

Assessment of Microbial Quality of Local and Packaged Ice Creams

Perihan AKBAŞ^{1*}

¹Ondokuz Mayıs University, Karadeniz Advanced Technology Research and Application Center, Samsun, Türkiye

¹<https://orcid.org/0000-0001-5977-7621>

*Corresponding author: perihan.akbas@omu.edu.tr

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ABSTRACT

The aim of this study is to analyse the microbiological quality of packaged (made in patisseries, n=15) and local (made in local enterprises, n=15) ice cream samples for sale in Kahramanmaraş (Türkiye) and to evaluate the results in the context of food safety. The samples were tested for the presence of total mesophilic aerobic bacteria (TMAB), total psychophilic aerobic bacteria (TPAB), yeast-mould, total coliform, and *Escherichia coli*. According to the communiqué on microbiological criteria by the Turkish Food Codex (2009/6), 40% of the tested local ice cream samples and 23% of packaged ice creams had high TMAB levels. The count of TPAB in packaged ice creams was substantially lower (13%), whereas its count in locally sold ice creams was rather high (73%). While 73.3% of packaged ice creams contained an average of 3.56 log CFU g⁻¹ yeast-mould, an average of 6.55 log CFU g⁻¹ yeast-mould was identified in 93.3% of local ice creams. The overall coliform quantity must be less than 2 log CFU g⁻¹, according to the Turkish Standards Institute. Eight samples (53.3%) of packaged ice creams and local ice creams in Kahramanmaraş province were above the acceptable limits for coliform bacteria. Ice creams must not contain *E. coli*, according to TS 4265. However, *E. coli* was discovered in six samples (40%) of packaged ice creams and four samples (27%) of local ice creams. Consequently, it is believed that the microbiological quality of packaged and local ice cream samples sold in Kahramanmaraş may be poor, which may have negative effects on public health.

Yerel ve Paketlenmiş Dondurmaların Mikrobiyal Kalitesinin Değerlendirilmesi

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ÖZ

Bu çalışmada, Kahramanmaraş'ta (Türkiye) satışa sunulan paketlenmiş (pastanelerde olarak üretilmiş, n=15) ve yerel (yerel işletmelerde üretilmiş, n=15) dondurma örneklerinin mikrobiyolojik kalitesinin incelenmesi ve sonuçlarının gıda güvenliği bağlamında değerlendirilmesi amaçlanmıştır. Örneklerde toplam mezofilik aerobik bakteri (TMAB), toplam psikofil aerobik bakteri (TPAB), maya-küf, toplam koliform ve *Escherichia coli* varlığı araştırılmıştır. Analiz edilen yerel dondurma örneklerinin TMAB açısından %40'ının, paketli dondurmalar ise %23'ünün Türk Gıda Kodeksi (2009/6) mikrobiyolojik kriterler tebliğine göre yüksek olduğu tespit edilmiştir. Paketli Maraş dondurmalarında TPAB sayısı çok daha az (%13) çıkmıştır, fakat yerel olarak satılan Maraş dondurmalarındaki sayı (%73) oldukça yüksektir. Paketli dondurmaların %73,3'ünde ortalama 3,56 log KOB g⁻¹ maya küf bulunurken, yerel dondurmaların %93,3'ünde ortalama 6,55 log KOB g⁻¹ maya küf bulunmaktadır. Türk

Standartları Enstitüsüne göre (TS 4265) toplam koliform miktarı 2 log KOB g⁻¹'dan daha düşük olmalıdır. Paketli Maraş dondurmalarında ve Kahramanmaraş ilinde yerel olarak üretilip satılan Maraş dondurmalarında koliform bakteriler açısından 8'er (%53,3) örnek kabul edilebilir sınıra üzerindedir. TS 4265'e göre dondurmalarda *E. coli* bulunmamalıdır. Ancak paketli dondurmalarından 6 örneğin (%40), yerel dondurmalarından ise 4 örneğin (%27) *E. coli* barındırdığı tespit edilmiştir. Sonuç olarak, Kahramanmaraş'ta satışa sunulan paketlenmiş ve yerel olarak üretilmiş dondurma örneklerinin mikrobiyolojik kalitelerinin yetersiz olabileceği ve bu durumun halk sağlığı açısından olumsuz etkileri olabileceği düşünülmektedir.

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Introduction

Ice cream is a dairy product that creates a favorable habitat for microbial growth due to its high nutritional content (Warke et al., 2000). According to the Regulation of the Turkish Food Codex, ice cream contains components such as milk and/or dairy products, sugar, potable water and permitted additives as well as seasoning and flavouring ingredients, sahlepe, egg and/or egg products, depending on need. Ice cream is a product that is made by processing the mixture in accordance with the production method after the pasteurisation stage and then introduced for consumption after it has softened or hardened (Turkish Food Codex, 2022). The fat in ice cream is composed of butter and margarine, while the protein and minerals are composed of milk fat-free dry matter and carbohydrates are composed of sucrose and partial stabilizers. Ice cream is a popular dairy product that is consumed especially in the summer, due to its pleasant flavour, low cost, refreshing nature, and aroma (Güner et al., 2004; Tekinşen and Tekinşen, 2008). Ice cream provides an ideal habitat for microorganisms to proliferate. Therefore, raw materials and additives used in production must be of a hygienic quality; the pasteurization applied to the mixture must be sufficient; the hygiene and sanitation rules must be obeyed during the production; the mixture must be frozen within 24 hours after thermal treatment and stored below +4°C at the latest, and hygiene rules must be followed at all stages until consumption (Kırdar, 2003; Kanbakan et al., 2004).

The provision of hygienic conditions during production, the contamination of various microorganisms at the transportation and storage stages of the product (poor storage conditions) during marketing after production, and the neutral pH situation all have an effect on the microbiological quality and microbial growth of ice cream (Lee et al., 2009).

Maraş ice cream is a product made by using the Maraş ice cream technique and adding of sugar, milk, sahlepe, and/or other permitted additives (Turkish Food Codex, 2022). Including goat's milk and sahlepe in Maraş ice cream is fundamental. Maraş pounded ice cream, which is prepared with milk, sugar, and sahlepe using traditional methods, has seen a fast technological advancement since the 1980s (Kaya et al., 2017). All around the world, foodborne infections impose a great threat. The presence of pathogens in ice cream samples is caused mostly by contamination during the distribution and transportation of ice cream and packaging material, as well as the environment, personnel, water, tools, and equipment (Çağlayanlar et al., 2009; Uğuz and Kireççi, 2018). The bacterial growth

accelerates, especially in the summer, when the temperature rises. Ice creams produced under aseptic conditions must never contain indicator bacteria such as *Escherichia coli* in a 100 ml sample. In this context, for humans, nutritional foods such as ice cream establish an excellent growth habitat for infectious factors such as cholera, typhoid fever, and bacillary dysentery. In most of the Asian, European, and North American countries, pathogen-contaminated ice cream causes gastrointestinal diseases (Bostan and Akın, 2002). Testing for coliforms as signs of unsanitary circumstances and post-processing contamination is common. This indicates that employees working in the ice cream production do not follow hygiene rules at any stage of the production (Martin et al., 2016).

The aim of this study is to determine and compare the microbiological quality of plain ice creams made in ice cream facilities in Kahramanmaraş and packaged ice creams and to investigate their compliance with Turkish Standards.

Material and Method

Sampling

A total of 30 samples were studied, 15 ice cream samples of which were purchased from those produced by the local sellers and 15 industrial ice cream samples from retail outlets in Kahramanmaraş. After adding 90 ml buffered peptone water to 10 g ice cream, 1 ml of each ice cream sample was aseptically transferred to a sterile test tube containing 9 ml peptone water and was serially diluted up to 10^{-5} . 100 μ l was inoculated from each dilution with the spread plate technique on the medium and the readings were reported in \log_{10} colony-forming unit (\log CFU g^{-1}) (Warke et al., 2000).

Bacteriological Analysis of the Collected Samples

Total Mesophilic Aerobic Bacteria (TMAB) Count

The petri dishes containing Plate Count Agar (PCA) (Merck, Germany) among the dilutions prepared for total mesophilic aerobic bacteria (TMAB) count was inoculated by employing the spread plaque method. Petri dishes were incubated for 48 hours at 37°C. Petri dishes containing 25-250 colonies were analyzed at the end of the incubation period, and the findings were expressed as \log CFU g^{-1} (Öksüztepe et al., 2005)

Total Aerobic Psychrophilic Bacteria (TPAB) Count

The petri dishes containing Plate Count Agar (PCA) (Merck, Germany) among the dilutions prepared for total psychrophilic aerobic bacteria (TMAB) count was inoculated by employing the spread plaque method. Petri dishes were incubated for 10 days at 5°C. At the end of the incubation period, colonies were counted and the findings were expressed as \log CFU g^{-1} (Öksüztepe et al., 2005)

Yeast-Mould Count

The Sabouraud Dextrose Agar medium (Merck, Germany) among the prepared dilutions was inoculated by employing the spread plaque method. Petri dishes were incubated for 7 days at $25\pm 2^{\circ}\text{C}$. At the end of the incubation period, all growing colonies were counted as total yeast-mould. The findings were expressed as $\log \text{CFU g}^{-1}$ (Güner et al., 2004).

Determination of Presence of Total Coliform Bacteria and *E. coli*

The most probable count was employed for the analysis in Lauryl Sulphate Tryptose Broth medium (Merck, Germany). 1 mL of the produced dilutions was added into LSTB medium (Oxoid, England) containing a Durham tube and incubated at 37°C for 48 hours. Gas positive tubes were determined at the end of the incubation period, and the count of potential coliform bacteria was calculated as most-probable-number $\log_{10} \text{MPN g}^{-1}$. All gas positive tubes were inoculated with loops into Brilliant Green Bile Broth medium containing the Durham tube for proof and incubated at 37°C for 48 hours. Gas positive tubes were identified at the end of the incubation period, and the count of coliform bacteria $\log_{10} (\text{MPN g}^{-1})$ was calculated. Petri dishes containing Eosin Methylene Blue (EMB) Agar (Merck, Germany) were inoculated with positive tubes and incubated at 37°C for 18-24 hours. The IMVIC test, which is a confirmatory test, was applied on typical colonies, and its results were evaluated (Güner et al., 2004).

Statistical Analysis

All samples analyzed three times. The data were statistically analyzed using the e-SPSS statistical package software (SPSS). The data was assessed using One Way Analysis of Variance (One Way ANOVA and Duncan's multiple range test). The $p < 0.05$ value was considered as statistically significant (Güner et al., 2004).

Results

Table 1. shows the microbiological properties of 15 samples of packaged ice cream collected from patisseries under this study. The average count of Total Mesophilic Aerobic Bacteria (TMAB) was found to be $4.86 \log \text{CFU g}^{-1}$, and Total Psychrophilic Aerobic Bacteria (TPAB) count was $3.38 \log \text{CFU g}^{-1}$ on average. The average count of yeast-mould was observed to be $3.56 \log \text{CFU g}^{-1}$. The average total coliform count was $4.17 \log \text{MPN g}^{-1}$, as well as the average *E. coli* count was $3.72 \log \text{MPN g}^{-1}$.

Table 2. provides the microbiological properties of 15 ice cream samples produced and sold in ice cream enterprises in Kahramanmaraş. The average Total Mesophilic Aerobic Bacteria (TMAB) count was $6.65 \log \text{CFU g}^{-1}$, whereas the average Total Psychrophilic Aerobic Bacteria (TPAB) count was $5.78 \log \text{CFU g}^{-1}$. The average count of yeast-mould was $6.55 \log \text{CFU g}^{-1}$. The average total coliform count was $6.36 \log \text{MPN g}^{-1}$, and the average *E. coli* count was $4.91 \log \text{MPN g}^{-1}$.

Table 1. Microbiological analysis of packaged ice cream

Sample	Total Mesophilic Aerobic Bacteria (TMAB) log CFU g ⁻¹	Total Psychrophilic Aerobic Bacteria (TPAB) log CFU g ⁻¹	Yeast-Mould Count log CFU g ⁻¹	Total Coliform log MPN g ⁻¹	<i>E. coli</i> log MPN g ⁻¹
1	4.47 ^b	2.85 ^c	2.47 ^c	-	-
2	4.62 ^b	-	-	3.77 ^c	3.44 ^c
3	4.69 ^b	-	-	3.76 ^c	3.41 ^c
4	4.69 ^b	-	-	4.57 ^b	3.62 ^c
5	5.79 ^a	-	3.50 ^c	4.93 ^{ab}	4.55 ^b
6	5.25 ^a	-	4.47 ^b	4.55 ^b	-
7	4.69 ^b	4.47 ^b	4.47 ^b	3.83 ^c	4.47 ^b
8	-	-	3.50 ^c	-	-
9	-	-	3.20 ^c	-	-
10	3.90 ^{bc}	-	3.38 ^c	-	-
11	-	-	3.47 ^c	-	-
12	3.84 ^c	-	3.47 ^c	3.68 ^c	-
13	3.79 ^b	-	4.77 ^b	3.57 ^b	2.60 ^c
14	3.90 ^{bc}	-	3.77 ^c	-	-
15	-	-	-	-	-

- Below Detectable Value ($\leq 25 \times 10^2$)

The figures that are represented in different letters in the same row and column are different at the level of $p < 0.05$.

Table 2. Microbiological analysis of local ice cream

Sample	Total Mesophilic Aerobic Bacteria (TMAB) log CFU g ⁻¹	Total Psychrophilic Aerobic Bacteria (TPAB) log CFU g ⁻¹	Yeast-Mould Count log CFU g ⁻¹	Total Coliform log MPN g ⁻¹	<i>E. coli</i> log MPN g ⁻¹
1	5.54 ^c	6.41 ^b	6.39 ^b	4.39 ^d	-
2	5.95 ^{bc}	4.55 ^d	6.38 ^b	-	-
3	4.04 ^d	6.47 ^b	6.39 ^b	4.77 ^d	-
4	3.39 ^e	6.44 ^c	6.07 ^b	-	-
5	3.68 ^e	5.69 ^c	6.07 ^b	3.38 ^e	-
6	-	-	4.41 ^d	-	-
7	6.77 ^b	5.25 ^c	6.47 ^b	3.41 ^e	3.30 ^e
8	3.77 ^e	-	3.84 ^e	-	-
9	5.17 ^c	5.47 ^c	6.34 ^b	3.87 ^e	-
10	4.30 ^d	4.77 ^d	4.88 ^{cd}	3.63 ^e	3.60 ^e
11	-	-	-	-	-
12	5.39 ^c	4.90 ^{cd}	4.90 ^{cd}	-	-
13	7.77 ^a	6.30 ^b	7.60 ^a	6.54 ^b	6.07 ^b
14	-	4.84 ^d	4.30 ^d	-	-
15	3.47 ^e	-	4.07 ^d	4.38 ^d	4.30 ^d

- Below Detectable Value ($\leq 25 \times 10^2$)

The figures that are represented in different letters in the same row and column are different at the level of $p < 0.05$.

The samples contained total mesophilic aerobic bacteria (TMAB) of 3.39 and 7.77 log CFU g⁻¹ (Table 1 and 2). TS 4265 sets out the total viable mesophilic aerobic bacteria content as 5 log CFU g⁻¹. Figure

1. compares packaged and local ice creams for total mesophilic aerobic bacteria. Since the samples of packaged ice cream, except for two, did not violate the standard, they were considered within acceptable limits for public health safety, however, six out of 15 samples of locally produced ice creams were above acceptable standards, and therefore they had potential of posing a risk to public health. The presence of a high count of TMABs indicated that the samples were not produced and/or stored under hygienic conditions. The ability to evaluate microbial contamination and the overall quality of a food product is made possible by the TAMB load, which is a reliable sign of sanitation (Noumavo et al., 2022).

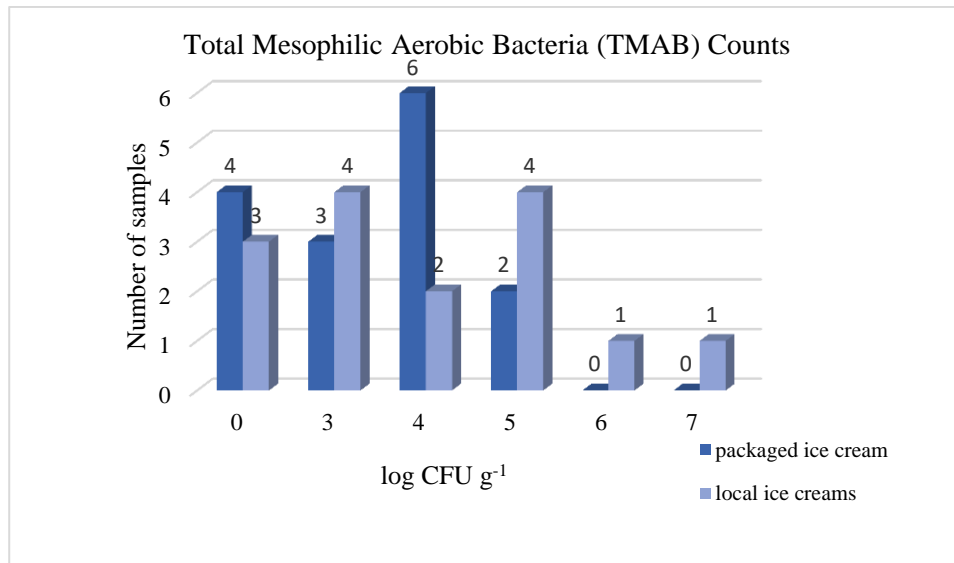


Figure 1. Comparison of total mesophilic aerobic bacteria (TMAB) counts in the samples of packaged ice cream and ice cream produced and sold in ice cream enterprises in Kahramanmaraş.

Total psychrophilic bacteria constitute a significant group of microorganisms for food stored in the cold. Figure 2 compares packaged and local ice creams for Total Psychrophilic Aerobic Bacteria (TPAB). The lowest and highest average TPAB counts of the analyzed ice cream samples ranged between 3.85 and 6.47 log CFU g⁻¹. Thirteen of the fifteen packaged ice cream samples (87%) were devoid of psychrophilic bacteria, while four of the fifteen local ice cream samples (27%) had no psychrophilic bacteria, suggesting that the packaged ice cream was safer for the microorganism load.

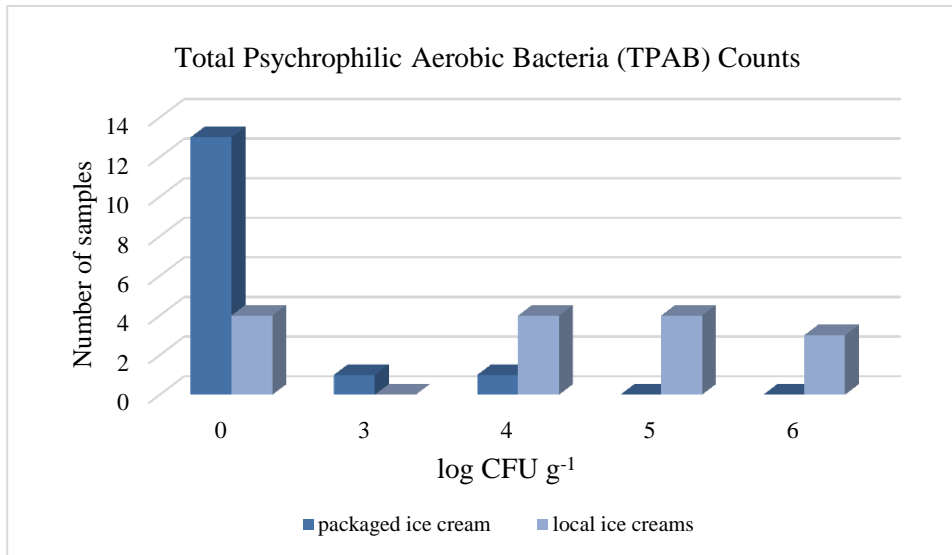


Figure 2. Comparison of total psychrophilic aerobic bacteria (TPAB) counts in the samples of packaged ice cream and ice cream produced and sold in ice cream enterprises in Kahramanmaraş.

The minimum and maximum yeast-mould counts in the ice cream samples ranged between 2 and 7 log CFU g⁻¹. While 73.3% of packaged ice creams contained an average 3.56 log CFU g⁻¹ yeast-mould, an average of 6.55 log CFU g⁻¹ yeast-mould was identified in 93.3% of local ice creams. The packaged ice creams contained higher yeast-mould population than local ice cream.

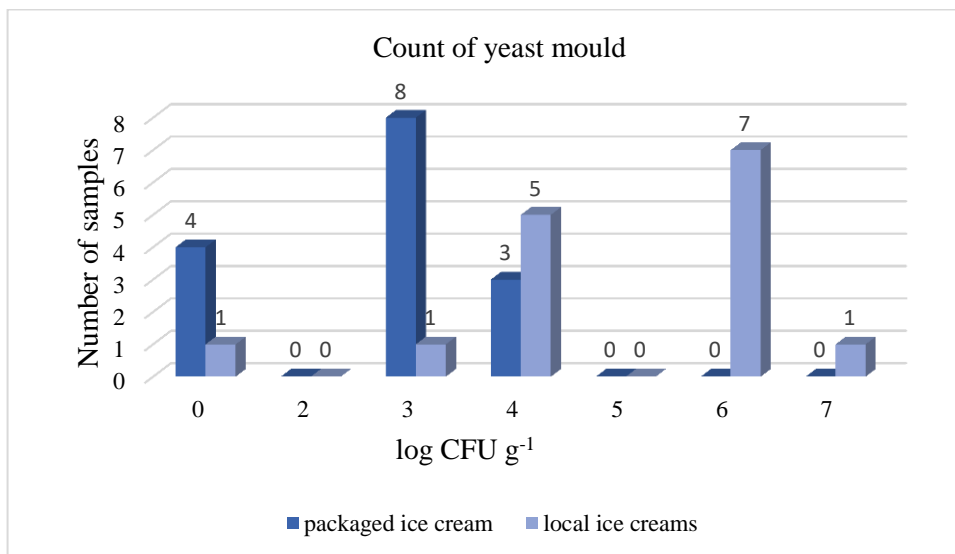


Figure 3. Comparison of the yeast-mould presence in the samples of packaged and local ice cream.

Figure 4 compares the count of coliform bacteria in packaged and local ice creams.

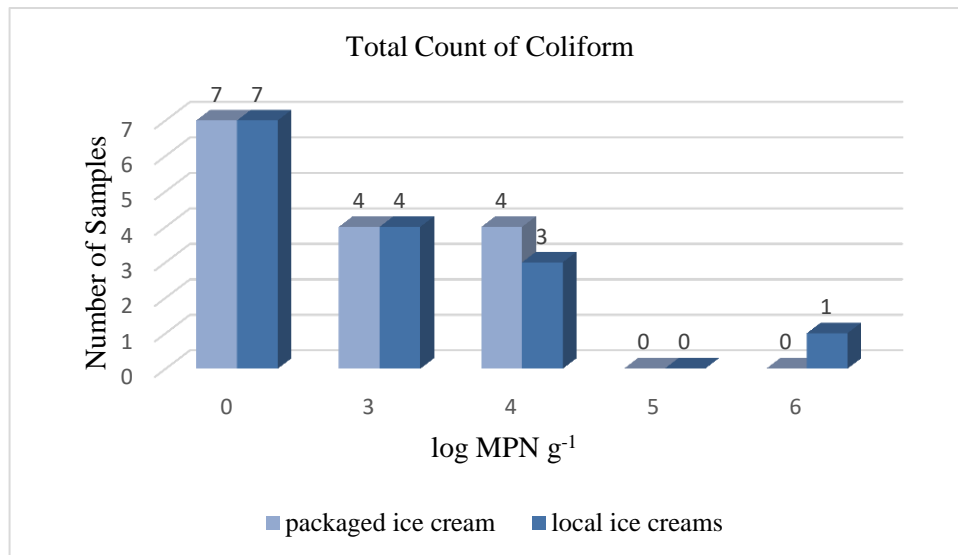


Figure 4. Comparison of the samples of packaged and local ice cream in terms of total coliform counts.

Coliform bacteria are commonly found in nature and the human intestine and are therefore accepted as a sanitation indicator. The lowest and highest total coliform bacteria values determined by MPN method were 3.38 and 6.54 log MPN g⁻¹, respectively. The *E. coli* count varied from 3.30 to 6.07 log MPN g⁻¹. Eight samples of packaged and local ice creams were above the acceptable limits for coliform bacteria. Figure 5 compares the samples of packaged and local ice cream for *E. coli* was discovered in six samples (40%) of packaged ice creams and four samples (27%) of local ice creams. Even though TFC requires that no *E. coli* be present at all, one sample of local ice creams was discovered to contain *E. coli* at a rate of 6.07 log MPN g⁻¹, posing a risk to public health.

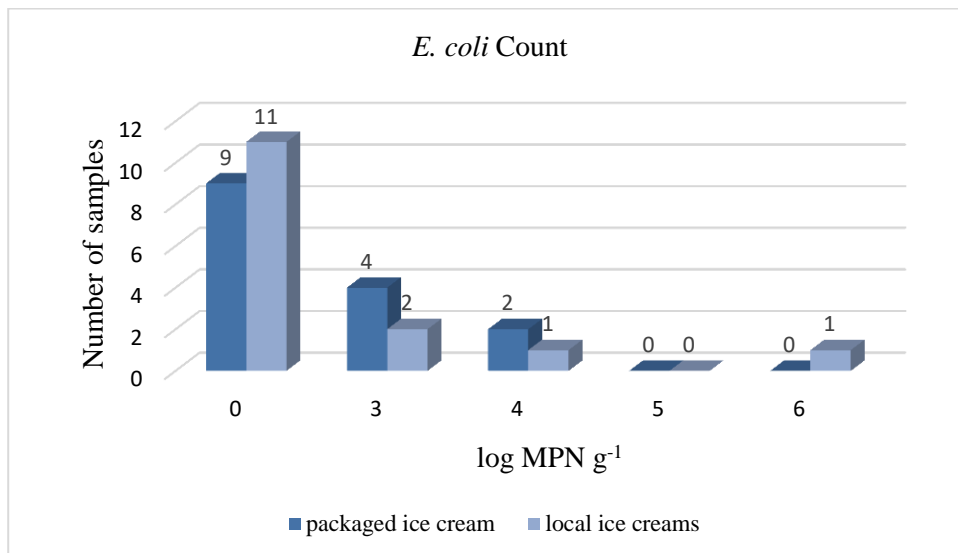


Figure 5. Comparison of the samples of packaged and local ice cream in terms of the presence of *E. coli*.

Discussion

Even though ice cream is kept at freezing temps during storage, ambient pathogen pollution is still a matter of public health issue (Mitropoulou et al., 2022). The presence of a high count of TMABs indicated that the samples were not produced and/or stored under hygienic conditions. Keskin et al.

(2007) live aerobic bacteria of 23.6% in total were identified. Our study identified that, 40% of the analyzed local ice cream samples and 23% of packaged ice creams had high levels of TMAB and therefore, they did not comply with the communiqué on microbiological criteria (TFC-2001). In the study conducted by Çelik et al. (1995) the total count of aerobic mesophilic bacteria was 1.6×10^7 CFU g^{-1} , and the maximum value was 6.0×10^7 CFU g^{-1} , but in this study, it is possible to assert that the analyzed ice creams were safer. In another study, 4.1% of 73 ice cream samples were found to be above the limit specified in the Turkish Food Codex (Yaman et al., 2006). In this study, revealed that 40% of the local ice cream samples and 23% of the packaged ice creams had more than 10^5 CFU g^{-1} and the rates were greater than those reported in similar studies. Korel et al., (2005) reported that, more than 10^5 CFU g^{-1} of TMAB was detected at the rates of 41.2% in unpackaged plain ice cream, 70.6% in chocolate ice cream, and 58.3% in fruit ice creams. In this study the average count of TMAB in local ice cream samples (45.13×10^5 CFU g^{-1}) was higher than the average count (0.74×10^5 CFU g^{-1}) in packaged ice cream samples, which is compatible with the findings of other researchers such as Warke et al. (2000), Akarca and Kuyucuoğlu (2008) and Çağlayanlar et al., (2009). The range of Total viable count and total coliform count in the ice cream samples was found $0-9.9 \times 10^9$ CFU/ml and $0-900$ CFU/ml, respectively. Interestingly, 93.75% of the total ice cream samples also showed fungal positive (Sohel et al., 2022). In this study TMAB count is similar, while the rate of yeast and mold is at a lower level.

Psychrophilic microorganisms in milk and dairy products are composed of groups, such as *Pseudomonas*, *Achromobacter*, *Flavobacterium*, *Yersinia*, *Listeria* and *Alcaligenes* species as well as certain Gram (-) bacilli. They can readily proliferate at temperatures below 15°C or even as low as 4°C . Although they do not generally lower the pH value, their protease and lipase enzymes lead to aroma and taste disorders. Even though psychrophilic microorganisms are inhibited by treatments, such as pasteurization and sterilization, they can spoil the products by producing heat-resistant enzymes. While the average count of TPABs in the analyzed samples of packaged ice cream was 3.38 log CFU g^{-1} , it was 5.78 log CFU g^{-1} in local ice creams. Since the psychotropic bacteria may grow even at low temperatures during storage, their presence in ice cream is critical. This causes the ice cream to spoil (Barman et al. 2017). When the findings of the psychotropic bacteria count were compared with the results of Barman (2017), who reported the presence of psychotropic bacteria in 100% of the small-scale ice cream samples and 78% of the large-scale ice cream samples analyzed, the packaged ice creams contained much less (13%) psychrophilic bacteria, but this is compatible with the count (73%) in ice creams locally sold. The result of the present study indicated that, local ice cream samples had higher levels of microorganisms in terms of TPAB count and this result is compatible with the findings of Korel et al. (2005) as well as Akarca and Kuyucuoğlu (2008). The TPAB count was found to be less than 4 log CFU g^{-1} in packaged ice creams and no more than 6 log CFU g^{-1} in local ice cream samples. This demonstrated that, the packaged ice creams analyzed were less contaminated than the local ice creams, and yet the production hygiene is still not at the desired level.

According to Alsagher (2021) 20 samples (66.7%) exhibited a significant amount of contamination, nevertheless, based on the total coliform count. The most of ice creams are, in conclusion, affected with germs, mainly *Escherichia coli*. Confirmatory tests were used to identify and count each test once it had been grown in accordance with the Iranian National Standard. According to the standard limit published by the Iranian Standard Department, 234 samples in total (85.4%) were not acceptable. *E. coli* were found in 10.9% of the samples, 72.2% and 80.2% of the samples, respectively, exhibited total Enterobacteriaceae and total microbe counts that were greater than the limits (Mohammadzadeh et al., 2021). The analysis's findings revealed that, all 30 samples cultivated aerobic mesophilic bacteria, moulds, and yeasts; just four (13.33%) lacked total coliforms (De Amarante et al., 2021). When compared with all these analysis findings, it is seen that the microbiological quality of the ice cream samples in our study is better.

The emulsifiers, inadequately processed sugar, sweeteners, utensils, equipment utilised, personnel, and the atmosphere may all contribute to forming yeasts and moulds in ice cream. The contamination caused by yeast and mould can cause the ice cream to spoil and result in significant economic losses, and certain mould types can be detrimental to public (Mathews et al., 2013; Edward et al., 2017). The different circumstances under which each sample is stored, distributed, or served lead to the variable of presence of yeast-mould in the analyzed samples (Kanbakan et al., 2004; Edward et al., 2017). The minimum and maximum yeast-mould counts in the ice cream samples ranged between 2 and 7 log CFU g⁻¹. While 73.3% of packaged ice creams contained an average of 3.56 log CFU g⁻¹ yeast-mould, an average of 6.55 log CFU g⁻¹ yeast-mould was identified in 93.3% of local ice creams. The packaged ice creams appear to be more hygienic than local ice creams. The detected values were found to be higher (25.3%) than those of Mathews (2013). The count of yeast-mould found in packaged ice creams was between 2 and 4 log CFU g⁻¹ identified by Barman (2017). However, the count of yeast-mould in locally produced and sold ice creams can reach up to 7 log CFU g⁻¹. To control yeast and mould contamination in ice cream, it is recommended that high sanitary standards be met, health training is provided, and adequate storage facilities are employed. These measures may reduce the higher the prevalence of micro-flora in the product (Barman et al., 2017).

Coliform bacteria are commonly found in nature in the human intestine and are therefore regarded as a sanitation indicator. Those that exist as natural flora in the lower digestive systems of humans and animals are referred to as "faecal coliforms" in this group. *E. coli* is a significant component of faecal coliforms. The presence of *E. coli* and/or faecal coliform in a portion of food suggests that it has been contaminated with faeces, either directly or indirectly, and other pathogen of the same origin may be present as well. The presence of *E. coli* in foods, drinking water, and potable water is therefore not requested (Doyle and Erickson 2006). In determining the environmental circumstances, coliform bacteria can be a useful biological indicator (Zubaidah et al., 2023). Eight samples (53.3%) of packaged and local ice creams were above the acceptable limits for coliform bacteria. The overall coliform quantity must be less than 2 log CFU g⁻¹, according to the Turkish Standards Institute (TS

4265). Akarca et al. (2008) reported that 44% of the ice cream samples in Afyonkarahisar province did not meet the standards in terms of coliform bacteria count. The findings of the study were similar to the results by Akarca.

The ice creams must not contain *E. coli*, according to the Turkish Standards Institute (TS 4265). Contamination is caused by poor personal hygiene and improper use of tools. *E. coli* was discovered in six samples (40%) of packaged ice creams and four samples (27%) of local ice creams. Nayak et al., (2020) found *E. coli* in 11.3% of the samples. *E. coli* was found in 22.09% of the ice creams available for consumption in Kahramanmaraş (Dıđrak et al., 2000). In another study, Keskin et al. (2007) found *E. coli* in 7.2% of the plain ice cream samples marketed in Istanbul. Abo El-Makarem (2017) reported that, *E. coli* was found in 48.96% of the unpackaged ice cream samples and 27% of the packaged ice cream samples. Turgay and Dereliođlu (2019) investigated the presence of some gastroenteritis bacteria in ice cream and found *E. coli* at the rate of 6.7%. While the presence of *E. coli* varies between studies, the packaged ice creams appear to be typically more hygienic than ice creams that are sold unpackaged.

Conclusion

The analysis revealed that the ice cream samples were not of the same quality, there were significant disparities between the producers, and the ice cream produced in major companies was more hygienic than the ice cream produced locally in patisseries. The ice cream must, therefore, be bought from reliable places, and not only the cost but also the quality of the ice cream should be taken into consideration. Ice cream that is past its expiration date, too firm, or too soft shouldn't be bought. The ice cream should either be consumed right after they have been bought or preserved in deep freezers. The usage of high-quality materials and the requisite practice of the production process are insufficient alone to ensure the microbiological reliability of ice cream. Microbial contamination from the air, tools and equipment, employees, and other sources is possible during the ice cream production process. The contamination following pasteurisation is particularly crucial for the ice cream quality and consumer health. The ice cream will no longer be a potential hazard in food poisoning and gastroenteritis by producing ice cream in modern facilities as much as possible, selecting raw materials, especially milk carefully, caring equipment and personnel hygiene, chlorinating water used at every stage of production, taking hygienic measures during production and sales, and preventing the contamination and pasteurizing the ice cream mixture.

Consequently, it was concluded that the findings of the packaged ice creams examined in this study were microbiologically close to the standards, similar to those of many other researchers (Aslantaş 2001; Korel et al., 2005; Akarca and Kuyucuođlu, 2008), and they did not pose a significant danger to public health, but that the microbiological quality of ice creams sold unpackaged was lower and may pose risks for public health.

Conflict of Interest

No conflict of interest was declared by the author.

Author's Contributions

All study done by Perihan AKBAŞ.

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