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Probiotic dairy drink for patients with Galactosemia*

Galaktosemi hastaları için probiyotik süt içeceği

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Anahtar sözcükler: Asidofiluslu süt, galaktosemi, kefir, laktoz intolerans

ABSTRACT

Objective: The objective of this study was to develop probiotic dairy products with lactose free and low-galactose contents were produced for patients with galactosemia from four different raw materials including conventional cow's milk, lactose free cow's milk and mixtures containing lactose free cow's milk and three different lactose and galactose free infant formulas.

Material and Methods: Probiotic fermented dairy drinks, specifically acidophilus milk and kefir, with lactose free and low galactose content for patients with galactose intolerance were produced by using a 1:1 mixture of lactose free milk and two different types of infant formula, fortified with strawberry flavor. Storage period was set for 30 days. Said types of products were also produced with lactose free milk and conventional milk as raw material in order to use as control groups. With priority, lactose and galactose contents, and some other chemical, physical, microbiological and sensory properties were examined.

Results: Chemical, physical, microbiological and sensory properties of these products were found to match the common quality characteristics of a commercial fermented dairy product. Also, such properties of fermented dairy drinks produced from lactose free milk have the same quality characteristics of a fermented dairy product.

Conclusion: The galactose contents of fermented dairy beverages produced from lactose free raw materials were reduced to a level suitable for the diets of galactosemic patients.

ÖZ

Amaç: Bu araştırmada, sütün içerisinde bulunan laktozu hidrolize ederek ve galaktozu da tolere edilebilir seviyeye çekerek laktoz intoleransına sahip ve/veya galakotosemi hastası olan kişilerin tüketebileceği, fonksiyonel, fermente süt ürünleri geliştirilmiştir.

Materyal ve Yöntem: Laktozu hidrolize edilmiş UHT inek sütü, galaktoz içermeyen iki farklı biberon maması ile 1:1 oranında karıştırılarak elde edilen hammaddelerden çilek aromalı asidofilus sütü ve kefir üretilmiştir. Aynı ürünler ayrıca sadece laktozu hidrolize edilmiş süt ve standart süt ile de üretilerek dört paralel olarak çalışılmıştır. Ürünler 30 gün depolanmış ve analizlerin özelliğine göre 1., 10., 20. ve 30. günlerinde analizleri yapılmıştır. Ürünlerin amacına uygunluğunu belirlemek amacıyla galaktoz ve laktoz oranları tespit edilmiştir. Bunu yanısıra pH, toplam kurumadde, yağ, protein asitlik, tirozin, asetaldehit ile viskozite ve mikrobiyolojik olarak laktobasil, lactokok ve maya analizler yapılmış, duyusal olarak değerlendirilmiştir.

Araştırma Bulguları: Probiyotik süt içeceklerinin kimyasal, reolojik, mikrobiyolojik ve duyusal özelliklerinin, fonksiyonel, fermente bir süt ürünün taşıması gereken özelliklere sahip olduğu tespit edilmiştir. Yine laktoz içermeyen inek sütünden elde edilen fermente süt ürünlerinde de benzeri olumlu kimyasal, reolojik, mikrobiyolojik ve duyusal özelliklerin elde edildiği tespit edilmiştir.

Sonuç: Laktoz içermeyen süt-mama karışımlarından elde edilen fermente ürünlerdeki galaktoz seviyesinin, galaktosemi hastalarının tolere edebileceği sınır galaktoz altına düştüğü belirlenmiştir.

INTRODUCTION

Galactosemia (CG, OMIM 230400) is an inborn error of galactose metabolism, caused by the deficiency of the enzyme galactose-1-phosphate uridyltransferase (GALT, EC 2.7.7.12), which converts galactose-1-phosphate (Gal-1-P) and uridine diphosphate galactose (UDP)-glucose to UDP-galactose and glucose-1-phosphate. Ingesting of galactose from breast milk or infant formula, newborn infants develop a life-threatening illness with feeding difficulties, liver failure, renal tubular dysfunction, sepsis and cataract. All acute symptoms resolve quickly after the initiation of a lactose-free, and galactose-restricted diet. It is estimated that the incidence is 1/40,000-1/80,000 in live births. (Kerckhove et al., 2015; Atik et al., 2016). In such treatment, foods containing lactose and galactose are eliminated or withdrawn from the daily diet. Prompt evaluation of symptomatic infants or infants with highly suspicious newborn screening results and removal of galactose-containing formulas from their diet are necessary means of treatment. Previous studies report that dietary restriction of dairy products may cause various health disorders, even long-term complications those related to an inadequate intake of calcium in the infancy period (Berry, 2012).

Previous studies have reported the following galactose consumption limit values, which were verified by doctors and dieticians based on many years of experience: babies 50 (-200 mg), infants 150-200 mg, schoolchildren 200-300 mg, youth 250-400 mg, adults 300-500 mg galactose/day Varga et al. (2006). This study aimed to develop fermented dairy products including acidophilus milk and kefir with galactose levels lower than 200 mg/L for galactosemic patients from all ages by using expanded variations of probiotic microorganisms. In addition, we determined whether the chemical and the sensory properties of the samples were acceptable.

MATERIALS and METHODS

Milk samples and fermented dairy production, experimental design:

UHT cow’s milk and lactose hydrolyzed UHT cow’s milk were obtained from Pinar Sut Co. (Izmir, TURKEY). In order to lower the galactose content prior to fermentation, lactose free UHT cow’s milk was mixed with galactose free infant formulas. The ratios in the mixtures were one part of lactose free milk and one part of galactose free infant formula (1:1). Two different galactose free infant formulas used as supplements of lactose free milk: Neocate, a maltose based, galactose free infant formula (Milupa/Numico, Netherlands); and Galactomin 19, a fructose based, galactose free complete infant formula (SHS, UK). The sensory properties of the two formulas were different and may influence the sensory properties of both raw material mixtures and fermented products. UHT cow's milk was considered to be the control group and lactose free milk and the two types of mixtures were inoculated with kefir and acidophilus milk cultures respectively (Table 1).

Table 1. Raw material properties of fermented dairy drinks for the individuals with galactosemia

Çizelge 1. *Galaktosemi bireyler için fermente süt içeceklerinin çiğ materyal özellikleri*

Raw Material	Dry Matter (%)	Fat (%)	Protein (%)	Acetaldehyde (ppm)	Lactose (mg/L)	Galactose (mg/L)
C	10.31±0.50	1.50±0.06	3.10±0.00	6.7±0.03	4208.35±23.35	0.00±0.00
L	10.19±0.18	1.45±0.05	3.10±0.04	6.6±0.11	0.00±0.00	2160.40±34.21
LN	10.54±0.24	2.50±0.07	2.97±0.02	6.4±0.14	0.00±0.00	1068.11±12.30
LG19	10.42±0.08	2.80±0.01	2.98±0.06	6.5±0.08	0.00±0.00	1080.07±14.10

C: Conventional UHT milk, L: Lactose-free UHT milk, N: Neocate, G19: Galactomin 19.

Commercial freeze-dried kefir starter culture containing *Lactococcus lactis* subsp. *diacetylactis*, *Lactococcus lactis* subsp. *cremoris*, *Lactococcus lactis* subsp. *lactis*, *Lactobacillus kefyr*, *Leuconostoc mesenteroides* subsp. *cremoris*, *Kluyveromyces marxianus* and *Saccharomyces unisporus* spp. was obtained from Danisco (Kefir-D) (Olsztyn, Poland). Freeze-dried commercial *Lactobacillus acidophilus* starter culture, LAFTI-L10, was obtained from DSM Food Specialities BV (MA Delft, Netherlands). The strawberry sauce used for enhancing the sensory properties of the products was obtained from Aromsa Co. (Kocaeli, Turkey). Skim milk powder used to activation of starter cultures was obtained from Pinar Sut Co. (Pinarbasi, Izmir).

500 ml reconstituted skim milk with 12 % non-fat dry matter were inoculated with freeze-dried kefir (2 %, in 25°C) and acidophilus milk (2 %, in 37°C) cultures, respectively. The inoculations were concluded when the inoculums' pH levels dropped to 4.6. Raw materials prepared for the production of fermented drinks were inoculated with 3.25 % culture in all cases. Incubation parameters for the products were 18 hours at 25°C for kefir and 15 hours at 37°C for acidophilus milk. Fermentation was carried out in two replicates in bottles containing 500 ml of raw materials and 3.25 % inoculum. In order to enhance the sensory properties of products fermented drinks were fortified with galactose free strawberry sauce (1.8 %). Manufacture of the products was run in duplicate and repeated twice in all cases.

Eight samples comprising three different beverages with four different raw materials were produced: Acidophilus milk; CAS: Control Acidophilus Milk, LAS: Lactose free milk Acidophilus Milk, LNAS: Lactose free milk + Neocate Acidophilus Milk, LG19AS: Lactose free milk + Galactomin 19 Acidophilus Milk; Kefir; CKF: Control Kefir LKF: Lactose free milk Kefir, LNKF: Lactose free Milk + Neocate Kefir, LG19KF: Lactose free milk + Galactomin 19 Kefir.

Chemical and microbiological analyses

The pH values of kefir and acidophilus milk were determined using a digital pH meter (Hanna pH 211 Microprocessor, Portugal). Dry matter (ISO 13580:2005), protein (AOAC 991.20) and fat (AOAC 905.02) contents were determined in accordance with the A.O.A.C (2005). The acetaldehyde contents of the samples were determined using spectrophotometric method as suggested by Robinson et al. (1977). Megazyme K-LACGAR 12/05 enzymatic kit used to determine of lactose and galactose levels was obtained from Megazyme International Ireland Limited (Co. Wicklow, Ireland). Bacterial enumerations were carried out at the storage period's 1^{st}, 10^{th}, 20^{th} and 30^{th} day. Samples (1 ml) were diluted with ringer solution (9 ml). Serial dilutions were carried out and bacteria counts were determined via the pour plate method. Lactobacilli counts in kefir and *L. acidophilus* counts in acidophilus milk samples were enumerated in MRS agar (pH 5.8) (Merck/1.10660, Darmstadt, Germany) via anaerobic incubation at 42°C for 48 h (Tharmaraj & Shah, 2003); whereas Lactococci in the kefir samples were counted in M17 agar (pH 6.9) (Merck/1.115108, Darmstadt, Germany) via aerobic incubation at 37°C for 48 h. Yeasts and molds were enumerated using YGC Agar (pH 6.8) (Merck/1.116000, Darmstadt, Germany) and incubated at 25°C for 72 h (Irigoyen et al., 2005).

Sensory characteristics

Samples were evaluated for their taste-aroma, consistency and overall sensory properties. The sensory properties scoring test was conducted by a panel group consisting of six individuals, three males and three females between ages 24-35 who received training on sensory analyses in Ege University Faculty of Agriculture Department of Dairy Technology. The scoring test was carried out using the modified versions of scoring cards developed by Clark et al. (2009). The sensory evaluations were conducted with the participation of non-galactosemic healthy individuals. Therefore, the study was not submitted to the approval of medicinal ethics committee. Nevertheless, the research was carried out by the principles of the Institutional Review Boards and Independent Ethics Committees (Jacobs, 2010).

Statistical analyses

The trials in the present study were replicated twice. All analyses were performed in triplicate. storage period storage period. One one-way analysis of variance (ANOVA) was adopted using SPSS software version 15.0 (SPSS Inc. Chicago, Illinois) for the statistical analyses. The significantly different groups were determined using the Duncan test ($p<0.05$).

RESULTS and DISCUSSION

Chemical properties and composition

Dry matter content and its properties are the prominent basic parameters for obtaining desired structural and sensory properties for fermented dairy products. Many studies have reported that dry matter contents directly affect the products' structural, microbiological, and sensory properties. In the production of these products, it is required to comply with the legally prescribed minimum dry matter levels. Dry matter, fat, and protein contents of all the acidophilus milk and kefir samples were analyzed on the 1st day of storage (Table 2). The results showed that dry matter, fat, and protein contents of all the acidophilus milk and kefir samples conform with the nutrient contents as specified in Fermented Dairy Products Communiqué (Communiqué No: 2009/25) in Turkish Food Codex (2009). Fat values of all samples varied between 1.5% and 2.79%. Milk fat is included in the gel structure of fermented dairy products; fat ratio reduced serum separation and increased viscosity between 20% and 60% (Sodini et al. 2004). Samples with higher fat contents also received higher scores in the sensory evaluations.

Table 2. The results for the compositional analysis of fermented dairy drinks for the individuals with galactosemia

Çizelge 2. *Galaktosemi bireyler için fermente süt içeceklerinin bileşim analiz sonuçları*

	Dry Matter (%)	Fat (%)	Protein (%)	Acetaldehyde (ppm)	Lactose (mg/L)	Galactose (mg/L)
Acidophilus Milk						
CAS	11.1±0.09	1.53±0.04^{a}	2.97±0.01	5.67±0.19^{a}	1380.79±26.26	103.21±1.31^{ab}
LAS	10.28±0.46	1.58±0.04^{a}	2.75±0.08	6.12±0.12^{b}	≤0.01±0.00	212.46±2.60^{c}
LNAS	10.98±0.45	2.56±0.02^{b}	2.73±0.13	6.85±0.42^{c}	≤0.01±0.00	98.54±1.21^{a}
LG19AS	10.60±0.35	2.75±0.06^{c}	2.76±0.11	5.82±0.02^{ab}	≤0.01±0.00	108.40±3.11^{b}
Kefir						
CKF	11.14±0.09	1.58±0.03^{a}	2.72±0.23	6.03±0.01^{a}	1649.13±23.87	105.35±0.84^{a}
LKF	10.77±0.43	1.65±0.01^{a}	2.99±0.15	6.85±0.15^{b}	≤0.01±0.00	161.95±8.99^{c}
LNKF	11.28±0.82	2.57±0.03^{b}	2.80±0.08	8.31±0.03^{d}	≤0.01±0.00	132.74±2.13^{b}
LG19KF	10.67±0.13	2.79±0.05^{c}	2.75±0.29	7.63±0.27^{c}	≤0.01±0.00	106.54±3.75^{a}

a,b,c,d: Values with the same lower-case letters in the same column differ significantly (P < 0.05).

In order to meet the objectives of this study, lactose-free milk and milk-formula mixtures were used in productions. Additionally, no lactose hydrolyzation process was done in a control group that is conventional semi-skimmed UHT milk. Therefore, except for the control samples i.e. CAS and CKF (Table 2), lactose was not detected in the samples, Examination of the galactose levels of other three lactose free samples showed that 212.46 mg/L galactose level in LAS sample was higher than the level reported by Varga et al. (2006). Different raw material contents significantly affected the galactose contents in all the kefir samples (p<0,05). LKF, LNKF, and LG19KF samples' galactose contents were lower than the threshold values reported by Varga et al. (2006); 161.95, 132.74, and 106.54 mg/L, respectively. In their study, Varga et al. (2006), determined the galactose level of kefir samples, pre-determined as the control sample, produced from lactose free milk as 270 mg/L; the galactose level of kefir produced from milk formula mixture containing Pregomin as 169 mg/L; and the galactose level of kefir produced from milk formula mixture containing Nutrilon as 171.5 mg/L. The researchers determined the milk-formula ratio as 2-parts milk and 1-part infant formula (2:1). Once these results were compared with the ones obtained in this study, it can be stated that the galactose levels obtained in this study appeared to be lower. The most probable reason for this difference is the 1:1 milk-formula ratio used in this method.

Different raw material compositions had a statistically significant effect on the acetaldehyde contents in all samples (p<0.05) (Table 2). This result was supported by the panelists' comments in taste-aroma evaluations in sensory analyses, reporting that they perceived acetaldehyde aroma in products. In additions, similar results were already reported by other researchers (Ozer et al., 2005; Kok-Tas et al., 2013).

In acidophilus milk samples, the pH values on this 1st day of the storage varied between 4.19 and 4.39 (Fig. 1a). From the 10th day of the storage, pH values became very close to each other and this has remained until the end of the storage. Statistical evaluations also support this result. The differences between the pH values in samples on the 10th, 20th and 30th day of the storage were found to be statistically not significant (p>0.05). The kefir pH values varied between 4.15 and 4.27 during 30 days of storage and contrary to the expectancy for being in a decreasing tendency, and pH values showed almost no change (Fig. 1b). The pH values of the acidophilus milk and kefir samples in our study were similar to the values in the studies of Ozer et al. (2005), Karagozlu et al. (2007), Akalin & Unal (2010), Fiorentini et al. (2011), Tonguç et al. (2013), Yerlikaya et al. (2013).

In fermented dairy products, as a result of the hydrolyzation of lactose by culture bacteria and the formation of lactic acid during incubation, pH reaches to a certain level, and coagulates, and maintains the gel formation. During ripening and storage, acidity increases, and the decrease in pH value continues. Culture bacteria determine the decreasing trend and rate of the pH. The type of bacteria used in the incubation is mainly responsible for the decrease rate of pH (Irigoyen et al. 2011).

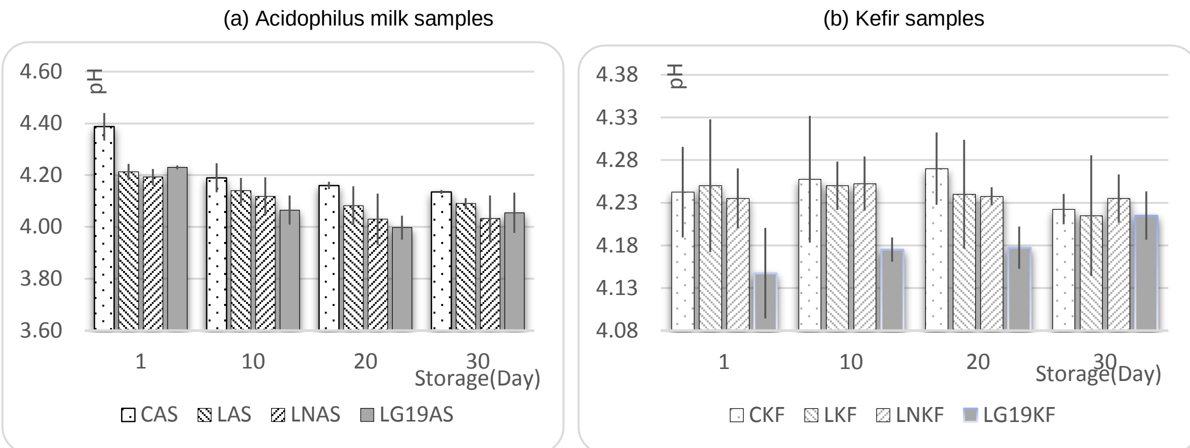

Figure 1. pH values of fermented dairy drinks for the individuals with galactosemia.

Şekil 1. *Galaktosemi bireyler için fermente süt içeceklerin pH değeri.*

Microbiological properties

Microbiological contents of acidophilus milk samples were relatively stable throughout the storage (Table 3). The lowest counts determined throughout the storage period was 7.85 log cfu/ml, whereas the highest was 8.49 log cfu/ml. According to the Turkish Food Codex Fermented Dairy Products Communiqué (2009), the total number of specific microorganisms that an acidophilus milk should contain is 10^7 cfu/ml minimum. Oliviera et al. (2001) produced two different probiotic drinks using whey, casein hydrolysate and milk protein, have reported the *L. acidophilus* counts to be 8 log cfu/ml. Van De Casteele et al. (2005) examined the growth of *L. acidophilus* at selective environments and determined the counts to be at 8.61-9.87 cfu/ml. Fiorentini et al. (2011), in their study on probiotic drink production using mozzarella whey powder, soy hydrolysate extract and sugar, have reported the *L. acidophilus* counts as 10^7 cfu/ml on the 1st day of the storage period and, with a 1 log decrease, 10^6 cfu/ml on the 21st day of the storage. The results obtained in this study were also compatible with those obtained by Oliviera et al. (2001) and Van De Casteele et al. (2005) but higher than those reported by Fiorentini et al. (2011). Different raw materials and storage periods had no significant effects on the *L. acidophilus* counts of the acidophilus milk samples (p>0.05). Using different raw materials had a significant effect on the lactobacilli counts of the kefir samples (p<0.05). The impact of the storage period on the lactobacilli counts was significant only in the LNKF sample (p<0.05).

Table 3. Microbiological contents of fermented dairy drinks for the individuals with galactosemia (log CFU/ml)

Çizelge 3. *Galaktosemi bireyler için fermente süt içeceklerinin mikrobiyal içeriği (log CFU/ml)*

	Storage (Day)			
	1st	10th	20th	30th
Acidophilus Milk				
L. acidophilus				
CAS	8.49±0.15	8.25±0.10	8.27±0.01	8.24±0.05
LAS	8.27±0.18	8.24±0.21	8.07±0.03	7.95±0.35
LNAS	8.21±0.16	8.22±0.14	8.36±0.01	7.85±0.53
LG19AS	8.33±0.04	8.16±0.04	8.03±0.41	7.89±0.51
Kefir				
Lactobacilli				
CKF	7.95±0.04	7.62±0.19	7.47±0.47	7.34±0.19^{a}
LKF	7.96±0.01	7.48±0.33	8.00±0.03	7.92±0.21^{b}
LNKF	8.02±0.11^{Y}	7.45±0.25^{X}	7.87±0.07^{Y}	7.88±0.07^{Yb}
LG19KF	7.65±0.26	7.49±0.02	7.82±0.01	7.81±0.03^{b}
Lactococci				
CKF	7.59±0.02^{Xa}	7.60±0.91^{X}	7.84±0.01^{Yd}	7.61±0.04^{X}
LKF	7.82±0.28^{Yab}	7.54±0.14^{XY}	7.73±0.01^{XYc}	7.47±0.19^{X}
LNKF	8.00±0.24^{Yc}	7.62±0.12^{XY}	7.52±0.05^{XYb}	7.34±0.37^{X}
LG19KF	7.91±0.03^{ab}	7.59±0.05	7.36±0.01^{a}	7.08±0.82
Yeast				
CKF	3.35±0.04^{XY}	2.69±0.64^{X}	3.86±0.17^{Y}	4.03±0.37^{Y}
LKF	3.15±0.12^{X}	3.36±0.16^{X}	4.04±0.13^{Y}	4.20±0.10^{Y}
LNKF	3.15±0.00^{X}	3.16±0.01^{X}	3.75±0.19^{XY}	4.00±0.49^{Y}
LG19KF	3.30±0.21^{X}	3.19±0.05^{X}	3.74±0.00^{Y}	3.89±0.15^{Y}

a,b,c,d: Values with the same lower-case letters in the same column differ significantly ($p < 0.05$).

X,Y,W,Z: Values with the same capital letters in the same row for each analysis differ significantly ($P < 0.05$).

Using different raw materials significantly affected the Lactococci counts of the kefir samples ($p<0.05$). Additionally, the effect of storage on Lactococci counts of the kefir samples was significant ($p<0.05$). Different raw materials had no significant effects on the yeast counts of the kefir samples ($p>0.05$). Also, the effect of storage on yeast counts of the kefir samples was significant ($p<0.05$) (Table 3). Our findings were higher than the results found in previous studies by Guzel-Seydim et al. (2005) and similar results were obtained in those by Wszolek et al. (2001), Chen et al. (2009), Cogulu et al. (2010), Kok-Tas et al. (2013), Akdan et.al. (2020). The yeast counts in the kefir samples varied depending on many factors including yeast and bacteria interactions, biochemical properties of the kefir, and concentrations of assimilated sugar. Association of Fermented Milks and Lactic Acid Beverages of Japan states that minimum concentration of microorganisms required for probiotic effect must be 10^7cfu/mL or above; Sweden Food Regulation suggests that the concentration must be $>10^6$ cfu/ml; Turkish Food Codex Fermented Dairy Products Communiqué (Communiqué No:2009/25) suggests that the culture should contain 10^7 cfu/mL minimum (Irigoyen et al., 2011; Yerlikaya et al., 2012). Accordingly, the microbiological content of the kefir samples was in accordance with the mentioned communiqué.

Sensory properties

In the acidophilus milk samples, different raw material formulations significantly affected the taste-aroma properties ($p<0,05$). As a result, LNAS received considerably lower scores than the other acidophilus milk samples (Table 4). However, the overall evaluation scores graded by the panelists were in line with the panelists' individual preferences for taste. Accordingly, the most favored sample was LG19AS in the acidophilus milk group.

Table 4. Sensory evaluation of fermented dairy drinks for the individuals with galactosemia
Çizelge 4. *Galaktosemi bireyler için fermente süt içeceklerinin duyusal özellikleri*

	Storage (Day)			
	1st	10th	20th	30th
Acidophilus Milk				
Taste-Aroma				
CAS	7.00±0.00b	7.37±0.17b	6.68±0.73b	6.76±0.68bc
LAS	6.67±0.66b	7.75±0.35b	7.40±0.56b	6.46±0.06b
LNAS	3.74±0.76a	4.04±0.30a	3.65±0.21a	3.44±0.43a
LG19AS	7.90±0.14b	7.95±0.29b	7.95±0.64b	7.75±0.35c
Consistency				
CAS	7.16±0.78	6.83±0.24b	7.33±0.95b	7.16±0.83b
LAS	7.43±0.60	7.54±0.30bc	7.88±1.02b	7.39±0.16b
LNAS	5.29±0.40	5.38±0.18a	4.95±0.64a	5.04±0.76a
LG19AS	7.17±1.37	8.25±0.35c	8.37±0.05b	7.64±0.91b
General				
CAS	7.09±0.69b	7.38±0.18b	7.13±1.24b	6.75±1.06b
LAS	7.03±1.17b	7.75±0.35b	7.88±1.02b	6.88±0.18b
LNAS	4.13±1.03a	4.38±0.53a	3.73±0.10a	3.95±0.28a
LG19AS	7.87±0.38b	8.24±0.12b	8.03±0.52b	7.77±0.73b
Kefir				
Taste-Aroma				
CKF	6.33±0.46b	6.20±0.28b	6.08±0.11b	5.58±0.11ab
LKF	6.21±0.54b	6.32±0.74b	5.74±0.58b	6.41±0.12ab
LNKF	3.71±0.16a	3.81±0.55a	2.91±0.12a	3.66±0.23a
LG19KF	5.91±1.53ab	5.88±0.44b	5.41±1.76 ab	4.83±1.88b
Consistency				
CKF	6.68±0.67b	6.88±0.98b	7.16±0.00b	6.41±0.12b
LKF	6.68±0.67b	6.91±0.72b	7.56±1.03b	7.33±0.22b
LNKF	4.46±0.19a	4.32±0.74a	4.08±1.30ab	3.83±0.70a
LG19KF	6.53±0.18b	6.82±0.03b	6.49±0.94b	6.58±1.06b
General				
CKF	6.36±0.04b	6.20±0.28bc	6.16±0.00b	6.08±0.35ab
LKF	6.11±0.40b	6.77±0.52c	5.91±0.58b	6.49±0.23b
LNKF	3.98±0.25Ya	3.82±0.03Ya	2.99±0.47Xa	3.41±0.12XYa
LG19KF	5.86±0.75b	5.85±0.20b	5.75±1.76b	4.58±2.08b

a,b,c,: Values with the same lower-case letters in the same column differ significantly (p < 0.05).
X,Y : Values with the same capital letters in the same row for each analysis differ significantly (P <0.05).

In the kefir samples, different raw material compositions had a significant effect on their taste-aroma properties (p<0.05). LNKF received considerably lower scores compared to those of the other kefir samples (Table 4). LNKF received the lowest taste-aroma scores in the sensory analysis throughout the storage period, and became the least favored sample among the kefir samples. CKF, LKF and LG19KF samples were statistically located in the same group and LNKF was statistically located in a separate group. Storage had no significant effect on the taste-aroma and consistency scores of the kefir samples (p>0.05). Using different raw material formulations had a significant effect on the taste-aroma properties (p<0.05). LKF received the highest consistency scores among the kefir samples. LNKF, was the least creditable sample. Panelists have reported that LNKF had lower viscosity. The difference between the general sensory scores of the samples with different raw material contents were statistically significant (p<0.05). General evaluation scores were statistically different only in the LNKF sample (p<0.05). In the kefir samples, the most creditable samples were CKF (control sample) and LKF (produced from lactose free milk). LG19KF sample containing Galactomin 19 was not favored as much as acidophilus. LNKF was the least favored sample among the kefir samples. In a general comparison, in this study samples scored higher for sensory properties than those of Varga et al. (2006) and were similar to those of Yerlikaya et al. (2012).

CONCLUSION

Consumption of dairy products leads to far more different and serious physiological consequences for galactosemic patients compared to those for individuals with lactose intolerance. Therefore, galactosemic patients have to eliminate dairy products from their daily diet in order not to experience these serious adverse effects and physiological damages. In this study, galactose levels in fermented dairy products produced from lactose free milk and infant formula mixtures were lower than the galactose threshold values reported in the referred studies Varga et al. (2006). The galactose levels in CAS and CAY samples produced from lactose free UHT milk were above the threshold value reported by Varga et al. (2006). However, galactose levels in CKF from lactose free UHT milk were below the threshold reported by Varga et al. (2006). Acidophilus milk samples were the optimum product type in terms of acidity development, microbiological content, and stability of these contents. In this study, LG19AS sample was possibly the most efficacious product. In addition, strawberry flavor fortification yielded positive results in sensory analyses. However, it is necessary to confirm these results with further studies prior to the introduction of these products to the consumption of the patients. In this study, dairy products were developed for the consumption of lactose and/or galactose intolerant individuals. Taking the sensory properties, chemical characteristics, and live microorganism count into consideration, and it is suggested that the favored samples in this study can be further investigated in multidisciplinary studies, especially in medicinal in vivo and in vitro studies.

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