6% (w/w), 6.98 and 0.12% (w/w) respectively, for the Marathon type and as 8.4% (w/w), 9.5% (w/w), 7.01 and 0.10% (w/w), respectively, for the Sultan type. In terms of ascorbic acid content, the Marathon type displayed higher values with 975.6 ppm than the Sultan type (910.8 ppm). The protein contents were determined as 2% (w/w) for both types. These values are in accordance with the results reported by Oktay et al. (1998).

Chemical properties of canned broccoli

The difference in pH values in canned broccoli varieties have been determined to be statistically significant ($p<0.05$) as it may be seen in Table 2. While the Marathon type canned broccoli provided lower pH values, the Sultan type canned broccoli yielded higher pH values. The effect of the type of boiling broth on the pH of the canned product has been determined to be statistically significant for both types of broccoli. The lowest mean pH of the Marathon type was recorded for the samples in 0.1% (w/v) citric acid with a value of 4.38 whereas the highest mean pH was recorded for the samples in 1.7% /w/v) salt with a value of 4.43. Similarly, for the Sultan type, the lowest mean pH of the Marathon type was recorded for the samples in 0.1% (w/v) citric acid with a value of 4.41 whereas the highest mean pH was recorded for the samples in 1.7% (w/v) salt with a value of 4.65. The pH was observed to remain unchanged during the 9 months of storage and the slight differences were determined to be statistically insignificant ($p>0.05$). The interaction between variety x boiling was determined as statistically significant ($p<0.05$) which can be explained with difference in buffer capacity of varieties. The interactions between variety x storage, boiling x storage and variety x boiling x storage were determined to be statistically insignificant ($p>0.05$).

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Table 2. Chemical composition of canned broccoli samples during storage period
Çizelge 2. Depolama süresi boyunca brokoli konservelerinin kimyasal bileşimi

Parameter	Variety	Boiling Liquid	Storage Period (Month)			
			0	3	6	9
pH	Marathon	A	4.40^{a3x}	4.37^{a3x}	4.39^{a3x}	4.37^{a3x}
		T	4.56^{a1x}	4.57^{a1x}	4.55^{a1x}	4.56^{a1x}
		A+T	4.42^{a2x}	4.43^{a2x}	4.43^{a2x}	4.43^{a2x}
	Sultan	A	4.41^{a3x}	4.41^{a3x}	4.40^{a3x}	4.41^{a3x}
		T	4.65^{a1y}	4.65^{a1y}	4.65^{a1y}	4.66^{a1y}
		A+T	4.58^{a2y}	4.59^{a2y}	4.59^{a2y}	4.59^{a2y}
% (w/w) Acidity	Marathon	A	0.08^{a1x}	0.08^{a1x}	0.09^{a1x}	0.08^{a1x}
		T	0.08^{a1x}	0.08^{a1x}	0.08^{a1x}	0.08^{a1x}
		A+T	0.08^{a1x}	0.09^{a1x}	0.09^{a1x}	0.08^{a1x}
	Sultan	A	0.08^{a1x}	0.08^{a1x}	0.09^{a1x}	0.08^{a1x}
		T	0.08^{a1x}	0.08^{a1x}	0.09^{a1x}	0.08^{a1x}
		A+T	0.08^{a1x}	0.07^{a1x}	0.08^{a1x}	0.08^{a1x}
Ascorbic Acid (ppm)	Marathon	A	202^{a1x}	181^{b1x}	146^{c1x}	125^{d1x}
		T	196^{a2x}	179^{b1x}	144^{c1x}	122^{d1x}
		A+T	195^{a2x}	180^{b1x}	149^{c1x}	132^{d1x}
	Sultan	A	200^{a1x}	187^{b1x}	152^{c1x}	127^{d1x}
		T	201^{a1x}	183^{b1x}	150^{c1x}	125^{d1x}
		A+T	204^{a1x}	185^{b1x}	149^{c1x}	134^{d1x}
% (w/w) Total Solid	Marathon	A	7.76^{a1x}	7.76^{a1x}	7.77^{a1x}	7.74^{a1x}
		T	7.73^{a1x}	7.74^{a1x}	7.74^{a1x}	7.72^{a1x}
		A+T	7.75^{a1x}	7.75^{a1x}	7.73^{a1x}	7.74^{a1x}
	Sultan	A	7.78^{a1x}	7.75^{a1x}	7.74^{a1x}	7.74^{a1x}
		T	7.75^{a1x}	7.73^{a1x}	7.73^{a1x}	7.73^{a1x}
		A+T	7.76^{a1x}	7.75^{a1x}	7.74^{a1x}	7.72^{a1x}

A: Boiled broccoli in 0.1% (w/v) citric acid, T: Boiled broccoli in 1.7% (w/v) brine, A+T: Boiled broccoli in 0.1% (w/v) citric acid + 1.7% (w/v) brine. Leads not connected by same letter are significantly different ($p>0.05$). ^{1},^{2} and ^{3} shows boiling liquid for each column. ^{x} and ^{y} shows broccoli varieties for each column. ^{a},^{b},^{c} and ^{d} shows storage period for each line.

The mean titration acidity values for the Marathon and Sultan varieties canned broccoli have been determined as 0.08% (w/w). The statistical evaluations showed that the broccoli variety, the type of the boiling broth, the duration of storage and the interactions among those components have not been effective on the titration acidity.

As shown in Table 2, the highest ascorbic acid content with 204 ppm was obtained from the Sultan variety that was boiled in citric acid and salt. The highest ascorbic acid content with 202 ppm was obtained from the Marathon variety that was boiled only in citric acid. A significant difference could not be obtained between broccoli varieties and methods of boiling in terms of the ascorbic acid content ($p>0.05$). The investigation of the change in the ascorbic acid content in canned broccoli as a response to the duration of storage led to the conclusion that the ascorbic acid content decreased as the duration of storage increased. For both types, this decrease that resulted from the elongation of the storage period was determined to be statistically significant ($p<0.05$).

The reason for the constant decrease in the ascorbic acid content is the ascorbic acid degradation. As mentioned by Nagy (1980), during the sealing of the products, even if steam injection was carried out during vacuum application, residual oxygen as low as 0.05% in concentration would remain, which would lead to the degradation of the ascorbic acid. Tatum et

al. (1967) have reported that although no oxygen remains in the medium, the degradation of ascorbic acid was sustained even if it was slowed down under anaerobic conditions.

The difference between the samples was found to be statistically significant in terms of the variations in the boiling broth composition as well as the boiling broth composition x variety interaction ($p<0.05$). For both types, the highest amount of total dry matter was obtained from the samples that were boiled in 0.1% (w/v) citric acid containing broth. The duration of storage, on the other hand was not determined to be effective on the total amount of dry material.

Some properties of canned broccoli

As shown in Table 3, the differences in terms of drained weight were small between the broccoli varieties and this difference was not determined to be statistically significant ($p>0.05$). The mean drained weight has been determined as 250.08 g for the Marathon variety and as 249.95 g for the Sultan variety. Similarly, the effects of the boiling broth composition and the duration of storage on the drained weight were found to be statistically insignificant.

Table 3. Some properties of canned broccoli samples during storage period
Çizelge 3. Depolama süresi boyunca brokoli konservelerinin bazı özellikleri

Parameter	Variety	Boiling Liquid	Storage Period (Month)			
			0	3	6	9
Drained Weight (g)	Marathon	A	250.87 a1x	251.30 a1x	248.61 a1x	250.32 a1x
		T	247.12 a1x	250.20 a1x	253.71 a1x	248.77 a1x
		A+T	251.10 a1x	250.44 a1x	248.00 a1x	250.58 a1x
	Sultan	A	251.34 a1x	251.47 a1x	250.35 a1x	249.61 a1x
		T	248.12 a1x	250.98 a1x	251.27 a1x	249.02 a1x
		A+T	250.57 a1x	246.96 a1x	249.21 a1x	250.50 a1x
Net Weight (g)	Marathon	A	628.65 a1x	628.58 a1x	626.43 a1x	628.45 a1x
		T	628.80 a1x	628.10 a1x	630.29 a1x	628.35 a1x
		A+T	630.15 a1x	627.96 a1x	628.61 a1x	629.25 a1x
	Sultan	A	629.41 a1x	629.16 a1x	627.11 a1x	626.82 a1x
		T	629.10 a1x	627.52 a1x	627.79 a1x	628.10 a1x
		A+T	628.97 a1x	627.70 a1x	628.71 a1x	628.24 a1x
Head Space (cm)	Marathon	A	1.35 a1x	1.35 a1x	1.35 a1x	1.40 a1x
		T	1.45 a1x	1.30 a1x	1.20 a1x	1.35 a1x
		A+T	1.20 a1x	1.30 a1x	1.30 a1x	1.25 a1x
	Sultan	A	1.35 a1x	1.40 a1x	1.20 a1x	1.40 a1x
		T	1.35 a1x	1.35 a1x	1.35 a1x	1.25 a1x
		A+T	1.40 a1x	1.25 a1x	1.30 a1x	1.40 a1x
Filling Rate (%)	Marathon	A	90.86 a1x	90.87 a1x	90.86 a1x	90.86 a1x
		T	90.86 a1x	90.86 a1x	90.87 a1x	90.87 a1x
		A+T	90.87 a1x	90.86 a1x	90.87 a1x	90.87 a1x
	Sultan	A	90.86 a1x	90.86 a1x	90.87 a1x	90.86 a1x
		T	90.86 a1x	90.87 a1x	90.86 a1x	90.86 a1x
		A+T	90.86 a1x	90.87 a1x	90.87 a1x	90.86 a1x

A: Boiled broccoli in 0.1% (w/v) citric acid, T: Boiled broccoli in 1.7% (w/v) brine, A+T: Boiled broccoli in 0.1% (w/v) citric acid + 1.7% (w/v) brine. Leads not connected by same letter are significantly different ($p>0.05$). 1,2 and 3 shows boiling liquid for each column. x and y shows broccoli varieties for each column. a,b,c and d shows storage period for each line.

The mean net weight of the canned broccoli has been determined as 628.63 g for the Marathon variety and as 628.22 g for the Sultan variety. The difference between the

varieties was not statistically significant (p>0.05). Similarly, the effect of boiling water composition and the duration of storage on the net weight was also determined to be insignificant.

In terms of the ratio of the drained weight to the net weight, the differences between the varieties and the compositions of the applied boiling broths was not determined to be statistically significant (p>0.05). For both varieties, the mean drained weight to net weight ratio was determined as 39.79 g. No statistically significant difference was found in the ratio of drained weight to net weight as the duration of storage was extended. As stated by Cemeroglu and Acar (1986), the mean drained weight to net weight ratio might change in response to factors such as the product and the degree of its ripeness

Since the product has been stacked in standard jars and they have been filled with equal amounts of filling fluid, the headspace values for all samples range within 1.20 – 1.45 cm as shown in Table 3. The conducted statistical evaluation has indicated that those differences in numbers were not significant (p>0.05).

The values of the filling ratio were very similar for both types and the differences were determined to be statistically insignificant (p>0.05). The filling ratio has been determined as 90.86% on the average for both varieties. Weighing the products prior to stuffing and the addition of equal amounts of filling fluid on top has been effective in obtaining this result. Generally, it has been reported in the regulations that the filling ratio of the canned products is required to be above 90% (Cemeroglu and Acar, 1986)

Sensory evaluation

The canned broccoli, which has been processed using different boiling water and stored at room temperature for 9 months, has been subjected to a sensory evaluation in terms of appearance, taste / aroma, texture and overall impression with the highest ranking of 5. The mean values obtained from the sensory evaluation of the canned broccoli are displayed in Table 4.

Table 4. Sensory characteristics of canned broccoli*
Çizelge 4. Brokoli konservelerinin duyusal özellikleri

Variety	Boiling Liquid	Appearance	Taste Aroma	Texture	Overall Impression	Total
Marathon	A	4.1±0.54 ^{1x}	4.0±0.44 ^{1x}	2.3±0.46 ^{1x}	3.7±0.64 ^{1x}	14.1±1.30 ^{1x}
	T	4.2±0.60 ^{1x}	3.9±0.54 ^{1x}	2.4±0.49 ^{1x}	4.0±0.45 ^{1x}	14.5±1.28 ^{1x}
	A+T	4.0±0.44 ^{1x}	3.9±0.54 ^{1x}	2.5±0.50 ^{1x}	3.8±0.60 ^{1x}	14.2±1.40 ^{1x}
Sultan	A	4.0±0.45 ^{1x}	3.7±0.64 ^{1x}	2.0±0.45 ^{1x}	3.6±0.66 ^{1x}	13.3±1.27 ^{1y}
	T	3.9±0.30 ^{1x}	3.9±0.54 ^{1x}	2.2±0.40 ^{1x}	3.5±0.66 ^{1x}	13.5±1.36 ^{1y}
	A+T	3.8±0.40 ^{1x}	3.8±0.60 ^{1x}	2.2±0.60 ^{1x}	3.4±0.49 ^{1x}	13.2±1.25 ^{1y}

A: Boiled broccoli in 0.1% (w/v) citric acid, T: Boiled broccoli in 1.7% (w/v) brine, A+T: Boiled broccoli in 0.1% (w/v) citric acid + 1.7% (w/v) brine. Leads not connected by same letter are significantly different (p>0.05). 1,2 and 3 shows boiling liquid for each column. x and y shows broccoli varieties for each column.
*Calculations were made with a ranking of 5 being the highest for each property.
General evaluation is for total 20 points.

The Marathon type scores 14.3 points out of 20 and the Sultan type 13.3 out of 20 as a result of the sensory evaluation. The products were generally enjoyed in terms of the overall impression and taste / aroma while they were not preferred in terms of their texture. The panelists

reported that the product was over-mellowed and they were easily mashed in mouth.

Conclusion

The following conclusions have been reached using the results obtained from the research.

1. As a result of the analyses conducted on the composition of the broccoli, a significant difference between the different broccoli varieties could not be attained.
2. The temperature applied during sterilization and its duration were determined to be effective on the textural properties and causing mellowing.
3. A significant change in the drained weight, net weight, drained weight to net weight ratio, overhead and filling ratio values were not detected throughout the period of storage.
4. A decrease in the ascorbic acid content was determined as the duration of storage increased.

As a result of the objective and subjective evaluations, both varieties of broccoli have been determined to be suitable for canning and, it was determined that better products would be obtained in terms of texture by increasing the acidity and lowering the duration and the temperature of sterilization or by using additives such as calcium salts.

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