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Evaluating the shelf-life of pasteurized milk in Oman

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ABSTRACT

The aims of this study were to survey the current storage condition of pasteurized milk in Oman and to evaluate its physicochemical and microbiological stability. The results of the statistical survey indicated that 50% of the total outlets surveyed were in violation in terms of providing the conditions for storing pasteurized milk, where grocery stores formed the majority of those outlets in violation. The results of physicochemical and microbiological tests of samples, which were stored at temperatures of 5 °C and 8 °C for a period of 12 days from the date of production, indicated that the characteristics of pasteurized milk were not affected during the storage period, and their results were consistent with the standard specifications of pasteurized milk. Therefore, extending the shelf-life of pasteurized milk stored at 5 °C for a period of 9 days from the date of production is considered safe.

1. Introduction

Pasteurized milk is defined according to the Gulf Standard "Pasteurized Milk" (GSO 984:2015), as the raw or dried milk after being reconstituted and homogenized, and which all its ingredients have been exposed to pasteurization by heating to between 63-66 °C for 30 min or 72–74 °C for 15 s; then immediately cooled to a temperature not less than 4 °C and not more than 8 °C; to ensure extermination of all pathogenic organisms including *mycrobacterium tuberculoisis* and improve keeping quality during storage. This low-heat treatment destroyed spoilage organisms, but was low enough not to destroy the original characteristics of the milk.

Reducing food waste is one of the concerns in the Omani food sector, and as pasteurized milk is one of the most consumed food products, it ends with a lot of waste in form of expired products. Whereas, the Gulf standard "Expiration date for food products" (GSO 150-1:2013) and the GSO 984:2015 have specified the shelf-life of pasteurized milk should not exceed 5 days from the date of production. Additionally, the Gulf standard GSO 984:2015 specifies that pasteurized milk should be transported and stored at a temperature not exceeding 5 °C until consumption. The limited shelf-life of pasteurized milk leads to marketing impediments to the dairy industry in Oman, as the short shelf-life consumed during distribution, leaving no time for selling the product before its expiry date. Also, the limited shelf-life of pasteurized milk hinders the export of this product to neighbouring countries, which increases the challenges facing this sector. Extending milk shelf-life will solve these issues and enable manufacturers to improve their competency in the dairy market; through the production of longer shelf life products which allow wider distribution over areas and to new outlets. Therefore, extending the shelf-life of pasteurized milk will reduce waste and increase income from the dairy industry in Oman.

The quality of milk is a high concern in different countries because of low-quality raw material, improper refrigeration and an inadequate system of packing (Rankin, 2002), which lead to short shelf-life. Bacterial spoilage is regarded as the main factor limiting the shelf-life of pasteurized milk, as microbial growth reduce the shelf-life of milk by producing adverse changes in taste and aroma that affect consumer acceptability of the product (Fromm and Boor 2004). The optimum conditions of processing and storage of pasteurized milk, and the quality of raw milk, can extend shelf-life to 3 weeks, as reported by Sepulveda et al. (2005). According to Rysstad and Kolstad (2006), high hygienic processing can extend the shelf life of pasteurized milk significantly.

Cromie (1991) reported the factors that influence the shelf-life of pasteurized milk which include quality of raw material, temperature/pasteurization time, resistant microorganisms to pasteurization such as *psychrotrophics*, contaminants after pasteurization, packaging system, and storage temperature. The storage temperature after pasteurizing milk had the highest impact on milk stability. Cromie (1991) also found that high-quality raw material with good

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manufacturing practices and low storage temperature (3 °C) will lower bacterial load and improve sensory stability to pasteurized milk.

As cold storage is one of the major factors affecting the shelf-life of pasteurized milk produced in Oman, therefore the aims of the present study were survey the current storage condition of pasteurized milk in the Omani market and to evaluate the physicochemical and microbiological stability of pasteurized milk filled in high-density polyethylene (HDPE) bottle at storage temperatures of 5 °C and 8 °C.

2. Material & methods

2.1. Statistical survey

A sample survey was conducted to assess the conditions of storing pasteurized milk in various outlets in Oman (grocery, cold store and shopping center). The survey included ten states representing the following governorates: Muscat, Al Dhahirah, Al Dakhiliyah, South Al Batinah, South Al Sharqiyah and Buraimi. The survey determined the availability of temperature indicator in the pasteurized milk storage refrigerator, set temperature and actual temperature of the storage refrigerator. The survey collected data from 281 outlets selling pasteurized milk from various states of Oman during the month of July 2020.

2.2. Samples

Samples of pasteurized milk were provided by two leading companies in milk production in Oman, and they were denoted by the symbols A and B. The product was in a 200 ml High-Density Polyethylene (HDPE) bottle. The samples were stored at temperatures 5 °C and 8 °C to be examined physically, chemically and microbiologically in various time periods on day 1, 5, 7, 9, 12 of the production date.

2.3. Odour and color

A sensory evaluation of milk samples to ascertain the natural odour and color of milk during storage. The sensory evaluation of milk samples was determined by three panelists, trained members highly selected to their knowledge in dairy products evaluation, were asked to determine whether the milk was acceptable or unacceptable as shown in Table 1, where a response of acceptable implied that the panelist would be willing to drink. The milk bottle samples were removed from the fridge and left for 30 min at room temperature. The sample bottle shacked for 30 s, which allows volatile compounds to evaporate. Immediately after shaking, the bottle holds up to the nose and removes the lid while inhaling to evaluate odour followed by color evaluation. The sensory evaluation was conducted according to established ethical guidelines, and informed consent obtained from the panelist.

2.4. Physicochemical tests

Three units were tested for each sample in each of the specified storage periods. The tests were performed according to the standard "Methods of physical and chemical milk testing" (GSO 570:1994) and included the following tests: *Coagulation test*: the milk coagulation after adding 68% ethanol to the milk sample indicated an increase in acidity in the range of 0.22–0.23%, which is thus not suitable for the pasteurization process; *Acidity*: total acidity is measured by titration using NaOH and expressed as lactic acid; *pH:* The pH was measured in milk samples by means of a pH Meter; *Phosphatase test*: The phosphatase enzyme is measured to ascertain the efficiency of the milk pasteurization process by means of the solution disodium phenylphosphate which regulating the action of the enzyme.

2.5. Microbiological tests

Five units for each sample of pasteurized milk were analysed according to "Microbiological Criteria for Foodstuffs" (GSO 1016:2015), where the following tests were performed: *Enumeration of Total Count*: according to ISO 4833-1:2013 method for enumeration of microorganisms that are able to grow and form colonies in a solid medium after aerobic incubation at 30 °C for a period of 72 h; *Enumeration of Escherichia coli*: according to ISO 16649-1:2018 method for the enumeration of *Escherichia coli* by colony-count technique after resuscitation using membranes and incubation at 44 °C on a solid medium for 24 h; *Enumeration of Coliforms*: was carried out by ISO 4832:2006 test for growth in dishes at 37 °C for 24 h; *Enumeration of Enterobacteriaceae*: according to ISO 21528:2017 test to count dishes at 37 °C for 24 h; *Enumeration of Psychotrophic*: tested according to ISO 6730:2005 method for the enumeration of colony-forming units of *psychrotrophic* microorganisms in raw and heat-treated milk by means of the colony-count technique at 6.5 °C for 10 days.

2.6. Statistical tests

The results of the statistical survey were analysed by Excel program, as well as the physicochemical and microbiological data were analysed in terms of mean, standard deviation and significant differences.

3. Results and discussion

3.1. Statistical survey

The statistical survey was conducted to know the storage conditions of pasteurized milk in various retail markets in Oman, which included 281 outlets, including groceries, cold stores and shopping centers. Table 2 illustrated the storage temperature of pasteurized milk in retail outlets in Oman, fridges without temperature display, range of actual temperature, percentage of retail storage above 5 °C, and percentage of retail storage above 7 °C.

The results of the survey showed that 15% of the surveyed pasteurized milk outlets their refrigerators do not contain a display showing the actual temperature of the refrigerator. The actual temperature in pasteurized milk refrigerators varied between 1.4-13.1 °C for grocery stores, between 3.6-17.1 °C for cold stores, and 0.7–12 °C for shopping centers. The percentage of outlets selling pasteurized milk whose refrigerator temperature exceeded 5 °C (the temperature of pasteurized milk storage specified by GSO 984:2015 standard) reached 50% of the total outlets surveyed, grocery stores represented 26% of them; while shopping centers represented 15.7% and cold stores 8.5%. The percentage of outlets selling pasteurized milk whose refrigerator temperature exceeded 7 °C reached 31% of the total outlets surveyed, grocery stores accounting for 14.2% of them, while shopping centers represented 11% and cold stores 6.1%.

Table 1. Odour and color evaluation questionnaire.

Milk Sensory Evaluation			
Panellist code:		Sample code:	
Parameters	Acceptable	Not sure	Unacceptable
Odour			
Color			

Table 2. Storage temperature of pasteurized milk in retail outlets in Oman ($n = 281$).

Type of retail	% fridge without temp. display	Range of actual temp.	% of retail > 5 °C	% of retail > 7 °C
Grocery	10.3	1.4–13.1	26.0	14.2
Cold store	2.9	3.6–17.1	8.5	6.1
Shopping center	1.8	0.7–12.0	15.7	11.0
Total	***15 %***		***50.2 %***	***31.3 %***

The results of the statistical survey indicated that half of the surveyed outlets selling pasteurized milk did not adhere to the requirements for storing pasteurized milk (5 °C), which is one of the mandatory requirements described in the GSO 984:2015 standard. The survey results also revealed that 31% of the outlets surveyed did not comply with the "Health Requirements for Activities Related to Public Health 29:2016" (HRA 29:2016) issued by the Ministry of Regional Municipalities and Water Resources, which required that refrigerated foodstuffs be kept at a temperature ranging from 1-4 °C, and it should not exceed 7 °C. Therefore, the storage of pasteurized milk to more than 7 °C is considered a violation of HRA 29:2016, and the fine for this act is 20 Omani Riyals for the violating outlets and destroying what proves unfit for human consumption. The HRA 29:2016 also set requirements for transporting refrigerated foodstuffs, whereby milk and dairy products were required to be transported at temperatures ranging from 1 to 5 °C, and a fine of 20 Omani Riyals was set for violating the transport requirements and destroying what proves unfit for human consumption. The survey indicated that grocery stores are the most non-compliance outlets in terms of pasteurized milk storage temperatures, (26%). Therefore, control over these groceries should be tightened and awareness of the importance of adhering to the storage conditions of pasteurized milk and the violations that result in non-compliance.

3.2. Odour and color

All sensory tests of samples during the storage period, which lasted for 12 days, reported that samples were natural in their odour and color and did not change in a way that affected the product. As there were no fermenting or rancid odors and the color of the product was bright white throughout the storage period, which complies with the requirements of the GSO 984:2015 standard.

3.3. Physicochemical tests

Table 3 shows the results of physicochemical tests for pasteurized milk products A and B kept at a temperature of 5 °C during a storage period of 1, 5, 7, 9 and 12 days from the date of production, while Table 4 shows the results of physicochemical tests for pasteurized milk products stored at a temperature of 8 °C. The results of tests for pasteurized milk were evaluated according to the requirements of the GSO 984:2015 standard.

The coagulation test is used to detect the curdling of milk due to the presence of high acidity, as it depends on the tendency of milk protein to be unstable as a result of disturbance of the mineral balance of the milk. The coagulation or precipitation of milk in this test indicates that the acidity is higher than 0.23% and is considered unfit for pasteurization. The coagulation test reported negative results for all pasteurized milk samples, whether stored at 5 °C or 8 °C (Tables 3 and 4), as no precipitation or coagulation occurred to the milk when alcohol was added, indicating that the acidity is lower than 0.23%.

The GSO 984:2015 standard specified that total acidity as lactic acid in pasteurised milk should not exceed 0.18%, and in light of this, the samples were evaluated during different storage periods. The acidity for all samples did not increase beyond the standard limits during the 12-day storage. However, there was a difference between the acidity of products A and B, as it ranged in product A between 0.16-0.18% and in product B between 0.14- 0.16 %. The acidity ratio is an indicator of milk age and its microbial load, as acidity increases due to an increase in microbial load that works to produce lactic acid from milk sugar (lactose). Fromm and Boor (2004) supported our findings, as they found no acidity differences between milk samples stored at 6 °C on the initial day and 7 days of production, then increased were significant at day 14 and day 17.

The GSO 984:2015 standard did not mention pH limits in pasteurised milk, but other international standards (Kenya Standard DKS 2191:2015) stated that it should range between 6.5-6.8. The results reported in Tables 3 and 4 shows that pH of the samples matched the requirements of international standards. Also, the pH was not affected during the storage period or by the different storage temperatures (5 and 8 °C), as it ranged between 6.58 to 6.76 for product A and between 6.57-6.75 for product B.

Phosphatase is an enzyme that is naturally present in milk, but is eliminated when exposed to the temperature of pasteurization, so the phosphatase test is used to indicate whether the milk is sufficiently pasteurized or whether it has been contaminated with raw milk after pasteurization. This test is based on the principle that the enzyme alkaline phosphatase in raw milk liberates phenol from disodium phenyl phosphate and forms a yellow complex which its intensity is proportional to the activity of the enzyme. This test does not apply to yogurt and milk with chemical preservatives. The GSO 984:2015 standard required that

Table 3. Physicochemical tests of pasteurized milk during different storage periods at 5 °C.

Storage (days)	Product	Odour	Color	Coagulation	Acidity (%)	pH	Phosphatase
Day 1	A	Normal	Normal	-	0.18 ± 0.00	6.76 ± 0.00	-
	B	Normal	Normal	-	0.15 ± 0.00	6.75 ± 0.00	-
Day 5	A	Normal	Normal	-	0.16 ± 0.00	6.71 ± 0.01	-
	B	Normal	Normal	-	0.14 ± 0.00	6.71 ± 0.00	-
Day 7	A	Normal	Normal	-	0.17 ± 0.00	6.70 ± 0.01	-
	B	Normal	Normal	-	0.15 ± 0.00	6.71 ± 0.00	-
Day 9	A	Normal	Normal	-	0.17 ± 0.00	6.58 ± 0.00	-
	B	Normal	Normal	-	0.15 ± 0.00	6.57 ± 0.00	-
Day 12	A	Normal	Normal	-	0.18 ± 0.00	6.70 ± 0.00	-
	B	Normal	Normal	-	0.16 ± 0.00	6.71 ± 0.02	-
Standard limits*		Normal	Normal	-	≤ 0.18	6.5–6.8	-

- Negative results; * GSO 984:2015 and DKS 2191:2015.

Table 4. Physicochemical tests of pasteurized milk during different storage periods at 8 °C.

Storage (days)	Product	Odour	Color	Coagulation	Acidity (%)	pH	Phosphatase
Day 1	A	Normal	Normal	-	0.17 ± 0.01	6.74 ± 0.00	-
	B	Normal	Normal	-	0.15 ± 0.00	6.74 ± 0.00	-
Day 5	A	Normal	Normal	-	0.16 ± 0.01	6.70 ± 0.00	-
	B	Normal	Normal	-	0.14 ± 0.00	6.71 ± 0.00	-
Day 7	A	Normal	Normal	-	0.16 ± 0.01	6.71 ± 0.00	-
	B	Normal	Normal	-	0.15 ± 0.03	6.71 ± 0.00	-
Day 9	A	Normal	Normal	-	0.16 ± 0.01	6.58 ± 0.00	-
	B	Normal	Normal	-	0.16 ± 0.00	6.59 ± 0.00	-
Day 12	A	Normal	Normal	-	0.14 ± 0.01	6.69 ± 0.01	-
	B	Normal	Normal	-	0.15 ± 0.00	6.70 ± 0.00	-
Standard limits*		Normal	Normal	-	≤ 0.18	6.5–6.8	-

- Negative results; * GSO 984:2015 and DKS 2191:2015.

pasteurized milk should give a negative result for the phosphatase test, and it was negative for all study samples, which confirms the efficiency of the pasteurization process for producers A and B.

3.4. Microbiological tests

The shelf-life of pasteurized milk is greatly influenced by the quality of milk and the extent of milk contamination with microorganisms resistant to heat treatment. Pasteurized milk may contain types of heat-resistant bacteria that can grow at low temperatures and represent a major factor in reducing the shelf-life of pasteurized milk. Table 5 shows the results of microbiological tests for pasteurized milk products kept at 5 °C during a storage period of 1, 5, 7, 9 and 12 days of production, while Table 6 shows the results of microbiological tests for pasteurized milk products kept at 8 °C. The results of microbiological tests for milk samples were evaluated according to the "Microbiological Criteria for Foodstuffs GSO 1016:2015".

The number of aerobic colonies in pasteurized milk varied between products A and B during the storage period, ranging between 3960-8680 cfu/ml in product A samples and between 15-48 cfu/ml for product B. Salji et al. (1988) reported a similar result for the total count in pasteurised milk was 3200 cfu/ml after 10 days of storage at 7 °C. The low number of aerobics colonies in product *B may* be due to the pasteurization temperature of the milk, as it was pasteurized at 85 °C while product A was pasteurized at 78 °C. Furthermore, this difference could be due to the microbiological quality of the raw milk. Despite the positive role of high heat treatment in reducing the microbial load of milk, it has a negative role in its effect on the organoleptic properties such as color, taste and smell, in addition to the nutritional value of vitamins and enzymes being affected. The results of this study show no significant effect in total count among each product, neither from storage temperature or length of storage period which lasted 12 days. These results were consistent with the requirements of the GSO 1016:2015 standard, as the standard specified that the number of total count in pasteurized milk should not exceed 100000 cfu/ml of milk. The microbial load in pasteurized milk could be due to post pasteurization contamination by Gram-negative bacteria or due to Gram-positive bacteria which survive the temperature of pasteurization (Boor and Murphy, 2002). Petrus et al. (2010) reported similar microbiological stability, since the total count in the milk in HDPE bottle did not reach 10000 cfu/ml after 10 days of storage at 4 °C.

Escherichia coli is found in the intestine of warm-blooded animals, including dairy cows, where raw milk is contaminated with it through contact with fecal matter. However, the heat treatment of milk's pasteurization is sufficient to eliminate these bacteria, and their presence in pasteurized milk after that is an indication of contamination after pasteurization. The *Escherichia coli* test gave negative results for all study samples during the storage period, as no growth was observed in all test dishes and it was expressed as less than 1 (<1) according to the requirements of ISO 7218:2007. This result is consistent with the requirements of the GSO 1016:2015 standard, as the standard required that pasteurized milk should be free of any colonies of *Escherichia coli*.

Coliform bacteria are usually used to monitor milk quality, as it is made up of a group of Gram-negative bacteria, including *Escherichia coli*. This group of bacteria is able to ferment lactose to produce acid and gas within 48 h at 35 °C, and it grows with or without oxygen. Due to the ease of coliform bacteria are eliminated by heat, the presence of this bacteria in milk can is an indicator of failure and post-contamination of heat treatment. The coliform test gave negative results for all study samples and during the storage period, as no growth was observed in all test

Table 5. Microbiological tests of pasteurized milk during different storage periods at 5 °C.

Storage (days)	Product	Total count (cfu/ml)	*E. coli* (cfu/ml)	*Coliforms* (cfu/ml)	*Enterobac.* (cfu/ml)	*Psychotrophic* (cfu/ml)
Day 1	A	7760	<1	<1	<1	<1
	B	40	<1	<1	<1	<1
Day 5	A	4760	<1	<1	<1	<1
	B	33	<1	<1	<1	<1
Day 7	A	8680	<1	<1	<1	<1
	B	38	<1	<1	<1	<1
Day 9	A	4300	<1	<1	<1	<1
	B	32	<1	<1	<1	<1
Day 12	A	3980	<1	<1	<1	<1
	B	15	<1	<1	<1	<1
Standard limits*		≤100000	0	≤10	≤5	≤100000

* GSO 1016:2015, SASO 40:1990 and MFA 1983.

Table 6. Microbiological tests of pasteurized milk during different storage periods at 8 °C.

Storage (days)	Product	Total count (cfu/ml)	*E. coli* (cfu/ml)	*Coliforms* (cfu/ml)	*Enterobac.* (cfu/ml)	*Psychotrophic* (cfu/ml)
Day 1	A	7800	<1	<1	<1	<1
	B	25	<1	<1	<1	<1
Day 5	A	4800	<1	<1	<1	<1
	B	25	<1	<1	<1	<1
Day 7	A	6240	<1	<1	<1	<1
	B	33	<1	<1	<1	<1
Day 9	A	3960	<1	<1	<1	<1
	B	48	<1	<1	<1	<1
Day 12	A	3960	<1	<1	<1	<1
	B	20	<1	<1	<1	<1
Standard limits*		≤100000	0	≤10	≤5	≤100000

* GSO 1016:2015, SASO 40:1990 and MFA 1983.

dishes. This result is in line with the Saudi standard (SASO 40:1990), as the standard required coliform bacteria in pasteurized milk should not exceed 10 cfu/ml of milk. Salji et al. (1988) reported a similar result with no change in the coliform count (<10 cfu/ml) during 10 days of storage of pasteurized milk at 7 °C.

Enterobacteriaceae is a group of Gram-negative bacteria. The main feature of this test is to detect the classic coliform group of bacteria, in addition to all other non-coliform Gram-negative groups that are common contaminants after pasteurization of milk. All samples of pasteurized milk gave negative results during the entire storage period, as no growth was observed in all test dishes. This result is consistent with the requirements of the GSO 1016:2015 standard, as the standard required that *Enterobacteriaceae* bacteria in pasteurized milk should not exceed 5 cfu/ml of milk.

Psychotrophic is microorganisms that have the ability to grow at low temperatures (7 °C), where the optimum and maximum temperatures for their growth are from 15 to 20 °C respectively. This property makes these microbes of particular importance with regard to food spoilage and safety. The results of *Psychotrophic* test were negative for all study samples and during the storage period, as no growth was observed in all test dishes. This result complies with the requirements of international standards Malaysian Food Act 1983 (MFA 1983), which specified that the number of *Psychotrophic* should not exceed 100,000 cfu/ml of milk. Petrus et al. (2010) stated higher *psychrotrophic* counts of 100 cfu/ml after 10 days of storage at 4 °C. Karatapanis et al. (2006) studied the stability of pasteurized milk in HDPE bottles and reported that the *psychrotrophic* counts were above 1000 cfu/ml at 0 times, and the counts have increased to more than 100000 cfu/ml after 7 days of storage at 4 °C. The Gram-negative *Psychrotrophic* reported as a common post contaminants of pasteurized milk (Cromie 1991; Gruetzmacher and Bradley 1999). Control these Gram-negative post pasteurization in processing will prolong the shelf-life and revealed the other hurdles to extend the shelf life of pasteurized milk (Ralyea et al., 1998). Low *psychrotrophic* load in milk is essential for its quality, as the metabolic activity of these microorganisms leads to biochemistry changes in milk constituents. This includes alterations in flavor, odor, and appearance of the product.

The results of this study indicated that the characteristics of pasteurized milk, whether physical, chemical or microbiological, were not affected during the storage period of 12 days at temperatures of 5 °C and 8 °C and their results were consistent with the standards of pasteurized milk. Therefore, extending the shelf-life of pasteurized milk at 5 °C for a period of 9 days from the date of production is considered a safe period. Although the 12 days shelf-life was safe, the 9 days at 5 °C was recommended as a safety precaution from the temperature fluctuation during handling and storage. The main object of this study was to reduce the loss in pasteurized milk caused by the short shelf-life by prolonging it; which is proved by this study increasing the shelf-life by almost double. The shelf-life of pasteurized milk is highly influenced by its storage temperature, Simon and Hansen (2001) stated similar recommendation that pasteurized milk has a shelf-life between 10 to 15 days when storage temperature between 8 °C to 4 °C respectively, while Petrus et al. (2010) reported microbiological stability of pasteurised milk varied from 36 to 7 days when stored at 4 °C–9 °C, respectively. Labuza (1982) also had a shelf-life of approximately 10–20 days when stored pasteurised milk at 6.1 °C.

4. Conclusion

The results of the statistical survey of pasteurized milk storage conditions in Oman indicated that 50% of the total outlets surveyed were in violation in terms of providing the conditions for storing pasteurized milk, where grocery stores formed the majority of those outlets in violation. The results of physicochemical and microbiological tests of pasteurized milk samples, which were stored at temperatures of 5 °C and 8 °C for a period of 12 days from the date of production, indicated that the characteristics of pasteurized milk were not affected during the storage period, and their results were consistent with the standard specifications of pasteurized milk. Therefore, extending the validity of pasteurized milk at 5 °C for a period of 9 days from the date of production is considered a safe period that guarantees the safety and quality of pasteurized milk for consumption in the event that the production and storage conditions recommended in the relevant standards and requirements are adhered to.

Declarations

Author contribution statement

M. Al-Farsi: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

I. Al-Gharibi, H. Al-Hashmi, S. Al-Shibli: Performed the experiments; Analyzed and interpreted the data.

A. Al-Abri, A. Al-Humaimi, F. Al-Nabhani, K. Al-Sarmi: Performed the experiments.

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Data availability statement

Data included in article/supplementary material/referenced in article.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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