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Microbiological, Chemical and Sensory Characteristics of Kefir Prepared with Various Fruit Additives

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ABSTRACT In this study, effects of kefir on the chemical (titratable acidity and pH), microbiological (*Lactobacillus* spp., *Lactococcus* spp. and yeast counts) and sensory properties of kefir that was prepared with fruits (strawberry, apricots, banana) (at a ratio of 20%) during the incubation (checked at 0, 3, 6, 9, 12, 15, 18 and 21 hours) and storage (checked at 1, 2, 3, 4, 5, 6, 7 and 14 days) periods were investigated. Significant differences ($p<0.05$) were found in the analysis of the characteristics of the different kinds of fruit kefir when compared with plain kefir. Differences were found both between the kinds of fruit and the time points at which the samples were analyzed. At the end of the incubation and storage periods, *Lactobacillus* spp. and *Lactococcus* spp. counts were found to be higher in the fruit kefirs than in plain kefir. At the end of the incubation stage, apricot kefir had the highest acidity (0.73) and strawberry kefir and apricot kefir had the lowest pH (5.80). The yeast count was found to be the highest in apricot kefir (5.00 $\log_{10}$ cfu/ml) and the lowest in banana kefir (4.00 $\log_{10}$ cfu/ml). At the end of the storage period (at +4°C), apricots kefir (0.70) had the highest acidity and the pH level was higher in all fruit kefirs when compared with plain kefir (5.20). Yeast counts were found to be the lowest in apricot kefir (3.04 $\log_{10}$ cfu/ml). Comparison of fruit kefirs with sensory analysis failed to identify any statistically significant effect of the fruit on the sensory characteristics, but the best-liked types were banana and plain kefir. We proved that the added varieties of fruit affected the pH and acidity levels of the kefir and also influenced the development of microflora, so we concluded that this could consequently affect the product's shelf life.

Keywords: *Fruit kefir, Microflora, Chemical and sensory analysis, Lactococcus and Lactobacillus* spp.

ÖZ

Farklı Meyve İlaveleri ile Hazırlanan Kefirlerin Mikrobiyolojik, Kimyasal ve Duyusal Özellikleri

Bu çalışmada, kefirlere üretim aşamasında katılan (%20) meyvelerin (çilek, kaysı, muz), kefirlerin inkübasyon (0. 3. 6. 9. 12. 15. 18. 21. saatler) ve muhafaza süresi (1. 2. 3. 4. 5. 6. 7. 14. günler) boyunca kimyasal (titre edilebilir asitlik, pH), mikrobiyolojik (*Lactobacillus* spp., *Lactococcus* spp. ve maya) ve duyusal özellikleri üzerine etkisi araştırıldı. Çalışmada meyveli kefirlere ait değerler; sade kefirlerle karşılaştırıldığında önemli farklılıklar olduğu saptandı ($p<0.05$). Bu farklılıklar hem meyve çeşitleri arasında hem de örneklerin analiz edilen zaman aralıklarında görüldü. İnkübasyon ve muhafaza sürelerinin sonunda *Lactobacillus* spp. ve *Lactococcus* spp. sayılarının meyveli kefirlerde sade kefirlerden daha fazla olduğu tespit edildi. İnkübasyon aşamasının sonunda en yüksek asitlik (0.73) kayısılı kefir, en düşük pH (5.80) kayısılı ve çilekli kefirde bulundu. Maya sayısı ise en yüksek kayısılı (5.00 $\log_{10}$ kob/ml) en az muzlu (4.00 $\log_{10}$ kob/ml) kefirde bulundu. Muhafaza süresinin sonunda en yüksek asitlik (0.70) kayısılı kefirde görüldü, pH değeri ise tüm meyveli kefirlerde sade kefirlerden (5.20) daha düşük bulundu. Maya sayıları ise en düşük kayısılı kefirlerde (3.04 $\log_{10}$ kob/ml) tespit edildi. Meyveli kefirler arasında yapılan duyusal analizde ise, meyvelerin duyusal niteliklere istatiksel olarak bir etkisi olmadığı tespit edilirken, en beğenilenlerin muzlu ve sade kefir olduğu tespit edildi. Sonuç olarak, katılan meyve çeşitlerinin kefirlerin pH ve asitlik değeri ile mikroflora gelişimini etkilediği ve dolayısıyla ürünün raf ömrünü etkileyebileceği ortaya konmuştur.

Anahtar Kelimeler: *Meyveli kefir, Mikroflora, Duyusal ve kimyasal analiz, Lactococcus ve Lactobacillus türleri*

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INTRODUCTION

In the Turkish language, the word 'kefir' is associated with something enjoyable that gives pleasure. It is a milk product made by placing kefir grains into fresh milk and waiting for the resulting alcohol and acid fermentation to occur (Motilva et al. 2013). Kefir is also known as *kefyr, kephir, kefer, kiaphur, knapon, kepi* and *kipi* (Arslan 2015) and it is thought that it was first made in the Caucasus (Özden 2008). It is known that after the 19th century, kefir production became widespread in countries throughout eastern and central Europe (Russia, Germany, Poland, Slovakia, Denmark, Switzerland, Norway and Hungary) (Karatepe et al. 2012; Saloff-Coste 1996).

Kefir is made up of grains that are 3-35 mm in size with a yellowish, cauliflower-like appearance. It has a complex makeup of bacteria and yeasts surrounded by a polysaccharide matrix (Achaintre et al. 2016). When milk is fermented by these lactic acid bacteria together with numerous other bacteria that exhibit symbiotic metabolic activity (such as *L. brevis, L. casei, L. fermentum, L. helveticus, L. acidophilus, L. caucasicus, L. acidophilus, Lactococcus lactis* ssp*. cremoris, Enterococcus durans, L. citrovorum, L. diacetylactis, Leuconostoc mesenteroides* subsp*. dextranicum, Acetobacter aceti, Acetobacter rasens*) and yeasts (*Kluyveromyces marxianus subsp. marxianus*, *Torulaspora delbrueckii, Saccharomyces cerevisiae)* (Witthuhn et al. 2005), this activity produces lactic acid, CO_2 and a small amount of ethanol and aromatic substances (acetaldehyde, acetone and diacetyl). These components give kefir its distinctive sensory characteristics (Arslan 2015; Güzel-Seydim et al. 2000). The type and relative ratios of the microorganisms in the grain varies, along with their geographic, the characteristics of the milk used to make kefir, the incubation period, and the storage duration and temperature (Yaygın 1995).

This experimental study was conducted in order to promote kefir consumption and increase product variety by investigating changes in the sensory and chemical characteristics and the effects on microflora during the incubation and storage periods, where strawberry, apricot and banana fruit pulp was added to the kefir during the fermentation stage.

MATERIALS and METHODS

Making Fruit Kefir

Kefir grains obtained from the Nutritional Hygiene Department of Kafkas University's Veterinary Faculty were inoculated at a ratio of 2% into milk obtained from the Kafkas University Veterinary Faculty Farm, where the milk had dry content of 12.4%, fat content of 3%, was pasteurized for 5 minutes at 90° C and then cooled to 25° C. After inoculation, the milk was separated into four groups in order to make banana, strawberry, apricot and plain varieties. After the aforementioned fruit purées were added to each of the groups *(First the peels, stems and leaves were separated from the fruit, and then they were puréed and pasteurized at 65°C)* at a ratio of 20%, the combination was mixed with a sterile plastic spoon and then fermented at a temperature of 25°C for approximately 21 hours until the pH level reached. After incubation, the kefir was stored at 4 °C for analysis (Aksu and Nas 1996).

Analytical Methods

Chemical and microbiological analysis of the fruit kefir was conducted at 0, 3, 6, 9, 12, 15, 18 and 21 hours into the incubation period and on days 1, 2, 3, 4, 5, 6, 7 and 8 of storage. Sensory analyses were performed on the day after the production of fruit kefir was complete. All of the analyses were done twice. Titratable acidity (LA) and pH measurements were performed using a pH-meter (Hanna HI 8521) (Meyer et al. 2007). *Lactobacillus* spp. counts were determined using MRS agar (Oxoid CM 361) (Anon 1983), while the *Lactococcus* spp. counts were made using M17 agar (Oxoid CM785) (Dave and Shah 1996; Elmer and James 2001). Yeast counts were determined using Potato Dextrose Agar (Oxoid CM 139) in accordance with the recommendations of Elmer and James (2001). For sensory analysis, the fruit kefirs were evaluated on the day after production by 5 panelists using a 9-point hedonic scale (1: worst, 9: extraordinary) in terms of appearance, viscosity, smell, flavor (Clark et al. 2008; Metin 2006). All of the data obtained from chemical, microbiological and sensory analyses were analyzed using ANOVA procedures using SPSS (Statistical Software 10.0 for Windows, SPSS). Significant differences between parameters were calculated using the Tukey comparison test at $p< 0.05$ (Pripp 2013).

RESULTS and DISCUSSION

In this evaluation of kefir made using different kinds of fruits, it was determined that levels of pH, acidity, *Lactobacillus* spp., *Lactococcus* spp. and yeast grew at very different rates during the incubation and storage stages and that these differences were statistically significant ($p<0.05$). These differences were found both between the kinds of fruit and between the various time points of the analysis.

Chemical analysis of the kefir showed that apricot kefir had the lowest initial pH value (6.10) of all the varieties. This situation continued until the end of the incubation period, but at the end of the storage period plain kefir had the highest pH value (5.20), followed by apricot kefir (5.00). At the end of the storage period, strawberry kefir had the lowest pH level (4.80). Dinç (2008) conducted a study that determined that the pH level of plain kefir (4.26) was higher than that of fruit kefir (4.13). Similarly, a study of the microbiological and chemical qualities of kefir sold in Ankara, Turkey found the pH level of plain kefir to be 4.73 while fruit kefirs had an average of 4.65 (Uslu 2010). A study by Yılmaz et al. (2006) found that kefir's pH value was 5.23, a study by Güzel-Seydim et al. (2005) found it to be 4.55, and a study by Öner et al. (2010) found the ratio to be 6.32. Garrote et al. (2001), however, found the pH levels of kefir samples to be much lower (3.5- 4.0).

At the beginning of the incubation, banana kefir had the lowest acidity value at 0.14% LA, while strawberry kefir was found to have the highest at 0.21 ($p=0.00$). Throughout the incubation period, the acidity of the fruit kefirs continually increased and at the end of the incubation period, plain kefir was found to have the lowest acidity (0.42). The situation did not change at the end of the storage period, where plain kefir was also found to have the lowest acidity ($p=0.00$). The fruit kefirs were observed to have a rapid and continual increase in acidity during the incubation period and throughout the storage period, depending on the kind of fruit. Dinç (2008) investigated kefir sold on the market and found that the acidity of plain kefir (0.78% LA) was lower than that of fruit kefir (0.82% LA), as was the case in our study.

Table 1. Average values for the chemical and microbiological parameters of samples during the incubation period (log_{10} cfu/ml ± Std deviation)

	Sample	Incubation periods (Hours)								
		0. hour	3. hours	6. hours	9. hours	12. hours	15. hours	18. hours	21. hours	
pH	Plain	6.500±0.14^{Ba}	6.380±0.10^{Aab}	6.200±0.11^{Aabc}	6.000±0.07^{Acd}	6.100±0.07^{Acd}	6.000±0.06^{Acd}	5.760±0.04^{Ad}	6.000±0.07^{Ae}	P=0.00
	Strawberry	6.400±0.10^{ABa}	6.280±0.10^{Aa}	5.900±0.07^{Bb}	5.800±0.07^{Ab}	5.900±0.03^{Bb}	5.400±0.06^{Ccd}	5.500±0.03^{Bc}	5.800±0.07^{Ade}	P=0.00
	Banana	6.500±0.13^{Ba}	6.000±0.23^{Ab}	5.900±0.07^{Bb}	6.000±0.07^{Ab}	5.900±0.03^{Bb}	5.800±0.03^{Bbc}	5.600±0.09^{ABc}	6.000±0.07^{Ad}	P=0.00
	Apricot	6.100±0.07^{Ab}	6.400±0.14^{Aa}	5.900±0.03^{Bcd}	5.800±0.07^{Ad}	6.000±0.03^{ABbc}	5.400±0.03^{Ce}	5.200±0.06^{Cf}	5.800±0.07^{Agh}	P=0.00
		P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	
Acidity (LA)	Plain	0.170±0.00^{Bg}	0.170±0.00^{Cg}	0.220±0.00^{Cf}	0.260±0.00^{Ce}	0.300±0.00^{Cd}	0.330±0.00^{Cc}	0.380±0.00^{Db}	0.420±0.00^{Da}	P=0.00
	Strawberry	0.210±0.00^{Ae}	0.210±0.00^{Be}	0.260±0.00^{Bd}	0.294±0.00^{Bc}	0.294±0.00^{Cc}	0.450±0.00^{Bb}	0.430±0.01^{Cb}	0.510±0.00^{Ca}	P=0.00
	Banana	0.140±0.00^{Cf}	0.260±0.00^{Ae}	0.270±0.00^{ABe}	0.294±0.00^{Bd}	0.410±0.00^{Ac}	0.440±0.00^{Bb}	0.460±0.00^{Bb}	0.650±0.00^{Ba}	P=0.00
	Apricot	0.200±0.01^{Ag}	0.220±0.00^{Bg}	0.280±0.00^{Af}	0.330±0.00^{Ae}	0.354±0.03^{Be}	0.530±0.00^{Ad}	0.650±0.00^{Ac}	0.730±0.00^{Aab}	P=0.00
		P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	
***Lactobacillus* spp.**	Plain	4.372±0.15^{Acd}	4.041±0.31^{Bd}	4.146±0.03^{Bd}	4.899±0.07^{BCc}	5.463±0.13^{Db}	5.621±0.02^{Db}	6.857±0.03^{Ba}	6.903±0.03^{Ba}	P=0.00
	Strawberry	4.316±0.09^{Abc}	4.996±0.03^{Aa}	4.115±0.31^{Bc}	4.724±0.18^{Cbc}	6.447±0.03^{Ca}	6.845±0.07^{Ca}	6.972±0.03^{Ba}	7.000±0.10^{Ba}	P=0.00
	Banana	3.593±0.11^{Be}	3.778±0.03^{Be}	4.301±0.03^{Be}	5.358±0.28^{Bd}	7.256±0.12^{Ac}	7.172±0.00^{Bc}	7.491±0.03^{Abc}	7.892±0.03^{Aab}	P=0.00
	Apricot	4.643±0.15^{Ae}	4.903±0.03^{Ae}	5.918±0.31^{Ad}	6.716±0.09^{Ac}	6.792±0.12^{Bc}	7.475±0.00^{Aab}	7.602±0.06^{Aab}	7.982±0.06^{Aa}	P=0.00
		P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	
***Lactococcus* spp**	Plain	4.114±0.03^{Cg}	3.833±0.03^{Ch}	4.556±0.03^{Df}	5.000±0.11^{De}	5.833±0.03^{Bd}	6.146±0.03^{Cc}	7.591±0.03^{Cb}	7.342±0.03^{Da}	P=0.00
	Strawberry	5.447±0.03^{Ae}	5.146±0.03^{Ag}	5.114±0.03^{Cg}	5.255±0.07^{Cf}	5.556±0.03^{Cd}	7.556±0.03^{Ab}	7.255±0.03^{Dc}	8.342±0.03^{Ba}	P=0.00
	Banana	4.732±0.03^{Bg}	4.301±0.03^{Bh}	5.740±0.03^{Bf}	6.477±0.07^{Be}	6.919±0.00^{Ad}	7.204±0.03^{Bc}	9.301±0.07^{Aa}	9.079±0.00^{Ab}	P=0.00
	Apricot	5.477±0.03^{Af}	5.204±0.03^{Ag}	6.000±0.07^{Ae}	7.813±0.07^{Ab}	7.000±0.10^{Ad}	7.255±0.03^{Bc}	9.041±0.00^{Ba}	7.699±0.07^{Cb}	P=0.00
		P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	
Yeast	Plain	2.447±0.00^{Da}	3.000±0.12^{Cb}	3.342±0.00^{BCe}	3.477±0.00^{De}	3.643±0.00^{Dd}	5.602±0.06^{Aa}	4.000±0.07^{Cc}	4.699±0.07^{Bb}	P=0.00
	Strawberry	2.623±0.00^{Cg}	2.914±0.00^{Cf}	3.914±0.00^{Ae}	4.146±0.03^{Ac}	4.204±0.03^{Ac}	5.556±0.03^{Aa}	4.903±0.00^{Ab}	4.041±0.00^{Cd}	P=0.00
	Banana	3.301±0.00^{Ad}	3.778±0.00^{Ac}	3.200±0.15^{Cd}	3.845±0.03^{Cbc}	3.933±0.00^{Cbc}	4.301±0.03^{Ba}	4.301±0.07^{Ba}	4.000±0.07^{Cb}	P=0.00
	Apricot	3.204±0.00^{Be}	3.415±0.00^{Bd}	3.447±0.01^{Bd}	4.000±0.06^{Bc}	4.079±0.00^{Bc}	5.699±0.07^{Aa}	4.000±0.07^{Cc}	5.000±0.07^{Ab}	P=0.00
		P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	

Capital letters (A, B, C,…) indicate statistical difference between groups in the same column, while miniscule letters (a, b, c,...) indicate the statistical difference between groups on the same line.

Table 2. Average values for the chemical and microbiological parameters of samples during the storage period (log_{10} cfu/ml ± Std deviation)

Sample		Storage periods (Days)								
		1. day	2. days	3. days	4. days	5. days	6. days	7. days	14. days	
pH	Plain	5.200±0.03^{Aab}	4.900±0.06$^{A c}$	5.400±0.06^{Aa}	5.000±0.03^{Abc}	5.200±0.03^{Aab}	5.300±0.03^{Aa}	5.300±0.03^{Aa}	5.200±0.03^{Aab}	P=0.00
	Strawberry	4.600±0.03^{ABe}	4.300±0.03^{Df}	5.200±0.03^{Ba}	4.700±0.03^{Cde}	4.800±0.03^{Ccd}	5.000±0.03^{Cb}	4.900±0.03^{Dbc}	4.800±0.03^{Dcd}	P=0.00
	Banana	4.900±0.03^{Aabc}	4.700±0.03^{Bc}	4.800±0.03^{Cbc}	4.700±0.03^{Cc}	4.900±0.03^{Babc}	5.000±0.03^{Cab}	5.000±0.03^{Cab}	4.900±0.03^{Cabc}	P=0.00
	Apricot	4.860±0.04^{Bcd}	4.500±0.03^{Ce}	4.800±0.03^{Cd}	4.800±0.03^{Bd}	4.900±0.03^{Bcd}	5.100±0.03^{Bab}	5.100±0.03^{Bab}	5.000±0.03^{Bbc}	P=0.00
		P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	
Acidity (LA)	Plain	0.470±0.00^{Cb}	0.540±0.01^{Cb}	0.550±0.00^{Da}	0.560±0.01^{Ca}	0.570±0.00^{Ca}	0.560±0.00^{Ba}	0.570±0.00^{Ca}	0.560±0.00^{Ca}	P=0.00
	Strawberry	0.570±0.00^{Be}	0.680±0.00^{Bc}	0.740±0.00^{Ca}	0.710±0.00^{Ab}	0.650±0.00^{Bd}	0.680±0.00^{Ac}	0.690±0.00^{Abc}	0.680±0.00^{Ac}	P=0.00
	Banana	0.750±0.00^{Ab}	0.840±0.00^{Aa}	0.850±0.00^{Aa}	0.680±0.01^{Bc}	0.690±0.00^{Ac}	0.700±0.01^{Ac}	0.640±0.00^{Bd}	0.630±0.00^{Bd}	P=0.00
	Apricot	0.740±0.00^{Ab}	0.690±0.01^{Bd}	0.790±0.00^{Bg}	0.700±0.00^{ABcd}	0.640±0.00^{Be}	0.690±0.00^{Ad}	0.710±0.00^{Acd}	0.700±0.00^{Acd}	P=0.00
		P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	
***Lactobacillus* spp**	Plain	7.806±0.04^{Aab}	8.340±0.03^{Aa}	7.477±0.31^{Aab}	7.875±0.03^{Aab}	7.881±0.31^{Aab}	7.982±0.03^{Aab}	8.000±0.18^{Aab}	8.000±0.33^{Aab}	P=0.00
	Strawberry	7.079±0.31^{Bc}	8.544±0.31^{Aa}	7.699±0.31^{Ab}	7.826±0.03^{Ab}	8.000±0.10^{Aab}	8.000±0.35^{Aab}	8.114±0.31^{Aab}	8.079±0.00^{Aab}	P=0.00
	Banana	6.980±0.12^{Bc}	8.477±0.03^{Aa}	7.857±0.03^{Ab}	7.468±0.32^{Abc}	7.982±0.31^{Aab}	7.940±0.31^{Aab}	8.079±0.18^{Aab}	8.041±0.31^{Aab}	P=0.00
	Apricot	7.902±0.03^{Aa}	7.079±0.31^{Bbc}	7.934±0.02^{Aa}	7.978±0.31^{Aa}	8.000±0.33^{Aa}	8.07±0.31^{Aa}	8.146±0.31^{Aa}	8.114±0.03^{Aa}	P=0.00
		P=0.02	P=0.01	P=0.510	P=0.438	P=0.989	P=0.988	P=0.981	P=0.986	
***Lactococcus* spp**	Plain	9.079±0.00^{Ca}	7.903±0.00^{Cc}	8.000±0.10^{Dc}	8.857±0.03^{Cb}	9.079±0.00^{Aa}	8.903±0.00^{Bb}	6.690±0.03^{Dd}	6.681±0.03^{Dd}	P=0.00
	Strawberry	8.415±0.03^{Ae}	8.806±0.03^{Ac}	9.114±0.03^{Ab}	9.580±0.03^{Aa}	7.813±0.03^{Cf}	8.643±0.00^{Cd}	7.580±0.03^{Bg}	7.568±0.03^{Bg}	P=0.00
	Banana	8.477±0.03^{Ab}	8.806±0.03^{Aa}	8.301±0.03^{Cc}	8.380±0.03^{Dbc}	8.778±0.03^{Ba}	8.477±0.00^{Db}	7.322±0.03^{Cd}	7.301±0.03^{Cd}	P=0.00
	Apricot	8.748±0.07^{Bde}	8.531±0.03^{Bf}	8.875±0.03^{Bcd}	9.301±0.07^{Ba}	8.301±0.03^{Cg}	8.982±0.00^{Abc}	8.699±0.03^{Ae}	8.690±0.03^{Ae}	P=0.00
		P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	
Yeast	Plain	5.778±0.03^{Bb}	6.000±0.07^{Ca}	5.602±0.03^{Ac}	5.954±0.00^{Aa}	4.602±0.03^{Bde}	4.556±0.03^{Bde}	4.544±0.03^{Be}	4.531±0.03^{Be}	P=0.00
	Strawberry	5.301±0.03^{Cd}	6.954±0.00^{Aa}	5.531±0.03^{Ab}	5.380±0.03^{Bc}	4.477±0.03^{Cf}	4.663±0.03^{Ae}	4.653±0.03^{Ae}	4.643±0.03^{Ae}	P=0.00
	Banana	4.991±0.00^{Dd}	6.000±0.11^{Ca}	5.000±0.11^{Bc}	5.301±0.03^{Bb}	4.748±0.03^{Ad}	4.556±0.03^{Be}	4.544±0.03^{Be}	4.531±0.03^{Be}	P=0.00
	Apricot	6.204±0.03^{Aa}	6.301±0.03^{Ba}	5.079±0.00^{Bb}	3.602±0.03^{Cc}	3.146±0.03^{Dde}	3.079±0.00^{Ce}	3.079±0.00^{Ce}	3.041±0.00^{Ace}	P=0.00
		P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	

Capital letters (A, B, C,…) indicate statistical difference between groups in the same column, while miniscule letters (a, b, c,..) indicate the statistical difference between groups on the same line.

Table 3. Total points awarded by the panelists for the characteristics samples

SCORING	PLAIN				STRAWBERRY			
	Appearance %	Viscosity %	Smell %	Flavor %	Appearance %	Viscosity %	Smell %	Flavor %
Extraordinary (9)	20 (3)		13.33 (2)	66.66 (10)		20 (3)		40 (6)
Very good (8)	13.33 (2)	66.66 (10)	20 (3)	6.66 (1)	6.66 (1)			6.66 (1)
Good (7)	33.33 (5)	13.33 (2)	40 (6)	6.66 (1)	40 (6)	20 (3)	6.66 (1)	20 (3)
Some good (6)	13.33 (2)	20 (3)	6.66 (1)	20 (3)	20 (3)	26.66 (4)	26.66 (4)	33.33 (5)
Undecided (5)	6.66 (1)				20 (3)	20 (3)	33.33 (5)	
A little bad (4)	6.66 (1)		13.33 (2)		6.66 (1)		6.66 (1)	
Bad (3)	6.66 (1)	6.66 (1)				6.66 (1)	6.66 (1)	
Very bad (2)						6.66 (1)	6.66 (1)	
Worst (1)							13.33 (2)	
Point	**102**	**116**	**98**	**123**	**87**	**92**	**67**	**113**

SCORING	BANANA				APRICOT			
	Appearance %	Viscosity %	Smell %	Flavor %	Appearance %	Viscosity %	Smell %	Flavor %
Extraordinary (9)	33.33 (5)	20 (3)	55.33 (8)	33.33 (5)		6.66 (1)	6.66 (1)	26.66 (4)
Very good (8)	46.66 (7)	26.66 (4)	13.33 (2)	13.33 (2)	13.33 (2)		33.33 (5)	6.66 (1)
Good (7)	6.66 (1)	33.33 (5)	26.66 (4)	6.66 (1)	13.33 (2)	40 (6)	26.66 (4)	6.66 (1)
Some good (6)	13.33 (2)	20 (3)		13.33 (2)	26.66 (4)	40 (6)	6.66 (1)	40 (6)
Undecided (5)				33.33 (5)	20 (3)	6.66 (1)	6.66 (1)	6.66 (1)
A little bad (4)			6.66 (1)		6.66 (1)			13.33 (2)
Bad (3)					13.33 (2)	6.66 (1)	6.66 (1)	
Very bad (2)							13.33 (2)	
Worst (1)								
Point	**120**	**112**	**120**	**105**	**79**	**65**	**95**	**100**

Another study found that the acidity of plain kefir was an average of 0.82% LA while that of fruit kefirs was 0.90% LA (Uslu 2010). In a study conducted on kefir varieties made from different animal species, Öner et al. (2010) reported that the acidity of kefir made from cow milk was 9.15 SH.

In that study, banana kefir was found to have the lowest count of *Lactobacillus* spp. 3.59 $\log_{10}$ cfu/ml; beginning of the incubation but 8.11 $\log_{10}$ cfu/ml; end of the storage. Plain kefir was reported to have the lowest *Lactobacillus* spp. count at the end of the storage period. In the microbiological analysis of kefirs, plain kefir had the lowest *Lactococcus* spp. count at the beginning and end of the study. *Lactococcus* spp. counts changed constantly in the fruit kefirs throughout the storage period, where apricot kefirs had the highest value at the beginning of the incubation (5.47 $\log_{10}$ cfu/ml) and end of the storage period (8.69 $\log_{10}$ cfu/ml). Among other studies, Dinç (2008) found quite the opposite situation; with *Lactobacillus* spp. counts reported as being higher (8.80 $\log_{10}$ cfu/ml) and fruit kefirs being lower (8.32 $\log_{10}$ cfu/ml). Uslu (2010) reported a bacteria count of 6.36 $\log_{10}$ cfu/ml in plain kefir and 6.50 $\log_{10}$ cfu/ml in fruit kefir. Öner et al. (2010) reported a *Lactobacillus* spp. count of 8.50 $\log_{10}$ cfu/ml at the end of the storage period, Çetinkaya and Elal-Mus (2012) reported a count of $1.0x10^2$-$5.90x10^8$, and Güzel-Seydim et al. (2005) recorded a *Lactobacillus* spp. count of 6.26 $\log_{10}$ cfu/ml. Öner et al. (2010) reported a *Lactococcus* spp. count of 8.23 $\log_{10}$ cfu/ml at the end of the storage period, while Altay et al. (2013) reported a count of 1.0x10-$6.3x10^8$. Yaman et al. (2016) used kefir grains to make kefir from cow and sheep milk and stored it for 7 days at 4 °C. They reported that the *Lactococcus* + *Leuconostoc* spp. counts fell from 9.68 - to 7.25 $\log_{10}$ cfu/ml in kefir made from cow milk, while kefir made from sheep milk dropped from 9.00 - to 8.00 $\log_{10}$ cfu/ml during the same period.

Yeast counts were found to be the lowest in plain kefir at the beginning of the incubation period, but this situation changed at the end of the incubation and storage periods. Banana kefir had the lowest value (4.53 $\log_{10}$ cfu/ml) at the end of the incubation, while at the end of the storage period, apricot kefir's level dropped to below its value at the beginning of the incubation (3.04 $\log_{10}$ cfu/ml). Öner et al. (2010) reported a yeast count of 5.34 $\log_{10}$ cfu/ml at the end of the storage period, while Çetinkaya and Elal-Mus (2012) reported a count of $<1.0x10^2$-$1.10x10^6$. Uslu (2010) reported an average yeast count of 6.70 cfu/ml in plain kefir and 6.44 $\log_{10}$ cfu/ml in fruit kefir. The study conducted by Dinç (2008) reported an average yeast count of 4.05 $\log_{10}$ cfu/ml in plain kefir and 3.23 $\log_{10}$ cfu/ml in fruit kefirs. Similarly, our study also found that yeast counts in the samples differed depending on the kefir culture as well as the type and amount of fruit that was added.

In the organoleptic analysis conducted on the appearance, consistency, smell and flavor of the samples, banana kefir had the best appearance, consistency and smell (120, 112 and 120 points), while plain kefir had the best flavor (123 points). In the overall evaluation, panelists liked banana kefir the best (457 points), followed by plain, strawberry and apricot kefir (439/359/339 points). The study conducted by Uslu (2010) also reported that panelists liked banana kefir the best, that they liked the flavor of strawberry kefir the least, and that kefir with a thicker consistency were preferred, as was the case in our study. Özer and Atamer (1994) attributed this situation to the fact that environmental acidity drops as the pH level increases, and because the viscosity is affected by the consequent reduction in the denaturation rate. In our study, the kefirs that had the highest pH level (plain and

banana) also received the most points for viscosity and in general the panelists liked them more.

In conclusion, this study showed that the type of fruit has an influence on the population development of the kefir flora, so we concluded that this could consequently affect the product's shelf life. Fruit additions have been shown to improve the sensory properties of kefir. It is thought that kefir can increase in consumption.

The results of analyzing the chemical (acidity and pH) and microbiological (*Lactobacillus* spp., *Lactococcus* spp. and yeast) effects during the incubation and storage of fruit kefirs have been shown in Table 1. Furthermore, the results of evaluations of the sensory analysis conducted on the varieties of fruit kefir have been shown in Table 2. The results of the chemical analysis that was conducted show that at the beginning and end of the incubation period and at the end of the storage period, acidity was 0.17/0.42/0.56% LA in plain kefir, 0.21/0.51/0.68% LA in the strawberry kefir, 0.14/0.65/0.63% LA in the banana kefir and 0.20/0.73/0.70% LA in the apricot kefir. In at these points the pH levels were 6.50/6.00/5.20 for plain kefir, 6.40/5.80/4.80 for strawberry kefir, 6.50/6.00/4.90 for banana kefir and 6.10/5.80/5.00 for apricot kefir.

Microbiological analysis of the microflora levels at the beginning and end of the incubation period and at the end of the storage period revealed that *Lactobacillus* spp. counts were 4.37/6.90/8.00 $\log_{10}$ cfu/ml for plain kefir, 4.31/7.00/8.08 $\log_{10}$ cfu/ml for strawberry kefir, 3.59/7.89/8.04 $\log_{10}$ cfu/ml for banana kefir and 4.64/7.98/8.11 $\log_{10}$ cfu/ml for apricot kefir. *Lactococcus* spp. $\log_{10}$ cfu/ml counts were determined to be 4.11/7.34/6.68 $\log_{10}$ cfu/ml for plain kefir, 5.44/8.34/7.56 $\log_{10}$ cfu/ml for strawberry kefir, 4.73/9.08/7.30 $\log_{10}$ cfu/ml for banana kefir and 5.47/7.69/8.69 $\log_{10}$ cfu/ml for apricot kefir. Yeast counts were determined to be 2.44/4.69/4.53 $\log_{10}$ cfu/ml for plain kefir, 2.62/4.04/4.64 $\log_{10}$ cfu/ml for strawberry kefir, 3.30/4.00/4.53 $\log_{10}$ cfu/ml for banana kefir and 3.20/5.00/3.04 $\log_{10}$ cfu/ml for apricot kefir.

For sensory analysis of the kefirs (Table 3) panelists evaluated the appearance, viscosity, smell and flavor, awarding 102/116/98/123 points to plain kefir, 87/92/67/113 to strawberry kefir, 120/112/120/105 to banana kefir and 79/65/95/100 to apricot kefir. Average values for the chemical and microbiological parameters of the fruit kefir during the incubation and storage periods ($\log_{10}$ cfu/ml ± Std deviation) have also been given in Table 1 and Table 2

REFERENCES

Achaintre D, Buleté A, Cren-Olivé C, Li L, Rinaldi S, Scalbert A (2016). Differential isotope labelling of 38 dietary polyphenols and their quantification in urine by liquid chromatography electrospray ionization tandem mass spectrometry. *Anal Chem*, 88, 2637- 2644.

Aksu MY, Nas S (1996). Manufacturing techniques of concentrated mulberry juice and some of its physicochemical properties. *Gıda*, 21, 83-88.

Altay F, Karbancıoğlu-Güler F, Daşkaya-Dikmen C, Heperkan D (2013). A review on traditional Turkish fermented non-alcoholic beverages: microbiota, fermentation process and quality characteristics. *Int J Food Microbiol,* 167, 44-56.

Anon (1983). Yogurt. Enumeration of Characteristic Microorganisms. IDF Standard E 117. Belgium.

Arslan S (2015). A review: chemical, microbiological and nutritional characteristics of kefir. *Cyta J Food*, 13, 340-345.

Clark S, Costello M, Drake M, Bodyfelt F (2008). "The Sensory Evaluation of Dairy Products," CRC Press and Woodhead Publishing Limited, *Springer*, Newyork, p 43-71.

Çetinkaya F, Elal-Mus T (2012). Determination of microbiological and chemical characteristics of kefir consumed in Bursa. *Ankara Univ Vet J,* 59, 217-221.

Dave RI, Shah NP (1996). Evaluation of media for selective enumeration *of Streptococcus thermophilus, Lactobacillus delbrueckii* ssp. *bulgaricus, Lactobacillus acidophilus* and *bifidobacteria*. *J Dairy Sci,* 79, 1529-1536.

Dinç A (2008). Kefirin mikrobiyolojik ve kimyasal kalitesinin belirlenmesi. Uzmanlık tezi, Ankara Üniversitesi Sağlık bilimleri Enstitüsü, Ankara.

Elmer M, James SL (2001). Applied Dairy Microbiology, Marcel Dekker: *Technology and Industrial Arts*, Newyork, 385-396.

Garrote GL, Abraham AG, Antoni G (2001). Chemical and microbiological characterization of kefir grains. *J Dairy Res,* 68, 639-652.

Güzel-Seydim ZB, Seydim AC, Greene AK, Bodine AB (2000). Determination of organic acids and volatile flavor substances in kefir during fermentation. *J Food Compos Anal,* 13, 35-43.

Güzel-Seydim ZB, Wyffels JT, Seydim AC, Greene AK (2005). Turkish kefir and kefir grains: microbial enumeration and electron microscopic observation. *Int J Dairy Tech,* 58, 25-29.

Karatepe P, Yalçın H, Patır B, Aydın I (2012). Kefir ve kefir mikrobiolojisi. *Electronik Mikrobiyoloji Dergisi*, 10, 1-10.

Metin M (2006). "Süt ve süt ürünlerinin analiz metotları: Fiziksel, Kimyasal ve Duyusal analiz," *Ege Universitesi yayınları,* No: 24, Izmir, p.251-290.

Meyer AL, Elmadfa I, Herbacek, I, Micksche M (2007). Probiotic, as well as conventional yogurt, can enhance the stimulated production of proinflammatory cytokines. *J Hum Nutr Diet*, 20, 590-598.

Motilva MJ, Serra A, Macià A (2013). Analysis of food polyphenols by U-HPLC coupled to mass spectrometry: an overview. *J Chromatog,* 1292, 66-82.

Öner Z, Karahan AG, Çakmakçı ML (2010). Effects of different milk types and starter cultures on kefir. *Gıda,* 35, 177-182.

Özden A (2008). Biyo yoğurt-Pro biyotik Yoğurt (Kefir). AÜ Tıp Fak, Gastroenteroloji Bilim Dalı. Güncel Gastroenteroloji. 12(3):169-181.

Özer HB, Atamer M (1994). Serum proteinlerinin yogurt jelin kıvamına etkisi. *Gıda Derg,* 18, 1-5.

Pripp A (2013). Statistics in Food Science and Nutrition. *Springer*, Newyork, p. 7-23.

Saloff-Coste CJ (1996). Kefir. *Danone World Newsletter*, 11, 5-7.

Uslu G (2010). Ankara'da satışa sunulan kefirlerin mikrobiyolojik, fiziksel, kimyasal ve duyusal özelliklerinin araştırılması. Uzmanlık tezi, Ankara Üniversitesi Fen Bilimleri Enstitüsü Süt Teknolojisi Anabilim Dalı, Ankara.

Witthuhn RC, Schoeman T, Britz TJ (2005). Characterization of the microbial population at different stages of kefir production and kefir grain mass cultivation. *Int Dairy J,* 15, 383-389.

Yaman H, Elmalı M, Kamber U (2016). Observation of lactic acid bacteria and yeast populations during fermentation and cold storage in cow's, ewe's and goat's milk kefirs. *Kafkas Univ Vet Fak Derg,* 16, 113-118.

Yaygın H (1995). "Yoğurt." *III. Süt ve Süt Ürünleri Sempozyumu,* 2-3 Haziran 1994 İstanbul, *Milli Produktivite Merkezi Yayınları*, 145-148, Ankara.

Yılmaz L, Yılsay TO, Beyazıt AA (2006). The sensory characteristics of berry flavored kefir. *Czech J Food Sci,* 24, 26-32.