How to cite: Akpınar, A., C. Söbeli, M. G. Çetin, M. Zeytin & Z. Dilek, 2021. Production of traditional milk jam with improved functional properties via probiotic and prebiotic, Ege Univ. Ziraat Fak. Derg., 58 (3):325-334, https://doi.org/10.20289/zfdergi.772761

Research Article
(Araştırma Makalesi)

Ege Üniv. Ziraat Fak. Derg., 2021, 58 (3):325-334
https://doi.org/10.20289/zfdergi.772761

Production of traditional milk jam with improved functional properties via probiotic and prebiotic

Probiyotik ve prebiyotiklerle fonksiyonel özellikleri geliştirilmiş geleneksel süt reçeli üretimi

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Received (Alınış): **22.07.2020** **Accepted (**Kabul Tarihi): **03.12.2020**

ABSTRACT

Objective: In this study, 3% *Lactobacillus rhamnosus* and *Bifidobacterium animalis* subsp *lactis* BB-12 as probiotics and 8% hazelnut paste and banana pulp as prebiotics were added to milk jam samples to produce functional milk jam. Physical, chemical, sensorial and microbiological properties of milk jam samples were discussed during 30 days of storage.

Materials and Methods: The milk jam samples were stored at +4 °C for 30 days. Physicochemical (proximate analysis, acidity, hydroxymethylfurfural (HMF), total sugar, viscosity), sensorial and microbiological analysis (*Lactobacillus rhamnosus* and *Bifidobacterium animalis* subsp *lactis* BB-12 counts) of milk jam samples were carried out on 1st, 15th and 30th days of storage.

Results: During storage, acidity, HMF, total sugar and *L. rhamnosus* and *B. lactis* BB-12 of samples were found to be 0,2-0,22%, 18,46-21,56 mg/L, 28,18 g/100 mL, 7,44-7,54 (log CFU/g) and 5,4-6,65 (log CFU/g) for control samples; 0,16-0,2%, 18,41-25,5 mg/L, 26,61 g/100mL, 7,44-7,58 (log CFU/g) and 5,6-6,54 (log CFU/g) for hazelnut paste added samples and 0,15-0,2 %, 13,6-28,65 mg/L, 24,47 g/100 mL, 7,3-7,67 (log CFU/g) and 5-6,3 (log CFU/g) for banana pulp added samples, respectively. Hazelnut paste added probiotic milk jam samples had the highest overall acceptability score (6,01) given by panellists.

Conclusion: It has been determined that probiotic microorganisms in milk jam which has high sugar content maintain probiotic effect level during 30 days storage, hazelnut added as prebiotic source contributes to viability of probiotics and ensures that products are approved and consumed.

Keywords: Milk jam, probiotic, prebiotic, hazelnut paste, banana pulp

ÖZ

Amaç: Bu çalışmada, süt reçeline fonksiyonel özellik kazandırmak amacıyla probiyotik olarak %3 *Lactobacillus rhamnosus* ve *Bifidobacterium animalis* subsp. *lactis* BB-12; prebiyotik olarak %8 oranında fındık ezmesi ve muz püresi eklenmiştir. 30 günlük depolama boyunca, süt reçeli örneklerinin fiziksel, kimyasal, duyusal ve mikrobiyolojik özellikleri incelenmiştir.

Materyal ve Yöntem: Üretilen süt reçelleri 30 gün boyunca +4°C'de depolanmıştır. Depolamanın 1., 15. ve 30. günlerinde süt reçeli örneklerinde fizikokimyasal (genel bileşim analizleri, asitlik, hidroksimetilfurfural (HMF), toplam şeker, viskozite), duyusal ve mikrobiyolojik (*Lactobacillus rhamnosus* ve *Bifidobacterium animalis* subsp. *lactis* BB-12 sayımları*)* analizler gerçekleştirilmiştir.

Araştırma Bulguları: Depolama boyunca örneklerin asitlik, HMF, toplam şeker ve *Lactobacillus rhamnosus* ve *Bifidobacterium animalis* subsp. *lactis* BB-12 sonuçları sırasıyla kontrol örnekleri için 0,2-0,22, 18,46-21,56 mg/L, 28,18 g/100 mL, 7,44-7,54 (log kob/g) and 5,4-6,65 (log kob/g); fındık ezmesi eklenmiş gruplar için %0,16-0,2, 18,41-25,5 mg/L, 26,61 g/100 mL, 7,44-7,58 (log kob/g) and 5,6-6,54 (log kob/g); muz püresi eklenmiş örnekler için %0,15-0,2, 13,6-28,65 mg/L, 24,47 g/100 mL, 7,3-7,67 (log kob/g) and 5-6,3 (log kob/g) olarak bulunmuştur. Fındık ezmesi eklenmiş probiyotik süt reçeli örnekleri panelistlerden en yüksek genel beğeni puanını (6,01) almıştır.

Sonuç: Yüksek şeker içeriğine sahip olan süt reçeli örneklerinde probiyotik mikroorganizmaların 30 günlük depolama boyunca probiyotik etki seviyelerini koruduğu, prebiyotik kaynağı olarak fındık ezmesi eklenmiş süt reçeli örneklerinin probiyotiklerin canlılığına katkı sağladığı ve ürünlerin kabul edilebilirliğini ve tüketilebilirliğini arttırdığı tespit edilmiştir.

Anahtar sözcükler: Süt reçeli, probiyotik, prebiyotik, fındık ezmesi, muz püresi

INTRODUCTION

Consumers' interest in healthy foods and adoption of healthy lifestyle increases the interest in functional foods (Shori, Baba and Muniandy, 2019). Functional foods are defined as foods that possess health benefits or prevent diseases and promote a better life quality through their natural nutritional properties or by addition of functional ingredients to them (Guimarães et al., 2019; Santeramo et al., 2018). Especially production and consumption of probiotic and/or prebiotic added foods is growing rapidly as functional foods (Shori, 2015). Probiotics are the live microorganisms that confer a health benefit on the host when present in sufficient amounts (Salminen, Kneifel and Ouwehand, 2015; Tripathi and Giri, 2014) and prebiotics are the undigestible food ingredients that are selectively utilized by host microorganisms conferring a health benefit (Guimarães et al., 2019; Pop et al., 2019). Apart from these, a combination of probiotics and prebiotics called symbiotic has been found to show promising effects in the prevention of diseases (Ashwini et al., 2019).

Dairy products are the most consumed functional foods due to their natural probiotic characteristics such as yogurt, cheese and kefir (Shori, 2015). Beyond their natural properties, dairy products are also enriched with prebiotics or probiotics in order to enhance their nutritional quality. Especially, lactic acid bacteria (LAB) such as *Lactobacillus* spp. and *Bifidobacterium* spp. play an important role in functionalising of dairy products (Ashwini et al., 2019; Ayhan and Karagözlü, 2019; Sağdıç et al., 2004; Shori, 2015). Various fruits and vegetables such as apple, kiwi, banana, onion and garlic, legumes, nuts and seeds such as almonds, coconut, peanut, sesame seeds are known as natural prebiotics that are used in functional dairy products (Ashwini et al., 2019; Pop et al., 2019).

Milk jam, also named as "dulce de leche" in Argentina and Uruguay, "arequipe" in Colombia, "manjar blanco" in Peru and "doce de leite" in Brazil, is a concentrated dairy product and especially consumed in Argentina and Brazil (da Silva et al., 2015; Gaze et al., 2015; Oliveira et al., 2009). It may be consumed pure as a dessert or with crackers, breads, in ice creams and as cake filling (Ramírez-Sucre and Vélez-Ruiz, 2011; Silva et al., 2015; Zarpelon et al., 2016). In order to produce milk jam, milk is concentrated by boiling at atmosphere pressure to total solids of 68% (minimum) and approximately 20% sucrose (glucose or saccharose) is added during evaporation (Barbosa et al., 2013; Giménez et al., 2008; Zarpelon et al., 2016). The product is usually creamy to browny in colour, homogenous, fluid and has a characteristic taste(da Silva et al., 2015).

In this study, it was aimed to enhance functional properties of milk jam with the addition of *Lactobacillus rhamnosus* and *Bifidobacterium animalis* subsp. *lactis* BB12 as probiotics and hazelnut paste and banana pulp as prebiotics; and to produce an innovative dairy product for consumers.

MATERIALS and METHODS

Production of milk jam samples

In this study, milk jam was produced following the procedure shown in Figure 1.

For milk jam production, milk, 20% sugar and 0.4% sodium bicarbonate were mixed and caramelized to 50 Bx°. After evaporation process at 90 °C, milk jam was cooled to 50 °C and filled to glass jars. Then milk jam was pasteurized at 85 °C for 20 min and cooled to 40 °C. Probiotic cultures (Christian-Hansen, Denmark) to be used in fermentation were added to 100 mL sterile milk according to ratio indicated in user's manual and inoculated cultures were fermented at 37 °C until pH 4.6 was reached. After pasteurization process, 3% of both cultures were added separately to milk jams that were cooled to 40 °C and mixed well.

Sugar-free hazelnut paste (Cerrino Organik, Turkey) and banana pulp (Milupa-Danone, France) were purchased from a local market. Prebiotics were also added to milk jams after pasteurization like probiotics. Three sample groups were prepared as follows: control group (C) with only 3% probiotic microorganisms, *L. rhamnosus* and *B. lactis* BB-12 and the other two sample groups *with 8%* hazelnut paste (H) and 8% banana pulp (B) added samples as prebiotics with 3 % *L. rhamnosus and B. lactis* BB-12*.* After fermentation at 37 °C for 12 hours, all sample groups were stored at +4 °C for 30 days. Physicochemical, textural, sensorial and microbiological analyses were carried out on the 1st, 15th and 30th days of storage.

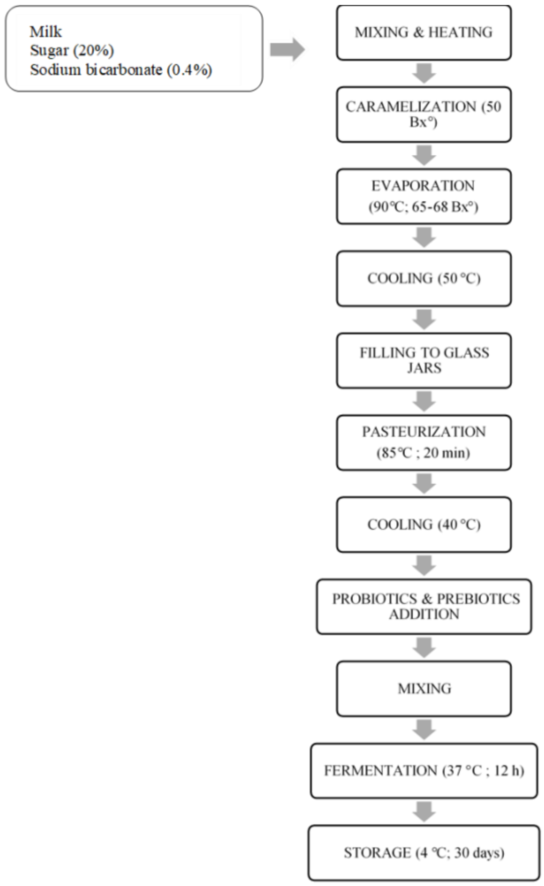

Figure 1. Milk jam production procedure

Şekil 1. *Süt reçeli üretimi akış şeması*

Methods

Physicochemical analysis

The proximate analysis (total dry matter, total protein and total fat) were carried out by using AOAC (2000) methods. The pH measurements were performed with a pH meter (Hanna HI83141, Hanna Instruments, Italia) by immersing the probe in the samples. Total and invert sugar and saccharose content of samples were determined by Lane Eynon volumetric method (Lane and Eynon, 1923). 5-(hydroxymethyl)-2-furaldehyde (HMF) content was determined by a spectrophotometric method (Porretta et al., 1991; Zappala et al., 2005). Briefly, 20 g sample was weighed in a beaker and transferred to a 100 mL glass flask with freshly boiled distilled water. It was filtered after shaking and mixed well. From the sample prepared by diluting in this way, 2 ml of each pipette was transferred to 2 test tubes with glass cap. 5 mL of p-toluidine solution was added to both tubes and the tubes were shaken well. 1 mL distilled water was added to the first tube to be used as blank from the tubes, and 1 mL barbituric acid solution was added to the second tube, which was the test tube. Glass caps of the tubes were placed and mixed by reversing many times. The absorbance of the second tube was determined by reading against the blank tube at 550 nm. HMF quantity was calculated as; HMF (mg/L)= 162 (A).

Viscosity of milk jam samples were evaluated by using a Brookfield Rheometer (Model DV-I, Brookfield Engineering Laboratories Inc., Middleboro, MA, USA) equipped with a LV4 spindle. The tests were performed at 5 rpm speed rate and 15 °C. Viscosity of samples expressed as mPa.s. All the analyses were carried out in triplicate.

Sensorial analysis

The appearance, colour, odour, consistency, taste/aroma, sugar rate and overall acceptability of milk jam samples were evaluated by 10 untrained panellists using a 7-point hedonic scale (1=extremely dislike, 7=extremely like) on the 1st, 15th and 30th days of storage. The samples were served in disposable cups at room temperature coded with 3 digit numbers. A glass of water was given to panellists in order to clear the palate between samples (Altuğ and Elmacı, 2005).

Microbiological analysis

During storage, milk jam samples were aseptically sampled from 30 mL glass jars stored for microbiological analysis. The samples (10 g) were placed in a sterile stomacher bag containing 90 mL of sterile Ringer's solution and homogenized for 2 min in a stomacher (BagMixer, Interscience, France). Then, 1 mL homogenate from each sample was serially diluted in 9 mL sterile Ringer's solution and the dilutions were aseptically plated in duplicate on MRS-vancomycin Agar for *Lactobacillus rhamnosus* and TOS-propionate Agar for *Bifidobacterium animalis* subsp. *lactis* BB-12. Plates containing MRS Agar were incubated 37 °C for 72 hours under anaerobic conditions using anaerobic gas jars containing Anaerocoult A gas pack (Merck). At the end of incubation, dark-centered, 1-1.5 mm in diameter and greenish brownish colonies grown on MRS Agar were counted as *Lactobacillus rhamnosus* (Philips et al., 2006). For the growth of *Bifidobacterium animalis* subsp. *lactis* BB-12, plates were incubated at 37 °C for 72 hours under anaerobic conditions using anaerobic gas jars containing Anaerocoult A gas pack (Merck).

Statistical analysis

All the experiments were conducted in two replicates and all analysis carried out in triplicate. The experimental data were presented as means ± standard deviations. The statistical analysis of data was performed by using two-way ANOVA procedures of SPSS (SPSS, v.20.0). Post-hoc comparison of means was performed by the DUNCAN test at the significance level of %5 ($P \leq 0.05$).

RESULTS and DISCUSSION

Physicochemical properties of milk used in the production of milk jam were shown in Table 1.

As seen in Table 1, the composition of the milk was found to be in accordance with the Turkish communique on raw milk except fat content (Anonymous,2019). Fat content of milk was found to be lower than the value stated in the communique.

Table 1. Milk Composition*(n=2)*

Çizelge 1. *Sütün Bileşimi (n=2)*

%	Composition
pH	6,62±0,02
Fat	3,22±0,02
Lactose	4,33±0,00
Protein	3,66±0,08
Total Solid	11,834±0,09
Ash	0,6213±0,01
Lactic acid	0,165±0,00

Physicochemical characteristics of milk jam samples

Chemical compositions of milk jam samples were shown in Table 2.

Total dry matter of milk jam samples were found to be statistically different ($P<0.05$). Banana pulp added milk jam had the highest total dry matter. As seen from the results, addition of hazelnut paste and banana pulp increased the total dry matter of samples. In general, as any solid matter is added, the total dry matter is increased. Similarly, Mahmood et al. (2008) stated that the total dry matter was increased when banana pulp added to yogurt samples. Total fat content of sample groups had no significant difference statistically ($P>0.05$).

Table 2. Gross composition of milk jam samples
***Çizelge 2.** Süt reçeli örneklerinin genel bileşimi*

	Milk Jam Sample		
	C	**H**	**B**
Total Dry Matter (%)	66,45±0,39^{C}	69,79±0,40^{B}	71,46±0,12^{A}
Fat (%)	7±0,00	8±0,00	7,5±0,05
Protein (%)	7,40±0,25^{B}	8,96±0,30^{A}	7,3±0,16^{B}
Lactose(%)	10,16±0,13	10,21±0,04	10,44±0,25
InvertSugar (g/100 mL)	8,68±0,03	8,92±0,06	9,03±0,23
Total Sugar (g/100 mL)	38,35±1,9	34,69±0,42	37,05±0,73
Saccharose (g/100 mL)	28,19±1,77	24,48±0,46	26,61±0,48

C: milk jam samples produced using *Lactobacillus rhamnosus* and *Bifidobacterium animalis* subsp*. lactis* ,**H:** milk jam samples produced using *Lactobacillus rhamnosus* and *Bifidobacterium animalis* subsp*. Lactis* with non-sugar hazelnut paste, **B:** milk jam samples produced using *Lactobacillus rhamnosus and Bifidobacterium animalis* subsp*. lactis* with banana pulp
^{A,B,C} Values with the different letters in the same row differ significantly (*P*<0.05).

However, hazelnut paste added milk jams had the highest fat values due to the high fat content of hazelnuts. Similarly, as the hazelnuts are rich in terms of protein content caused the hazelnut paste added milk jam group to have the highest protein values. Also, the protein content of hazelnut paste added milk jam group was found statistically different than other two group samples (P<0.05). Gaze et al. (2015) found the total dry matter of "Dulce de Leche" samples between 70,33-82,51 % and found the fat and protein contents lower than the results obtained in our study. Total dry matter of milk jam samples in this study were in the range of those found by Ranalli et al. (2012) for traditional Dulce de Leche samples and protein and fat contents of the same samples were higher than the values reported by these authors.

When the sugar contents of the samples were evaluated, the difference between lactose (%), invert sugar, total sugar and sucrose contents was not found statistically significant (P>0.05). Banana pulp added milk jam samples had the highest invert sugar and higher sugar rate values. Saccharose is a disaccharide, which can be broken down into a mixture of two monosaccharides known as glucose and fructose by inversion. Glucose has a lower sweetness than sucrose (Oliviera, 2009). This may be the reason why panellists gave the lowest sugar rate scores to banana pulp added milk jam samples during sensorial evaluation.

Table 3 shows pH, viscosity and HMF values of samples during 30-days storage. pH values of milk jam samples were ranged between 6,13-6,38. In accordance with our study, Gaze et al. (2015) found the pH values of Dulce de Leche samples between 6,14-6,37. Sarı (2020) found that the pH of flavored milk jams, on which they evaporated at different rates, ranged between 6.06-6.39 and Yüksel Önür (2018) found that the pH value varied between 6.09-6.75. Tuna (2018) found that in milk jams produced by adding different dried fruits, the pH value of the control sample was between 7.56-7.82 during storage, milk jams with dried figs were 6.63-6.92, milk jams with dried apricots were 5.85-5.95, and milk jams with dried mulberry were 6.99- It found that it was in the range of 7.11. pH values of samples had shown statistical difference after the 15th day of storage. In general, banana pulp added samples had the lowest pH values. The decrease in pH might be due to the acidity of banana. Similarly, Mahmood et al. (2008) found that banana added yogurts had the highest acidity and the acidity of yogurt samples increased as the banana amount increased.

Viscosity of samples differ significantly between samples and throughout the storage (P<0.05). The most viscous group is banana pulp added milk jam samples following by control and hazelnut paste added samples, respectively. Similar results were obtained for the sensorial consistency evaluation. On the 30th day of storage, panellists gave the highest consistency scores for banana pulp added samples.

Maillard reaction, known as non-enzymatic browning reaction in foods, is based on the interaction of heat and protein and sugar. Maillard reactions are desired for the formation of characteristic color and aroma in milk jams (Akal et al., 2018). HMF (5-hydroxymethylfurfural) is one of the most used markers of the thermal treatment in foods, especially for honey and jam and indicates the intensity of thermal treatment (Francisquini et al., 2018; Akal et al., 2018). The difference between HMF values of samples were not found statistically different during the storage (P>0.05). HMF values were found to be 16,41-20,60 mg/kg. It is known that increased water activity and moisture content increases the HMF value. Banana pulp added samples had the lowest HMF values that are because they had the highest total dry matter content.

Table3. pH, viscosity and HMF values of milk jam samples

***Çizelge 3**. Süt reçeli örneklerinin pH, viskozite ve HMF değerleri*

		Milk Jam Samples		
	Storage Days	**C**	**H**	**B**
pH	1	6,38±0,04	6,32±0,04	6,28±0,01^{a}
	15	6,27±0,02^{A}	6,29±0,02^{A}	6,14±0,00^{bB}
	30	6,25±0,01^{A}	6,28±0,01^{A}	6,13±0,01^{bB}
Viscosity (mPa.s)	1	48332,67±867,3^{aB}	35141,66±317,2^{aC}	70325,55±610,0^{aA}
	15	73759±586,1^{bB}	49812,22±852,2^{bC}	82595,55±737,7^{bA}
	30	67356,66±401,1^{bB}	48706,66±306,6^{bC}	90261,11±274,4^{cA}
HMF (mg/kg)	1	19,33±0,23	20,60±0,16	16,41±1,18
	15	20,13±1,64	19,44±0,44	16,74±1,06
	30	19,60±1,13	19,46±1,18	17,30±1,78

C: milk jam samples produced using *Lactobacillus rhamnosus* and *Bifidobacterium animalis* subsp*. lactis* ,**H:** milk jam samples produced using *Lactobacillus rhamnosus* and *Bifidobacterium animalis* subsp*. Lactis* with non-sugar hazelnut paste, **B:** milk jam samples produced using *Lactobacillus rhamnosus and Bifidobacterium animalis* subsp*. lactis* with banana pulp

^{a,b,c}Values with the different letters in the samecolumn differ significantly (*P*<0.05).

^{A,B,C} Values with the different letters in the same row differ significantly (*P*<0.05).

Microbiological quality

Enumeration of the probiotic bacteria added in milk jam samples were shown in Table 4.

Table 4. Viability of probiotic in milk jam samples

***Çizelge 4.** Süt reçeli örneklerinde probiyotik mikroorganizmaların canlılığı*

		Milk Jam Samples		
	Storage Days	**C**	**H**	**B**
***L.rhamnosus* (Log CFU/mL)**	1	7,54±0,00	7,58±0,06	7,66±0,09
	15	7,63±0,05	7,43±0,09	7,67±0,05
	30	7,44±0,08	7,43±0,11	7,26±0,08
***B.lactis* BB-12 (Log CFU/mL)**	1	6,63±0,15^{a}	6,50±0,20	6,24±0,04^{a}
	15	5,35±0,35^{b}	5,54±0,24	5,00±0,00^{b}
	30	5,90±0,05^{bA}	5,99±0,09^{A}	5,30±0,00^{bB}

C: milk jam samples produced using *Lactobacillus rhamnosus* and *Bifidobacterium animalis* subsp*. lactis* ,**H:** milk jam samples produced using *Lactobacillus rhamnosus* and *Bifidobacterium animalis* subsp*. Lactis* with non-sugar hazelnut paste, **B:** milk jam samples produced using *Lactobacillus rhamnosus and Bifidobacterium animalis* subsp*. lactis* with banana pulp

^{a,b,c} Values with the different letters in the same column differ significantly (*P*<0.05).

^{A,B,C} Values with the different letters in the same row differ significantly (*P*<0.05).

For *L. rhamnosus*, it has been determined that all samples had a microbial count at the level of 10^7 log CFU/g during 30-day storage. On the contrary, *B. lactis* BB-12 counts were above the level of 10^6 log CFU/g on the 1st day. The level of bacteria count decreased approximately by 1 log CFU/g on the 15th day and then slightly increased on the last day of storage. So, it can be concluded that *L. rhamnosus* retained the probiotic level in milk jam samples with high sugar content during the 30-day storage period, but *B.*

lactis BB-12 could not maintain this level despite the addition of a prebiotic source. Arıkan (2016) evaluated the viability of probiotic microorganisms during the 7-day storage period in the probiotic rice puddings. Enumeration of probiotic bacteria was determined as logarithmic (log10) *Lactobacillus acidophilus* values as 7.73-7.54 log10 CFU / g, *Bifidobacterium bifidum* value as 7.78-7.68 log10 CFU / g. As seen in this study, it is a good carrier such as ice cream for probiotic microorganisms in products with high sugar content such as rice pudding or milk jam. Salem et al. (2005) used 5 different probiotic cultures in ice cream production and found that probiotic viability remained at 6 log level and above in ice creams stored at -26°C during 12 weeks of storage. The pH value of the final product as well as the sugar concentration of probiotic ice creams is effective on the viability of probiotic microorganisms (Mohammadi et al., 2011).

Sensorial evaluation

As seen in Table 5, hazelnut paste and probiotic bacteria added milk jam samples had the highest appearance, colour, odour, taste/aroma, sugar rate and overall acceptability scores. Statistically significant differences were found between groups for taste/aroma, sugar rate and overall acceptability scores (P<0.05). Storage temperature plays an important role in determining the shelf life of milk jam. Garitta et al. (2004) revealed that the increase in temperature negatively affects the storage period. They stated that the shelf life of milk jams stored at room temperature (25 ° C) is 109 days, milk jams stored at 37 ° C for 53 days and milk jams stored at 45 °C have a shelf life of 9 days.

Table 5. Sensorial properties of milk jam samples

Çizelge 5. *Süt reçeli örneklerinin duyusal özellikleri*

		Milk Jam Samples		
Sensorial Properties	**Storage Days**	**C**	**H**	**B**
	1	5,50±0,20	5,40±0,00	5,50±0,20
Appearance	15	5,43±0,43	6,25±0,58	5,82±0,04
	30	5,70±0,30	6,13±0,13	5,65±0,45
	1	5,45±0,25	5,15±0,15	5,30±0,10
Colour	15	5,80±0,20	6,00±0,00	5,82±0,04
	30	5,74±0,36	5,86±0,24	5,67±0,54
	1	5,45±0,45	5,70±0,10	5,20±0,20
Odour	15	5,69±0,02	6,16±0,27	5,64±0,08
	30	5,54±0,34	5,35±0,35	5,68±0,43
	1	5,70±0,00	5,65±0,25	5,55±0,05
Consistency	15	5,93±0,07	5,55±0,32	5,62±0,05
	30	5,65±0,65	5,78±0,02	6,10±0,10
	1	6,10±0,50	5,75±0,15	5,15±0,45
Taste/Aroma	15	$6,01±0,1^{A}$	$6,13±0,0^{A}$	$5,22±0,2^{B}$
	30	5,70±0,20	5,90±0,10	5,20±0,20
	1	$5,50±0,3^{A}$	$5,65±0,1^{A}$	$4,55±0,05^{B}$
Sugar Rate	15	$5,75±0,0^{A}$	$5,52±0,1^{A}$	$4,37±0,09^{B}$
	30	4,90±0,10	5,15±0,05	5,35±0,35
	1	$5,70±0,2^{A}$	$5,85±0,05^{bA}$	$4,75±0,15^{aB}$
Overall Acceptability	15	$5,95±0,06^{A}$	$6,06±0,06^{aA}$	$5,02±0,13^{aB}$
	30	$5,38±0,13^{B}$	$5,62±0,02^{c}$	$5,15±0,15^{b}$

C: milk jam samples produced using *Lactobacillus rhamnosus* and *Bifidobacterium animalis* subsp*. lactis* ,**H:** milk jam samples produced using *Lactobacillus rhamnosus* and *Bifidobacterium animalis* subsp*. Lactis* with non-sugar hazelnut paste, **B:** milk jam samples produced using *Lactobacillus rhamnosus and Bifidobacterium animalis* subsp*. lactis* with banana pulp

^{a,b,c} Values with the different letters in the same column differ significantly (*P*<0.05).

^{A,B,C} Values with the different letters in the same row differ significantly (*P*<0.05).

For the appearance score, the dispersion of hazelnut kernels in the sample gained the appreciation of the panellists and gave the highest score to this group. Hazelnut-added milk jams were more appreciated by panellists in terms of appearance, color-odor, taste and aroma. At the same time, the use of sugar-free hazelnut paste in production has resulted in the liking of hazelnut-added milk jams in terms of sugar content.

Tuna (2018) stated that the control sample had a higher score in the milk jams they produced by adding different foods compared to the samples with dried fruit. In this study, the use of dried fruits made the sugar content felt more, and in this case, it is similar to the fact that in our study, the sugar ratio was higher in milk jams with banana.

In the sensory evaluation of milk jams, which are evaporated at different rates and added different flavors, Sarı (2020) found that the product preferred by the panelists in terms of appearance, structure and flavor is the cocoa flavored sample produced by evaporating up to 30% dry matter. The findings are similar to our study because the addition of flavoring to milk jam increases the consumability

CONCLUSIONS

In this study, it was aimed to determine the effects of probiotics (*Lactobacillus rhamnosus* and *Bifidobacterium animalis* subsp*. lactis* BB-12*)* and prebiotics (hazelnut paste and banana pulp) on the physicochemical, sensorial and microbiological quality of milk jam. Hazelnut paste added probiotic milk jam samples had the highest fat and protein values and this group is also the favorite of panelists in sensorial evaluation.

As a result of this study, it was determined that the viability of *Bifidobacterium animalis* subsp *lactis* BB-12 in milk jams containing high levels of sugar remained below the probiotic level after 30 days of storage. However, *L. rhamnosus* maintained its probiotic level at the end of this period. Considering this situation, it has been revealed that the shelf life studies of the product can be carried out with other *Lactobacillus* species that are resistant to high sugar concentrations in further studies. It is thought that milk jams, which have been added functional properties by adding probiotics and prebiotics, both extend their shelf life and make them useful, which will affect their consumption positively.

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