EFFECT OF CAYENNE PEPPER ADDITION ON PHYSICOCHEMICAL, MICROBIOLOGICAL AND SENSORY PROPERTIES OF DRINKABLE YOGHURT-AYRAN

– Research paper –

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Abstract: Cayenne peppers (*Capsicum annuum* L.) were incorporated to ayran aiming to obtain a health promoting ayran with different flavour. The effects on the physico-chemical characteristics, antioxidant and phenolic capacity, counts of *Streptococcus*, *Lactobacillus*, yeast, moulds and coliforms, sensory and volatile compounds analysis were performed. Ayran samples with powdered peppers had significantly higher antioxidant and total phenolic contents than the ayrans with sliced pepper. Pepper addition increased *Lactobacillus* and *Streptococcus* counts compared to control ayrans. The dominant bacteria during the storage period (7.61-8.88 log CFU/ml) was *Streptococcus*. Panelists rated flavour, texture, appearance and color properties of ayran samples with sliced pepper similar to control samples. Ayran samples with 15% sliced peppers had the maximum overall scores.

Keywords: Ayran; yoghurt drink; cayenne pepper (*Capsicum annuum* L.); traditional beverage; spicy

INTRODUCTION

Consumers are interested in the production of foods that are rich in nutrients as well as having positive effects on human health. Dairy products are more attractive to consumers because of their positive effects on health compared to carbonated beverages. Fermented dairy products had an increased interest as a result of their nutritional quality and attractiveness (Erkaya et al., 2015). Ayran, refreshing and drinkable fermented dairy product, has commonly been consumed in most countries in the world, especially in Asia and the Middle East, comprising Turkey. Ayran as of a fermented dairy product is the second most widespread consumed and liked product after yoghurt in Turkey. It is traditionally prepared by diluting yoghurt with water at a level of 30–50% (Köksoy et al., 2003); it is also be industrially produced by the fermentation of the milk standardized to 8% dry matter content, the addition of yoghurt starter culture and table salt at a maximum level of 1%. Although plain ayran as a national dairy beverage has several advantages like better nutritional value, easy digestion, refreshing

effect, and satisfying thirstiness, the preference of consumer turns toward carbonated beverages at restaurant and hotels during the summer compared to fermented dairy beverages. It may be important to widespread ayran consumption by diversifying ayran products like pepper added ayran since the promotion of various fruit flavoured yoghurts significantly contributed to yoghurt consumption of all ages.

Pepper fruit (*Capsicum annuum* L.) is grown worldwide and consumed fresh or in dried form as food additives, flavouring agent to deliver a hot and pungent aroma (Lu et al., 2017). Phenols, flavonoids, and capsaicinoids (Loizzo et al., 2015), vitamins C and E as well as provitamin A and carotenoids (Materska et al., 2005) are a good source of various health-promoting compounds in peppers.

There is no research about fruit-added ayrans in the literature, except the studies mentioning with the properties of health, technological, physicochemical, organoleptic, and microbiological of fruit-added yoghurt. Consequently, the main objective of this research is to examine the effects of Cayenne pepper addition on the compositional, physicochemical and organoleptic, microbiological and functional properties of ayrans during the storage time.

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MATERIAL AND METHODS

Cow milk was provided by Samsut to produce ayran samples in Samsun, Turkey. Cayenne peppers were purchased from Metro market (Samsun, Turkey). DVS starter cultures YFL350 (*Streptococcus thermophilus* and *Lactobacillus delbrueckii subsp. bulgaricus*) for ayran production were kindly provided by Maysa Gida (Istanbul, Turkey).

Ayran production

The cow's milk (12.75 % total solids and 4.03 % fat) standardized to 8 % total solids and 1.5 % fat was used to produce ayran samples. After the standardization, homogenization was conducted at 55 °C under 200 kg/cm² pressure. After the pasteurization at 90 °C for 5 min, the milk was cooled (43–45°C), inoculated with 10 u/1 ton of YFL350 culture and then incubated until the pH fell to 4.3. Ayran samples were then cooled down (10 °C) and salt at a concentration of 0.5% in the final product was added to each sample. Samples were mixed thoroughly and filled into 1000 ml of cups and stored at 4 °C. To prepare ayrans with sliced peppers, the red peppers were cleaned from their stems and seeds and sliced into two pieces longitudinally about 5 mm thick. Then, the sliced peppers were added to ayran samples at 5, 10 and 15% concentrations after the salt addition step. Sliced peppers - added ayran samples were transferred to 1 L sterile glass bottle and kept in refrigerator for 24 hours. Ayran samples were then passed through a stainless steel strainer (25 cm x 7 cm) to remove the sliced peppers. The sieved ayran samples were kept at 3-5°C for 20 days.

For the ayrans with powdered peppers, the sliced peppers were pre-dried at 60 °C for three hours in a conventional oven and then samples were transferred to a microwave oven with rotary table operated at a power level of 900 Watt for 15 minutes. The microwave dried peppers were milled at 2000 rpm by an electrical grinder and passed through a 0.5 mm open sieve. The powdered peppers were then added to ayran at 0.5, 1, 2.5 % concentrations after the salt addition step.

Physicochemical analyses

pH, titratable acidity, total solids, fat, protein and ash were determined according to the methods described by Bradly et al. (1992). Viscosity values (cP) of ayran samples were determined by a viscometer (Model DV-1+; Brookfield Engineering Laboratories, Inc., MA, USA). Viscosity measurements for ayran samples with temperature set to 15°C taken in 250 ml beakers

were carried out at 30 rpm using spindle no 3 as cP after a 30-second rotation.

Microbiological analyses

M17 agar (Oxoid Ltd., UK) was used to count *Streptococcus* and plates were aerobically incubated at 30 °C for 5 days. MRS agar (Oxoid Ltd., UK) was used to count *Lactobacillus* incubating the plates at 30 °C for 5 days. Total yeast and molds were enumerated at 30°C for 3-5 days by using Yeast Extract Glucose Chloramphenicol Agar (YGC) (acidified with 10% lactic acid. Violet red bile agar (VRB) was used for coliform analysis. The incubation was carried out at 37°C for 24 hours (Erkaya et al., 2015).

Bioactive compound extraction

Ayran extracts were prepared according to Demirci et al. (2017). Briefly, each Ayran sample (2 ml) was mixed with a appropriate amount (8 ml) of methanol (80:20, methanol: distilled water) and centrifuged at 7200 rpm for 10 min at 4°C. The supernatant was filtered and stored at 4°C for DPPH and TPC analysis.

Total phenolic content assay (TPC)

The procedure by Singleton et al. (1965) was followed for TPC. Briefly, 0.5 ml of phenolic extract was mixed with 2.5 ml of Folin Ciocelteau's phenol reagent (0.2N) and 2 ml Na₂CO₃ (7.5%) was added within 3 minutes. After 30 minutes of the incubation in dark conditions, absorbance was measured at 760 nm using a UV/VIS spectrophotometer (Shimadzu UV-1800, Japan). Total phenolic content (TPC) was calculated as µg gallic acid equivalents (GAE) per gram of sample using the calibration curve ($R^2 = 0.998$) in Eq.1.

$$TPC (\mu\text{g/ml}) = [\text{Absorbance} - 0.0179] / 0.0123 \times \text{Dilution Factor} \quad (1)$$

Determination of DPPH free radical scavenging activity

To determine the DPPH free radical scavenging activity of the extracts, the method described by Behrad et al. (2009) was followed with some modifications. An amount of 0.1 ml supernatant was mixed with 4.9 ml DPPH solution (6.1×10^{-5} M in methanol). The absorbance was measured at 517 nm by a spectrophotometer (Thermo Fisher, G10S UV-Vis, USA) after 30 minutes of incubation in a dark room at room temperature. The results were expressed according to Eq.2.

$$ARA(\%) = ((A_c - A_s) / A_c) \times 100 \quad (2)$$

Antiradical activity as ARA (%), control (methanol) absorbance as A_c and sample

absorbance as A_s . Results were calculated as Trolox equivalent and expressed as μM Trolox equivalents (TE) per gram of sample (calibration curve linearity range: $R^2 = 0.999$).

Sensorial analysis

The sensory properties of ayrans were organoleptically evaluated by using the modified method of William E. S et al. (1970) with maximum scores of 10 for appearance and colour, flavour and general acceptability and 5 for body and texture. Ayran samples in 150 mL plastic cups with three-digit random numbers were randomly presented to 15 sensory panelists selected from Department of Food Engineering at Ondokuz

Mayis University. The evaluations were carried out after the first and 20th days of storage at 3-5°C.

Volatile aromatic compound

Analyses of volatile aromatic compounds were carried out at days 1 and 20 of storage time according to Temiz et al. (2017). Results were calculated as percentage of total volatile aroma compounds.

Statistical analysis

Statistical analysis of data was done by one-way and three factors randomized complete block design using IBM SPSS software (Version 21, Chicago, USA). Tukey's post-hoc test at the 5% level of significance was conducted.

RESULTS AND DISCUSSIONS

Effect of pepper addition on composition

The milk used for the ayran production had 12.4 % total solids, 3.7 % fat, 3.1 % protein, and 6.50 pH and pepper had 5.5 pH, 3.6 % fat, 8.38 % total solids, 4.88 log CFU/mL yeast and moulds count. Table 1 shows total solids, fat and protein contents of ayrans. The total solid contents of all ayrans were between 7.21 %-8.55 %. Total solid of ayrans with powdered peppers were significantly higher than that of sliced pepper – added and control samples. The increase in sliced pepper concentration did not increase total solid properties and gave similar results as with control samples. This result was expected because the sliced peppers were removed during the production, but powdered peppers were left within ayran.

In our study, ayran samples had the fat ratio between 1.8-2.87 %. Pepper addition significantly affected the fat contents of ayrans ($p < 0.05$). Fat contents of ayrans with powdered peppers were significantly higher than that of sliced pepper-added and control samples. The mean fat ratio in the ayrans with peppers was similar to those previously reported by Köksoy and Kılıç (2003). The effect of pepper form and concentration did not significantly affect the protein contents of ayrans ($p > 0.05$).

Effect of storage time on physicochemical and functional properties of Ayran

The effect of pepper form and concentration level on the pH, viscosity, DPPH and TPC values of ayrans during storage is shown in Table 2. The pH values of ayrans did not change until the 10th day of storage ($p > 0.05$) and then significantly declined at the 20th storage day ($p < 0.05$). The concentration

of each sliced and powdered peppers was not significantly affected by the pH values of the samples ($p > 0.05$). The mean pH values of the ayrans with pepper added were similar to the those stated by Köksoy and Kılıç (2003) and Ozturkoglu-Budak et al. (2016). Twenty days of storage decreased the pH of ayrans to lower pH values (4.34–3.47) possibly as a result of accumulation of lactic acid.

Viscosity values of the ayrans with sliced and powdered peppers were significantly different ($p < 0.05$). Samples with 10% sliced and 2.5% powdered peppers had the highest viscosity, while control samples had the lowest. While storage period, viscosity values of the ayrans significantly increased ($p < 0.05$). Lopez-Hernandez et al. (1996) reported that *Capsicum annuum* L. contained 0.73 g pectin/ 100 g fresh fruit. The increase in the viscosity values of the ayrans with pepper while storage period may be related the pectin content of the peppers. Parallel to our findings, Tamucay-Ozunlu (2005) found viscosity values of ayrans between 54 and 175 cP.

Since pepper includes complex phenolic compounds (Materska & Perucka, 2005), the samples with peppers had higher phenolic contents and antioxidant activity than control samples. The ayran samples with powdered peppers had significantly higher antioxidant and total phenolic contents ($p < 0.05$) than the ayrans with sliced pepper, but ayrans with sliced peppers and control ayrans were similar ($p > 0.05$). Ayrans with 2.5 % powdered peppers had the maximum total phenolic content and radical scavenging activity. Phenolic and antioxidant capacity generally decline day by day. But an increase in TPC and DPPH radical scavenging activity was observed for all ayran samples throughout the storage period.

Table 1. Fat, protein and total solid (%) contents of ayrans

Pepper type	Pepper concentration (%)	Total solids (%)	Protein (%)	Fat (%)
Control	0	7.36 ± 0.16 ^c	2.87 ± 0.01 ^a	1.80 ± 0.05 ^d
Sliced	5	7.31 ± 0.14 ^c	2.84 ± 0.03 ^a	1.90 ± 0.11 ^d
	10	7.41 ± 0.24 ^c	2.86 ± 0.01 ^a	1.93 ± 0.19 ^{cd}
	15	7.42 ± 0.26 ^c	2.86 ± 0.01 ^a	2.06 ± 0.27 ^{cd}
	0.5	7.81 ± 0.54 ^{bc}	2.86 ± 0.02 ^a	2.27 ± 0.19 ^{bc}
Powder	1	8.38 ± 0.62 ^{ab}	2.87 ± 0.03 ^a	2.60 ± 0.27 ^{ab}
	2.5	9.07 ± 0.74 ^a	2.87 ± 0.02 ^a	2.87 ± 0.28 ^a

a-c: Means followed by the same letters with in the same column are not significant at p>0.05.

Table 2. Physicochemical properties of ayrans during storage

Analysis	Pepper form	Added pepper (%)	Storage time (day)		
			1	10	20
pH	Control	0	4.32 ± 0.22 ^{Aa}	4.29 ± 0.03 ^{Aa}	3.70 ± 0.08 ^{Ab}
		5	4.32 ± 0.04 ^{Aa}	4.30 ± 0.02 ^{Aa}	3.72 ± 0.07 ^{Ab}
	Sliced	10	4.32 ± 0.03 ^{Aa}	4.31 ± 0.02 ^{Aa}	3.71 ± 0.08 ^{Ab}
		15	4.33 ± 0.02 ^{Aa}	4.31 ± 0.01 ^{Aa}	3.71 ± 0.09 ^{Ab}
	Powder	0.5	4.33 ± 0.03 ^{Aa}	4.29 ± 0.06 ^{Aa}	3.55 ± 0.35 ^{Ab}
		1	4.33 ± 0.05 ^{Aa}	4.28 ± 0.06 ^{Aa}	3.51 ± 0.37 ^{Ab}
		2.5	4.34 ± 0.06 ^{Aa}	4.28 ± 0.07 ^{Aa}	3.47 ± 0.45 ^{Ab}
Viscosity	Control	0	36.00 ± 1.41 ^{Cb}	40.50 ± 0.71 ^{Da}	42.50 ± 0.71 ^{Fa}
		5	40.00 ± 0.00 ^{BCc}	43.00 ± 0.00 ^{CDb}	48.00 ± 1.41 ^{DEa}
	Sliced	10	44.00 ± 4.24 ^{Ba}	45.00 ± 0.00 ^{CDa}	46.50 ± 0.71 ^{Ea}
		15	45.50 ± 6.36 ^{Ba}	46.70 ± 3.53 ^{Ca}	50.00 ± 0.00 ^{Da}
	Powder	0.5	66.50 ± 0.71 ^{Ab}	67.50 ± 0.71 ^{Bb}	70.00 ± 0.00 ^{Ca}
		1	67.00 ± 0.00 ^{Ab}	72.50 ± 3.53 ^{Aab}	78.00 ± 0.00 ^{Ba}
		2.5	69.50 ± 0.71 ^{Ac}	75.50 ± 0.71 ^{Ab}	80.50 ± 0.71 ^{Aa}
DPPH (mg Trolox/L)	Control	0	140.08 ± 0.32 ^{Bb}	151.53 ± 0.19 ^{Cb}	272.42 ± 0.06 ^{EFa}
		5	140.96 ± 0.35 ^{Bc}	163.67 ± 0.22 ^{BCDb}	276.29 ± 0.13 ^{DFa}
	Sliced	10	143.91 ± 0.06 ^{Bc}	167.65 ± 0.07 ^{BCDEb}	278.38 ± 0.13 ^{DFa}
		15	144.69 ± 0.09 ^{Bc}	170.06 ± 0.46 ^{BDEb}	281.52 ± 0.40 ^{CDa}
	Powder	0.5	150.68 ± 0.22 ^{ABb}	156.03 ± 0.33 ^{BCb}	287.18 ± 0.12 ^{BCa}
		1	153.33 ± 0.30 ^{ABc}	193.19 ± 0.32 ^{Ab}	290.84 ± 0.14 ^{Ba}
		2.5	161.78 ± 0.31 ^{Ac}	199.99 ± 0.04 ^{Ab}	311.88 ± 0.17 ^{Aa}
TPC (mg gallic acid/L)	Control	0	103.74 ± 2.22 ^{Cb}	109.65 ± 2.01 ^{Db}	131.48 ± 1.22 ^{Ca}
		5	106.26 ± 0.57 ^{Cc}	113.84 ± 1.24 ^{Db}	131.69 ± 0.20 ^{Ca}
	Sliced	10	110.81 ± 2.00 ^{Cb}	119.19 ± 1.32 ^{Db}	135.27 ± 0.13 ^{CDa}
		15	112.82 ± 0.86 ^{Cb}	121.18 ± 1.09 ^{Db}	140.70 ± 0.48 ^{Da}
	Powder	0.5	156.15 ± 0.53 ^{Cb}	157.66 ± 1.01 ^{Cb}	171.13 ± 1.55 ^{Ba}
		1	161.08 ± 1.42 ^{Bb}	170.73 ± 1.01 ^{Bb}	192.28 ± 1.56 ^{Ba}
		2.5	222.23 ± 1.62 ^{Ab}	245.24 ± 1.22 ^{Aa}	245.99 ± 1.46 ^{Aa}

A-C : Means followed by the same letters with in the same column are not significant at p>0.05.

a-c :Means followed by the same letters with in the same row are not significant at p>0.05.

Effect of storage time on microbiological properties of Ayran

Microbiological features of Ayran produced in different cayenne pepper concentrations are shown in Figures 1, 2 and 3. *Lactobacillus* counts of ayran with sliced pepper were significantly higher than the ayran with powdered pepper (p<0.05) (Figure 1). The average counts of *Lactobacillus* of

control ayran increased 1.14 logs throughout the storage period that is comparable to the increase in the ayran with sliced or powdered pepper. This result indicates that the addition of pepper to ayran did not significantly retain the activity of lactic acid bacteria. Our results are higher than some studies reported by Ozturkoglu-Budak et al. (2016) and similar to other (Erkaya et al., 2015).

Figure 1. Effect of pepper addition on the *Lactobacillus* counts of ayrans (Capital letters show the significant difference ($P < 0.05$) between treatments at the same storage day. Small letters show the significant difference ($P < 0.05$) between storage days of the same treatment)

Figure 2. Effect of pepper addition on the *Streptococcus* counts of ayrans (Capital letters show the significant difference ($P < 0.05$) between treatments at the same storage day. Small letters show the significant difference ($P < 0.05$) between storage days of the same treatment)

The population of *Streptococcus* increased from 7.61 to 8.88 log CFU ml⁻¹ in all samples during the storage time (Figure 2). Contrary to the *Lactobacillus* trend, *Streptococcus* population significantly decreased from the first day to 20th day of storage ($p < 0.05$). As it is in the case of *Lactobacillus* counts, more *Streptococcus* transferred from sliced pepper to ayran compared to powdered pepper. Pepper form added to ayran did not considerably suppress the *Streptococcus* growth throughout the storage period. During storage, the population of *Streptococcus* was higher than those of *Lactobacillus* in all ayran samples. The ratio of the mean counts of *Streptococcus* to *Lactobacillus* in all Ayran samples was calculated as 1.68 that is within the recommendation limits of 1:1 to 2:1 (Sun-Waterhouse et al., 2013).

Yeasts and moulds are microorganisms that play an important role in food spoilage. Total yeasts and

moulds counts recommended are <10 CFU g⁻¹ (Kiros et al., 2016). The population of control samples increased about 1.5 logs compared to about 1 log increase in the samples with pepper added during the storage period (Figure 3). It may be related to the antimicrobial activity of the pepper. One of the capsaicin analogues, vanillin has shown inhibitory activity towards the growth of yeast and moulds (Bae et al., 2012).

To assess the microbiological quality and hygienic conditions of the ayran samples, total coliforms and *E. coli* were counted and were not detected in any of the ayran samples during the storage period. Results from microbiological analysis reveal that the addition of Cayenne Pepper to the ayran composition as a plant adjunct did not significantly decline desirable yoghurt bacteria of *Streptococcus* and *Lactobacillus* and considerably reduce the yeasts and moulds counts during the storage.

Figure 3. Effect of pepper addition on the yeasts and moulds counts of ayrans (Capital letters show the significant difference ($P < 0.05$) between treatments at the same storage day. Small letters show the significant difference ($P < 0.05$) between storage days of the same treatment)

Effect of storage time on sensory properties of Ayrans

Sensory evaluation values of pepper-added ayrans are shown in Table 3. Panelists found that the ayrans with powdered pepper at all concentrations lacked the optimum ayran appearance and color because the samples were too dark and red. Since sliced peppers were removed from ayran formula after the fermentation step, panelists did not offense the appearance and colour and other sensory properties. All ayran samples with sliced pepper took higher body and texture scores than control ayrans ($p < 0.05$); ayrans with powdered pepper were criticized for being too weak, whey-off, and broken body, especially at 2.5%

concentration. As in the case of flavour, sliced pepper-added samples took higher general acceptability scores than powdered pepper-added samples ($p < 0.05$); the samples with %15 sliced pepper received the highest score among all samples.

Volatile compounds of ayran

The percentage of acids, terpenes, aldehydes, esters, alcohols and ketones on total volatiles varied between 9.86-77.33%, 2.31-10.02%, 0.47-12.12%, 1.08-25.97%, 0.46- 30.73% and 2.75-61.36%, respectively (Figure 4). During storage, the acid content of the control and powdered pepper-added samples did not change significantly ($p < 0.05$) while the slice pepper-added samples decreased. The dominant acids found in all samples are octanoic, hexanoic, decanoic, benzoic and acetic acid. Benzene, styrene and limonene were detected in all samples. In addition, linalool was also detected in pepper added ayran. The linalool, found in *Capsicum annum* by Korkmaz et al.(2017), contributes to the sweet caramel and fresh flowery aroma, commonly found in many fruits, vegetables and food aroma (Mazida et al., 2005).

Aldehyde content was decreased during storage in all samples. Hexanal, nonanal, octanal and acetaldehyde were found as the main aldehydes in all samples as main aldehydes. Safranal, 3-methylbutanal and 2-octenal were also detected in pepper added ayran. These aldehydes were also reported in red bell peppers by van Ruth et al. (2003).

Acetic acid ethyl ester and acetic acid hexyl ester, hexanoic acid ethyl ester, octanoic acid ethyl ester, hexanoic acid methyl ester and octanoic acid methyl ester were found in all ayran samples. These esters were found in researches with yogurt and pepper (Korkmaz et al., 2017). Ethanol, 2-ethyl hexanol, 1-pentanol, 1-octanol, hexanol, 2-(2-Ethoxyethoxy) ethanol were dominant alcohols in all samples. In addition to these alcohols, 2-ethyl hexanol and 1-octen 3-ol and methanol were detected in pepper added ayrans. Acetoin, acetone, 2-octanone, heptan-2-one, 3-methyl-2-butanone, diacetyl, 2-nonanone were identified in all ayran samples.

Table 3. Effect of pepper addition on sensory properties of ayrans during storage

Analysis	Pepper form	Added pepper (%)	Storage time (day)	
			1	20
Appearance and colour	Control	0	9.00 ± 0.000 ^{Aa}	9.00 ± 1.414 ^{Aa}
		5	9.50 ± 0.707 ^{Aa}	9.00 ± 1.414 ^{Ab}
	Sliced	10	9.00 ± 1.414 ^{Aa}	9.00 ± 0.707 ^{Aa}
		15	9.00 ± 0.354 ^{Aa}	8.00 ± 0.000 ^{ABb}
	Powder	0.5	7.00 ± 0.000 ^{Ba}	6.00 ± 0.707 ^{BCb}
		1	4.50 ± 0.354 ^{Ca}	4.00 ± 0.269 ^{Cb}
Flavour	Control	2.5	3.00 ± 0.354 ^{Ca}	2.00 ± 0.000 ^{Db}
		0	8.00 ± 0.000 ^{Aa}	7.00 ± 0.000 ^{Bb}
	Sliced	5	7.13 ± 0.177 ^{Bb}	7.63 ± 0.177 ^{Ba}
		10	7.66 ± 0.481 ^{Ba}	7.32 ± 0.445 ^{Bb}
	Powder	15	9.19 ± 0.622 ^{Aa}	8.63 ± 0.177 ^{Ab}
		0.5	6.00 ± 0.707 ^{Ca}	4.00 ± 0.000 ^{Cb}
Body and texture	Control	1	4.00 ± 0.000 ^{Da}	3.38 ± 0.000 ^{Da}
		2.5	3.50 ± 0.000 ^{Da}	2.75 ± 0.707 ^{Db}
	Sliced	0	7.86 ± 0.530 ^{Ba}	3.50 ± 0.000 ^{Cb}
		5	4.5 ± 0.000 ^{Aa}	4.06 ± 0.177 ^{Bb}
	Powder	10	4.12 ± 0.354 ^{ABa}	4.00 ± 0.000 ^{Ba}
		15	4.37 ± 0.354 ^{ABb}	4.53 ± 0.092 ^{Aa}
General acceptability	Control	0.5	3.50 ± 0.354 ^{Ca}	2.87 ± 0.707 ^{Db}
		1	1.69 ± 0.177 ^{Da}	1.50 ± 0.000 ^{Eb}
	Sliced	2.5	1.62 ± 0.000 ^{Da}	0.84 ± 0.445 ^{Fb}
		0	8.00 ± 0.354 ^{BCa}	7.50 ± 0.354 ^{BCb}
	Powder	5	6.50 ± 0.707 ^{Db}	8.00 ± 0.707 ^{CDa}
		10	8.50 ± 0.707 ^{ABa}	8.00 ± 1.414 ^{ABb}
		15	9.50 ± 0.707 ^{ACa}	9.00 ± 0.707 ^{Ab}
		0.5	7.00 ± 0.354 ^{Da}	5.00 ± 0.000 ^{Db}
		1	3.50 ± 0.707 ^{Ea}	3.00 ± 0.000 ^{Eb}
		2.5	2.00 ± 0.000 ^F	1.50 ± 0.354 ^{Eb}

A-C : Means followed by the same letters with in the same column are not significant at p>0.05.

a-c : Means followed by the same letters with in the same row are not significant at p>0.05.

Figure 4. GC-MS results of the main volatile compounds detected on the 1st and 20th storage days of Ayran samples (S1-S2-S3: Ayran with sliced peppers with 5-10-15% concentration; P1-P2-P3: Ayran with powdered peppers with 0.5-1-1.5% concentration, respectively)

CONCLUSIONS

This study demonstrated that cayenne pepper was successfully used in ayran production. The form of the pepper used for the ayran production significantly affect the physicochemical, microbiological, and sensory properties of ayrans. The addition of the pepper to ayran formula significantly improved the phenolic content and antioxidant activity of the final product and this effect increased with respect to the control samples

throughout the storage period. While the addition of pepper to ayran did not reduce the desired yogurt bacteria of *Streptococcus* and *Lactobacillus* counts, it had a suppressive effect on the number of yeasts and molds that played an important role in food spoilage. It is therefore possible to produce a more functional ayran and to maintain its stability until the storage period of 20 days. It can be concluded that cayenne pepper in the form of slice can be added to the ayran formula at a level of 10 to 15%.

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