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Investigation of Consumer Reactions Towards Yoghurts Produced by Using Autochthonous Isolates

Otokton İzolatlar Kullanılarak Üretilen Yoğurtlara Yönelik Tüketici Beğenisinin İncelenmesi

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ABSTRACT

Microorganism diversity of yoghurt, an important fermented milk product, is decreasing, because only two strains are used in production and industrial yoghurts are used as starter cultures. In this study, a total of 114 traditional and exopolysaccharide (EPS)-yoghurt samples produced from cow milk using different combinations of *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus* were offered to consumers. Consumers were asked to evaluate some characteristics (general acceptability, packaging and labelling, flavor, texture, and odor) of yoghurt samples using a hedonic 5-point scale (1: dislike extremely; 2: dislike slightly; 3: neither like nor dislike; 4: like slightly; 5: like extremely). 60% of consumers scored general acceptability as "like extremely" for the samples. 13.30% of consumers preferred “neither like nor dislike” for packaging and labelling. In addition, consumers were asked to produce homemade yoghurt using these yoghurts and 73.30% of consumers liked flavor of the homemade yoghurt. Textural properties of homemade yoghurt with traditional and EPS-yoghurts were evaluated as "like extremely" by 66.70 and 73.30 % of consumers, respectively. Finally, odor properties of homemade yoghurt with traditional samples were liked by 73.30% of consumers. On the contrary, 46.70% of consumers liked odor of homemade yoghurt with EPS-yoghurt samples. Results showed that packaging and labelling of the yoghurt samples and odor characteristic of EPS-yoghurt need to be improved. It is thought that the yoghurt samples were generally liked by consumers and these products can be consumed as yoghurt or can be used as starter culture in homemade production. The products can be beneficial for national economy and preservation of diversity of yoghurt bacteria.

Keywords: Yoghurt production, traditional yoghurt, EPS-yoghurt, consumer reaction

ÖZ

Üretiminde sadece iki bakterinin kullanılması ve endüstriyel yoğurtların starter kültür olarak kullanılması gibi nedenlerden dolayı önemli bir fermente süt ürünü olan yoğurdun mikroorganizma çeşitliliğinde azalmalar/kaybolmalar görülmektedir. Bu çalışmada, *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus*'un farklı kombinasyonları ile inek sütünden üretilmiş 114 geleneksel ve EPS-yoğurt örneği tüketici beğenisine sunulmuştur. Tüketicilerden söz konusu yoğurtların bazı özelliklerini (genel kabul edilebilirlik, ambalaj ve etiket, tat, tekstür ve koku) 5 noktalı hedonik skala (1: hiç beğenmedim; 2: beğenmedim; 3: kararsızım; 4: beğendim; 5: çok beğendim) yardımıyla değerlendirmeleri istenmiştir. Tüketicilerin % 60'ı her iki örneğin genel kabul edilebilirlik skorlarını “aşırı derecede beğendim” şeklinde değerlendirmişlerdir. Tüketicilerin % 13,30'u örneklerin ambalaj ve etiket özelliklerine “ne iyi ne de kötü” şeklinde puanlamışlardır. Ayrıca, tüketicilerden bu yoğurtları kullanarak ev yapımı yoğurt üretmeleri istenmiş ve tüketicilerin % 73,30'u bu ev yapımı yoğurtların tat özelliklerini beğenilmiştir. Geleneksel ve EPS-yoğurtlardan üretilen ev yapımı yoğurtların tekstürel özellikleri ise sırasıyla tüketicilerin % 66,70 ve 73,30'u tarafından “aşırı derecede beğendim” şeklinde değerlendirilmiştir. Son olarak, geleneksel örneklerden üretilen ev yapımı yoğurtların kokusu tüketicilerin % 73,30'u tarafından beğenilmiştir. Bunun aksine, EPS-yoğurttan üretilen ev yapımı yoğurtların kokusu tüketicilerin % 46,70'i tarafından beğenilmiştir. Bu sonuçlar, yoğurt örneklerinin ambalaj ve etiket özellikleri ile EPS-yoğurtların koku özelliklerinin iyileştirilmesi gerektiğini göstermiştir. Bunların dışında, yoğurt örneklerinin genel olarak tüketiciler tarafından beğenildiği ve bu ürünlerin yoğurt olarak tüketilebileceği veya ev yapımı üretimlerde starter kültür olarak kullanılabileceği düşünülmektedir. Bu ürünlerin ülke ekonomisine ve yoğurt bakterilerinin çeşitliliğinin korunmasına faydalı olacağı düşünülmektedir.

Anahtar Kelimeler: Yoğurt üretimi, geleneksel yoğurt, EPS-yoğurt, tüketici tepkisi

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Introduction

Fermentation, one of the oldest food preservation methods, is a microbial transformation process. It is known that fermented foods have longer shelf life and that compounds produced as a result of microbial activity have positive effects on both taste/flavor and nutrition of the products. Today, fermented foods constitute a very important part of the human diet worldwide due to these advantages (Azam et al., 2017; Zapasnik et al., 2022). Yoghurt, which can be produced from the different animal milks such as cow, goat, sheep and buffalo, is one of the most produced and consumed fermented products today. Yoghurt is the product of symbiotic relationship between *Lactobacillus delbrueckii* subsp. *bulgaricus* (*L. delbrueckii* subsp. *bulgaricus*) and *Streptococcus thermophilus* (*S. thermophilus*) in pasteurized milk. Commercial cultures are used for industrial production, while in homemade production, previous yoghurt or industrial yoghurt is usually used as starter culture (Surono & Hosono, 2003; Tamime & Robinson, 2007).

Yoghurt is one of the most widely studied fermented products. However, in recent studies, it has been reported that the diversity of yoghurt bacteria (*L. delbrueckii* subsp. *bulgaricus* and *S. thermophilus*) has decreased/disappeared due to reasons such as the use of industrial yoghurts as starter cultures in homemade production and inadequate aseptic conditions (Aktaş et al., 2022; Kayacan Çakmakoğlu et al., 2022; Popovic et al., 2020; Pourahmad & Mazaheri Assadi, 2007). On the other hand, in homemade yoghurt production, it is difficult to achieve a standardized product due to factors such as inadequate aseptic conditions and environmental conditions (Celik et al. 2021). There are many studies reporting that the microorganisms in fermented products should be isolated, investigated and preserved to prevent the decrease/disappearance of diversity of these autochthonous starter cultures (Kayacan Çakmakoğlu et al., 2022; Meral Aktaş & Erdoğan, 2022; Popovic et al., 2020; Pourahmad & Mazaheri Assadi, 2007; Topisirovic et al., 2006). This situation shows the importance of studies to preserve the bacterial diversity of fermented products such as yoghurt.

In this study, it was aimed to determine consumer reactions to yoghurts produced using autochthonous yoghurt strains isolated in previous study by Aktaş and Çetin (2024). For this purpose, the performance of two types of yoghurts, traditional and exopolysaccharide (EPS)-yoghurts, produced by using different combinations of autochthonous *L. delbrueckii* subsp. *bulgaricus* 169M, *S. thermophilus* 108S, and 212S (Table 1) was evaluated by consumers. Thus, it was aimed to reveal the usability of the samples as yoghurt or starter culture on a large scale. This study aimed to produce and investigate a novel starter culture that could be used in production of standard homemade yoghurt.

Table 1.

Some properties of L. delbrueckii subsp. bulgaricus and S. thermophilus strains used as starter cultures for yoghurt production (Aktaş, 2023)

		Yoghurt type			
		Traditional		EPS-yoghurt	
Isolates used in production		169M	212S	169M	108S
Molecular identification (16S-rRNA)	Result	*L. delbrueckii* subsp. *bulgaricus*	*S. thermophilus*	*L. delbrueckii* subsp. *bulgaricus*	*S. thermophilus*
Phenotypic characterization	Arginine hydrolysis	-	-	-	-
	CO_2 production	-	-	-	-
	EPS production	-	+ (*epsA*)	-	+ (*epsA, p-gtf*)
	Proteolytic activity	-	-	-	-
	Lipolytic activity	-	-	-	-
	H_2O_2 production	+	-	+	+
Safety evaluation	Antibiotics (resistant)	Kan	CnKan	Kan	Kan
	Virulence factor (*cylA, hyl, asa* and *ace*)	-	-	-	-
	Haemolytic activity	-	-	-	-
	DNAse activity	-	-	-	-

+: positive, -: negative, Cn: gentamicin (10 µg), Kan: kanamycin (30 µg)

Material and Methods

Raw milk and yoghurt strains

In this study, two different types yoghurts (traditional and EPS-yoghurts) were produced to determine consumer reactions. The yoghurt samples were produced by using cow's milk obtained from Atatürk University Food and Livestock Application and Research Centre. *L. delbrueckii* subsp. *bulgaricus* 169M, *S. thermophilus* 108S, and 212S used as starter cultures for yoghurt production in presented study were isolated from yoghurt samples in the study by Aktaş and Çetin (2024). These isolates were characterized in terms of techno-functional properties and determined to be suitable for yoghurt production by Aktaş and Çetin (2024). Although *L. delbrueckii* subsp. *bulgaricus* 169M and *S. thermophilus* 212S were used for producing the traditional yoghurt samples, *L. delbrueckii* subsp. *bulgaricus* 169M and *S. thermophilus* 108S for EPS-yoghurt. Some properties (molecular identification, phenotypic characterization and safety evaluation) of these strains used in this study are given in Table 1.

Yoghurt production, storage, packaging and labelling

For preparation of the starter cultures, the strains were revived by streak plate method on De man-Rogosa-Sharpe Agar (MRS, Merck, Darmstadt, Germany) and M17 agar (Merck, Darmstadt, Germany). Lactic bacilli isolates were incubated anaerobically at 37 ℃ for 48-72 h, lactic cocci isolates aerobically at 37 ℃ for 24 h. Then, the isolates were inoculated sterile skim milk and incubated at 42 ℃ for 15 h for pre-activation (Aktaş, 2023). The yoghurt production was carried out according to Robinson et al. (2006) at Atatürk University Food and Livestock Application and Research Centre. Briefly, raw cow's milk was heated at 85 ℃ for 25 min. Pre-activated starter culture (2%) of *L. delbrueckii* subsp. *bulgaricus* and *S. thermophilus* (1:1) was inoculated to the milk cooled to 42 ℃. The milk was distributed into glass jars (21 cL) and incubated at 42 ℃ until the pH 4.6±0.1. Then, the labelled yoghurts (Figure 1) were stored at 4 ℃ and offered to consumers. Summarized process of the yoghurt production, storage and marketing is given in Figure 2.

Figure 1.

Labelled traditional and EPS-yoghurt samples

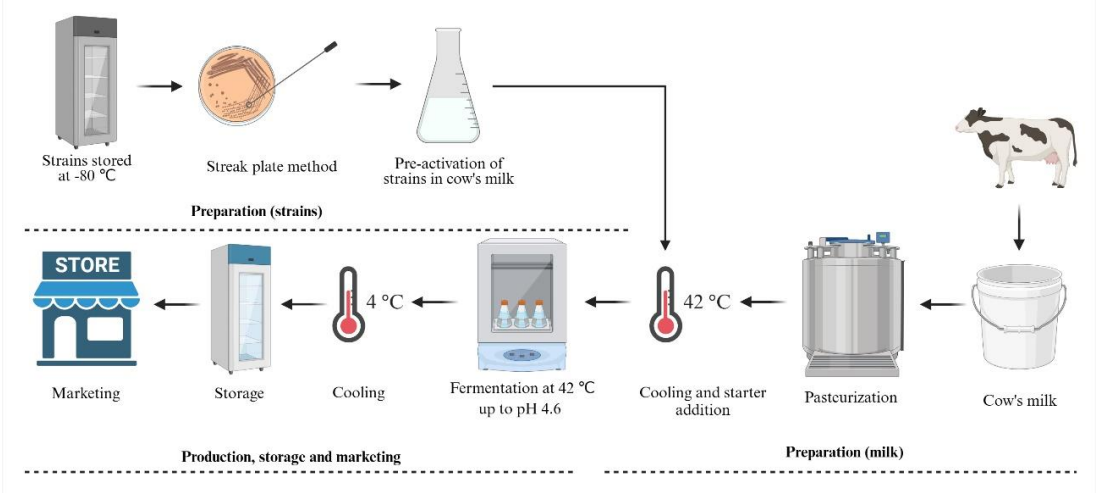

Figure 2.

Summarized process of yoghurt production, storage and marketing (Created with BioRender.com)

Investigation of consumer reaction towards yoghurt

A total of 114 samples of traditional and EPS-yoghurt were offered to randomly consumers at Atatürk University Farm Products Centre at three different times. Moreover, consumers were asked to evaluate general acceptability, packaging and labelling, flavor, texture, and odor properties of the yoghurt samples and yoghurts (homemade yoghurts) produced with these samples using hedonic 5-point scale (1: dislike extremely; 2: dislike slightly; 3: neither like nor dislike; 4: like slightly; 5: like extremely) according to the parameters given in Table 2 (Lim, 2011). In this study, consumer selection did not do to evaluate the yoghurt samples, rather the samples were randomly offered to consumers. Thus, this study aimed to determine consumer reactions to the traditional and EPS-yoghurt samples and to understand whether these samples are a product that can compete in the market. In this study, traditional and EPS-yoghurt samples were offered to consumers under Atatürk University Food and Livestock Application and Research Centre and in accordance with the permission from Ministry of Agriculture and Forestry, the Republic of Türkiye (TR-25-0070).

Table 2.

Evaluation parameters of the yoghurt samples

Date: Please mark the type of yoghurt starter you use: Traditional yoghurt ☐ EPS-yoghurt ☐	Like extremely (5)	Like slightly (4)	Neither like nor dislike (3)	Dislike slightly (2)	Dislike extremely (1)
General acceptability of traditional and EPS-yoghurt samples					
Packaging and labelling of traditional and EPS-yoghurt samples					
Taste property of homemade yoghurts produced by using traditional and EPS-yoghurt samples					
Textural property of homemade yoghurts produced by using traditional and EPS-yoghurt samples					
Smell property of homemade yoghurts produced by using traditional and EPS-yoghurt samples					
Please let us know your opinion about yoghurt:					

Statistical analysis

The results obtained from this study were evaluated by using SPSS version 20.0 package program (SPSS Inc., Chicago, IL, USA). In addition to descriptive statistic, frequency analysis, independent *t*-test and Pearson correlation test were carried out to determine consumer reaction distribution and correlation between some parameters of traditional and EPS-yoghurt samples, respectively (Tavşancıl, 2006). Consumer reactions are presented as percentages for better understanding.

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Results and Discussion

Investigation of consumer reaction towards yoghurt

General acceptability

Percentage of general acceptability points of the traditional and EPS-yoghurt samples by the consumers is given in Figure 3. According to the results, it was determined that 60% of the consumers selected “like extremely” for both the traditional and EPS-yoghurt samples. On the contrary, 6.70% of the consumers preferred "dislike slightly” for general acceptability points of the traditional yoghurt samples. The results revealed that these yoghurt samples were generally liked by consumers and showed that traditional and EPS-

yoghurt samples can have the potential to compete in the market. In addition, it was found that sample difference was not effective on the general acceptability score ($P > 0.05$). The characteristics of food products such as taste and odor can directly affect general acceptability and general acceptability is one of the parameters that directly indicate the liking of foods by consumers (Sharif et al. 2017). In the present study, the high general acceptability scores of both traditional and EPS-yoghurt samples indicated that these products were generally liked by consumers and could be a potential novel products. In study by Bibiana et al. (2014), sensory characteristic of five different types of yoghurt samples sold in Makurdi metropolis (Nigeria) was evaluated by panellists. The results showed that there was no difference between yoghurt samples in the general acceptability. The results of the present study are similar to the study. On the other hand, Omola et al. (2014) investigated physico-chemical, sensory and microbiological qualities of one hundred commercial yoghurt samples obtained from Kano Metropolis, Nigeria. It was stated that some yoghurt samples had higher general acceptability score. According to these studies, it is understood that yoghurts can have different organoleptic properties and the differences can affect general acceptability score. Moreover, in this study, Pearson correlation test was performed to evaluate correlation between consumer reactions. The results showed that there were positive correlations between flavor, textural properties of homemade yoghurts by using traditional or EPS-yoghurt samples and general acceptability scores ($P < 0.01$) (Table 3). It is thought that it can be increased the general acceptability of consumers for the traditional and EPS-yoghurt samples with improving flavor and textural characteristics of the products.

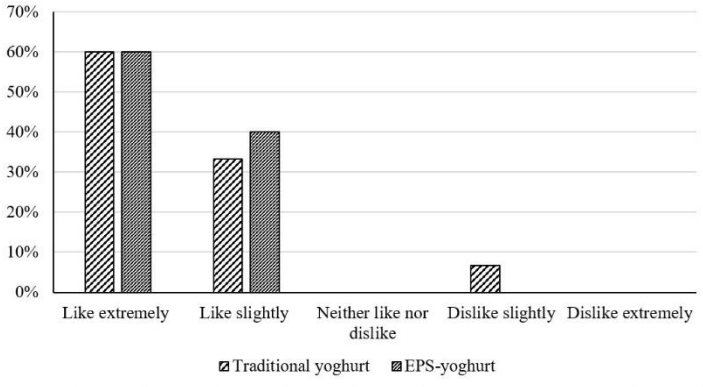

Figure 3.

Percentage of general acceptability score of traditional and EPS-yoghurt samples by consumers

Packaging and labelling

Percentage of packaging and labelling scores of the traditional and EPS-yoghurt samples by the consumers is given in Figure 4. Majority of consumers liked packaging and labelling of the yoghurt samples. However, 13.30% of the consumers evaluated packaging and labelling of the traditional and EPS-yoghurt samples as the "neither like nor dislike". Packaging and labelling are the most important factors directly affecting consumer acceptability in the food industry. In addition, it is known that foods with remarkable, reassuring and well-designed packaging and labelling are more preferred by consumers (Meijer et al. 2021; Ramos and Squeff 2020). Therefore, packaging and labelling of a food are very important. In the study by de Morais Sato et al. (2019), it was revealed that the packaging and labelling of foods are very important and that consumers pay most attention to nutrients, ingredients, composition, and expiration date on the packaging. In the presented study, although none consumer selected "dislike slightly" or "dislike extremely", it is thought that the packaging and labelling characteristics of the yoghurt samples should be improved. Thus, consumer appreciation towards the traditional and EPS-yoghurt samples can be further increased.

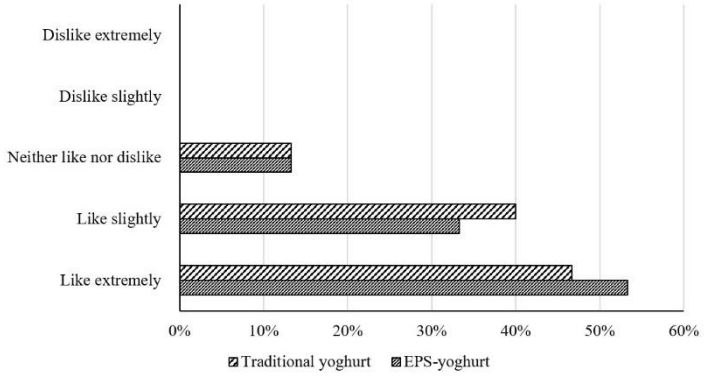

Figure 4.

Percentage of packaging and labelling score of traditional and EPS-yoghurt samples by consumers

Flavor properties of homemade yoghurts produced by using traditional and EPS-yoghurt samples

In the present study, consumers were asked to produce yoghurt (homemade yoghurt) by using the traditional or EPS-yoghurt samples as starter cultures and to evaluate the flavor property of the homemade yoghurt. Percentage of flavor characteristic score of the homemade yoghurts produced by using the traditional or EPS-yoghurt samples by the consumers is given in Figure 5. The results showed that 73.3% of the consumers scored the homemade yoghurts produced by using both traditional and EPS-yoghurt samples as "like extremely". Moreover, about 20% of the consumers preferred "like slightly" choice for homemade yoghurts produced by the two samples. Finally, some consumers (6.70%) evaluated homemade yoghurts by the traditional samples as "dislike slightly". It is thought that this situation

can be due to the fact that *L. delbrueckii* subsp. *bulgaricus* 169M and *S. thermophilus* 212S used in traditional yoghurt samples cause a faster pH decrease and the sour flavor could not like by some consumers. Similarly, Aktaş (2023) reported that the acidity of yoghurt increased or pH decreased, the general acceptability points of yoghurt by panellists decreased. Moreover, in study by Barak and Mudgil (2020), it was determined that some consumers liked sour yoghurt less. As in the above studies, the presented research also revealed that some consumers liked sour yoghurts less. The response by consumers increases importance of isolates with low acidification during storage (post-acidification). Usage of isolates with low post-acidification as starters in yoghurt production may make the products more appreciated by consumers. In this study, Pearson correlation test results showed that there was positive correlation between flavor property of homemade yoghurts by using traditional or EPS-yoghurt samples and general acceptability scores ($P < 0.01$) (Table 3).

Table 3.

Correlation between consumer reactions towards traditional and EPS-yoghurt samples

Parameters	General acceptability	Packaging and labelling	Taste property of homemade yoghurts	Textural property of homemade yoghurts	Smell property of homemade yoghurts
General acceptability	1				
Packaging and labelling	0.221	1			
Taste property of homemade yoghurts	0.638**	-0.024	1		
Textural property of homemade yoghurts	0.645**	0.069	0.770**	1	
Smell property of homemade yoghurts	-0.162	0.039	0.105	0.064	1
Mean	4.53	4.37	4.67	4.57	4.60
Standard deviation	0.68	0.72	0.66	0.86	0.50

* p<0.05, ** p<0.01

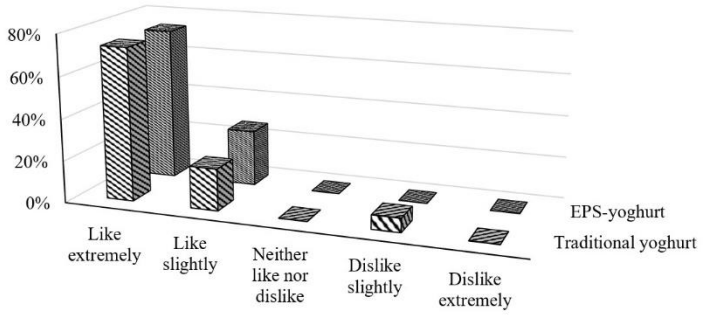

Figure 5.

Percentage of flavor score of yoghurts produced by using traditional and EPS-yoghurt samples by consumers

Textural properties of homemade yoghurts produced by using traditional and EPS-yoghurt samples

Consumers evaluated textural characteristic of homemade yoghurts produced the traditional or EPS-yoghurt samples and percentage of the responses is present Figure 6.

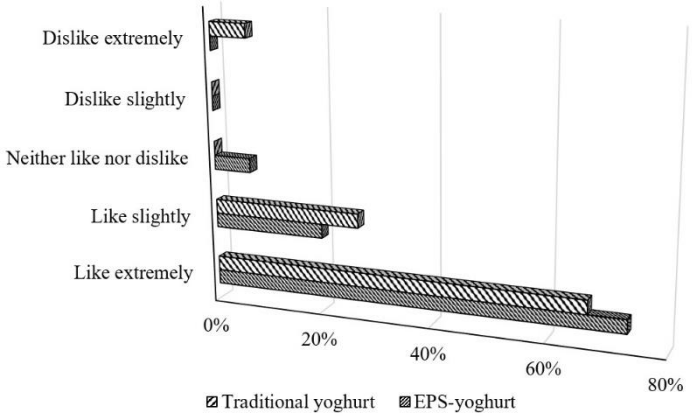

Figure 6.

Percentage of textural property score of yoghurts produced by using traditional and EPS-yoghurt samples by consumers

Majority of consumers liked (like extremely) homemade yoghurt by using the traditional and EPS-yoghurt. In addition, consumers liked homemade yoghurt produced by using EPS-yoghurt samples more (73.3%), compared that by using traditional (66.70%). Moreover, homemade yoghurt by traditional samples was scored as “dislike extremely” by

6.70% of the consumers. It is known that EPS by lactic acid bacteria can increase the consumer appreciation by improving textural properties of products such as yoghurt and kefir (Dertli et al. 2016; Patel and Roy 2016; Tiwari et al. 2021). Similarly, in this study, isolates that had potential ability to produce EPS were used for EPS-yoghurt production (Table 1). The results showed that the EPS-producing isolates could be able to improve textural properties of homemade yoghurts and these properties were noticed and appreciated by consumers. Moreover, Pearson correlation test revealed that textural property of homemade yoghurts affected positively general acceptability score ($P < 0.01$) (Table 3). Similarly, in study by Folkenberg et al. (2006), sensory and rheological properties of yoghurt samples with EPS-producing strains were investigated. It was determined that EPS-producing strains improved the sensory and rheological properties of the yoghurts. In addition, Madhubasani et al. (2020) reported that the amount of EPS in yoghurts produced from goat milk increases, the general acceptability and texture properties of the product also improve. However, in the present study, further studies such as characterization of the potential EPS producer isolates and their usage in fermented products, are also necessary for food industry and human health.

Odor properties of homemade yoghurts produced by using traditional and EPS-yoghurt samples

Consumers were asked to score odor property of homemade yoghurt by using the traditional or EPS-yoghurt samples as starter cultures. Percentages of odor property points of the homemade yoghurts by the yoghurt samples is given in Figure 7.

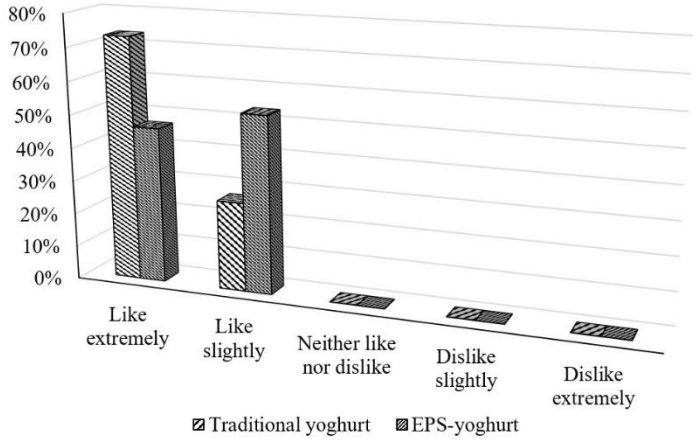

Figure 7.

Percentage of odor property score of yoghurts produced by using traditional and EPS-yoghurt samples by consumers

Results showed that 73.30% of consumers liked (like extremely) odor of homemade yoghurt produced by using the traditional yoghurt samples. On the other hand, 46.70% of consumers liked (like extremely) odor of homemade yoghurt by the EPS-yoghurt samples. The rest of the consumers evaluated the homemade yoghurt as "like slightly". The EPS-yoghurt samples need to improve on the odor properties for better consumer acceptability. Olugbuyiro and Oseh (2011) investigated physicochemical and sensory characteristics of nine different market yoghurt. They reported that some yoghurts had better odor property. The results from our study are similar with the study.

Conclusion and Recommendations

Nowadays, it is known that the diversity of yoghurt bacteria is decreasing/disappearing. Therefore, it is very important to preserve and characterize these isolates, global heritage, and to determine their properties in the product. In this study, it was determined that the traditional and EPS-yoghurt samples produced with different strains combinations were generally liked by the consumers. However, it is thought that the packaging and labelling of two types of the yoghurt samples need to improve. In addition, consumers were asked to produce homemade yoghurt by using the traditional or EPS-yoghurt samples as starter cultures and to evaluate some properties of the homemade yoghurt. According to results, it was determined that EPS-yoghurt samples need to improve their odor characteristics. Thus, consumer appreciation towards the traditional and EPS-yoghurt samples can be increased. As a result, it was understood that these fermented products can be used as starter cultures in both industrial and homemade production. It is thought that these products will be beneficial for the country's economy and protection of bacterial diversity, which is a world heritage. Moreover, it is thought that yoghurt combinations can be studied on different properties in future studies, such as larger-scale consumer analysis, effects on health by animal experiment, etc.

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