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The Effect Of Partial Replacement Of Cow's Milk Prepared For The Manufacture Of Low-Fat Monterrey Cheese With Skim Buffalo Milk On The Traits Of Product Quality

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Abstract:

The current study was conducted to determine the effect of replacing cow's milk prepared for the manufacture of low-fat Monterrey cheese with different percentages of buffalo milk on the chemical, rheological, sensory, and yield percentage of Monterrey cheese. Whole cow's milk was used as a control treatment (C), full-fat buffalo milk (T1) and sorting buffalo milk, which was divided into four sections. As for the other three sections, they were used for the manufacture of Monterrey cheese for the treatments T3, T4 and T5, in which cow's milk was replaced by skim buffalo milk,in percentage (25, 50 and 75%) respectively, Chemical tests were conducted, which included estimating the percentage of moisture, protein, fat, carbohydrates, ash, and total acidity, in addition to estimating the pH, while the rheological tests included checking the hardness, flexibility, and cohesion, in addition to estimating the percentage of yield and performing sensory evaluation. The results showed a high percentage of moisture in the replacement treatments, in addition to a decrease in the percentage of solids represented by protein, fat and ash, and the percentage of carbohydrates varied compared to the control treatment. It has also noted a high percentage of stiffness for the substitution coefficients compared to the control treatment, while the elasticity and cohesion decreased for the substitution coefficients compared with the control treatment. The percentage of cheese yield decreased in the replacement treatments compared to the control treatment. The results also showed an improvement in the sensory properties of the addition treatments compared to the control treatment.

Keywords: cow's milk, low-fat Monterrey cheese, Skim buffalo milk, product quality

Introduction

Milk is the fluid secreted by the mammary glands of all females. The main function of milk is to provide the body with the nutrients needed to meet the growing needs of the newborn and to provide immune protection for the newborn. Fox et al,2015 ,Milk is a very complex liquid, containing several hundred or even several thousand molecular species in addition to the main components of water, fats, carbohydrates, proteins, and salts.In addition, there are many micro-components, most of which are in trace levels (eg, vitamins and various other compounds (Fox et al., 2015)Buffalo milk is used alone or after mixing with other types of milk to produce yoghurt. Buffalo milk is characterized by a higher concentration of fat, protein, total solids, calcium and phosphorous compared to other types of milk.

The yoghurt produced from this milk has good structural and sensory properties (Erkaya and Sengul, 2012; Murtaza et al, 2013; Nguyen et al, 2013; Bilgin, and Kaptan, 2016; Pelegrine and Silva, 2014).

Cheese manufacture was known in Mesopotamia 6000-7000 years ago, when the skins of slaughtered ruminants were used as containers for preserving the milk of these animals. There are a large number of varieties of cheese, more than 1000 varieties in different parts of the world (Guggisber et al 2017).Dairy products are one of the most common options for reducing the percentage of fat. Through previous experiments and studies, it was found that removing fat from dairy products significantly affects the texture and composition due to the low total of total solids in them, which results in products with a weak texture and texture (Tansman, 2014).Monterey cheese is a semi-dry and ripe American cheese that requires a long process of ripening to reach the flavor, taste and qualities of Monterey cheese (Al-Dahhan, 1983).our study included the manufacture of low-fat Monterey cheese by replacing part of the cow's milk used in the manufacture with different percentages of buffalo milk.The current study aimed to show the effect of replacing cow's milk with different percentages of buffalo milk on the physicochemical, rheological, and sensory properties of low-fat Monterrey cheese immediately after processing and during the ripening period.

Materials and methods:

1- Materials: Raw cow's milk and buffalo milk were used, and the starter was made up of strains of Lactococcus lactis subsp and Lactococcus lactis subsp Cremoris bacteria.

Produced by the French company Dinesco. The direct addition method and the percentage of addition according to what is indicated by the producing company Microbial rennet was used to make cheese from Co. Ltd. Meito sengyo Co. Japanese and within the shelf life.

2- Working methods:

Manufacture of Monterrey cheese: Manufacture of Monterrey cheese according to the method described by Al-Dahhan (1983), as it took a quantity of full-fat cow's milk and full-fat buffalo milk from the milk processing point in the Babylon province.Whole cow's milk was used in the manufacture of the control treatment, while the buffalo milk was divided into two parts.The first part of it was used in the manufacture of the cheese of the T2 treatment, in which the fat of buffalo milk was replaced with vegetable fat, and the second part of this milk was used in the manufacture of the cheese of the treatments T3, T4 and T5, in which cow's milk was replaced by the Skim buffalo milk in proportions of 25, 50 and 75% respectivelyPasteurized all types of milk at 62.8°C for 30 minutes. The milk was cooled to 32°C and the starter was added at an average of 0.004% g/L (according to the specified quantity from the starter producing company) and left for half an hour as the acidity developed to 0.18%.Rennet was added in the right amount and mixed with milk for 5 minutes and waited for the clotting to take place within 30 minutes. Then the curd was cut with longitudinal and transverse knives, then left for 5 minutes without moving, then the curd was cooked by raising its temperature to 39°C for 30 minutes using steam in the vacuum of the cheese basin while moving the curd quietly and continuing to move the curd after reaching this temperature until the acidity of the whey became 0.2 % (as lactic acid) in a period of 90 minutes after that drain the whey to a distance of 2.5 cm above the level of the clot and then replace the drained whey with the same amount of cold water at a temperature of 20°C,Resulting in reducing the temperature of the curd to 30°C, then mixing well for five minutes and draining the washing water from the basin, and adding salt at an average of 2.5% of the curd's weight. The curd was then packed into container molds on a clean cloth and pressed.

Chemical tests for cheese:

The moisture content was estimated according to the method mentioned in A.O.A.C (2005). Total nitrogen was estimated according to the method mentioned by FSSAI (2015). The percentage of fat was also estimated by the Kerber method, which was mentioned in Min and Ellefson, (2010).
The percentage of carbohydrates was also estimated using the mathematical method by subtraction, according to what Ihokoronye and Ngoddy (1985) mentioned.The percentage of ash was estimated by the direct burning method as mentioned in A.O.A.C (2005) and the pH of cheese was estimated according to the method mentioned in Ling (2008) and the acidity was estimated according to the method mentioned in A.O.A.C (1980).

Yield percentage Calculation:
The yield percentage was calculated by collecting the product of the mass of cheese produced to the weight of the milk used in cheese-making ((Mistry, Kosikowski 1999).
Tissue estimation tests: The texture of cheese parameters were estimated using a tissue analyzer (CT3, 4500 Brookfield engineering lab) with a carrying force of 5 kg, according to what Joon et al mentioned (2017).

sensory evaluation for cheese:
Sensory tests for Monterey cheese samples were conducted in the Department of Dairy Science and Technology - College of Food Sciences - Al-Qasim Green University by a number of specialized professors, according to the sensory evaluation form created by Al-Dahhan (1977).

The chemical composition of Monterey cheese
Moisture content: The results in Table (1) show the moisture content of the different treatments of Monterrey cheese during the three-month ripening period, as the results were taken in three stages (1, 45, 90 days),Where the moisture percentage for the control treatment C in which cheese is made from whole cow's milk on the first day was 42.45%, for the treatment of full fat buffalo milk T1 it was 42.15%, and for the treatment of buffalo milk replaced entirely with vegetable fat T2 it was 41.33%As for the partial replacement treatments of cow's milk with different percentages of buffalo milk (T3, T4, T5), they amounted to 43.33, 44.75 and 45.0%, respectively (the reason for the increase in the substitution treatments compared to the control treatment may be due to the replacement of cow's milk by the skim buffalo milk). These percentages all fall within the moisture content determined by the Iraqi standard (1988) for semi-dry cheeses, which is between 40-50.These results also agree with what was found by Al-Obaidi et al (1988), which indicated that the moisture content of Monterrey cheese produced from fresh milk was 44.38%. The reason for these differences in the percentage of moisture in the early stages of ripening may be due to the pressing process and its inhomogeneity between different treatments (Darwish et al, 1989: El-Soda et al, 1990).It is also noted that the moisture content is high in all the replacement transactions with skim buffalo milk compared to other treatments. This result is consistent with what was found by Visser (1991), who indicated that the reduction of fat leads to a high percentage of moisture in low-fat cheddar cheese made from skim milk.It is also noted from the results that the values of moisture content of all the cheeses decreased with the progression of the ripening period, where the values after 45 days for treatment C, T1, T2, T3, T4 and T5 were 41.33%, 41.0, 40.45, 42.34, 43.47, 44.35%, respectively.The reason for the decrease in moisture may be due to the evaporation of a part of the moisture during ripening despite the wax coating of these cheeses, and this result is consistent with what was mentioned by Hofi et al (1991) El-Sissi and Neamat-Allah 1996. After 90 days of ripening (the end of the ripening period), the moisture content of the treatments (C, T1, T2, T3, T4 and T5) was 40.5, 39.0, 39.5, 41.0, 42.65, 43.75%, respectively.

Table 1: Chemical composition of monterey cheese for the different treatments (C, T1, T2, T3, T4 and T5).

Treatment	Storage Period(day)	Moisture%	Protein%	Fat%	Carbohydrates%	Ash %
C	1	42.45	22.84	26.8	6.61	1.30
	45	41.33	24.30	27.7	5.32	1.35
	90	40.5	26.15	29.2	2.75	1.40
T1	1	42.15	24.88	30.5	1.13	1.34
	45	41.0	25.52	31.5	0.58	1.40
	90	39.0	27.0	32.5	0.05	1.45
T2	1	41.33	23.60	29.0	4.57	1.50
	45	40.45	24.90	30.1	2.96	1.59
	90	39.5	26.80	31.0	1.04	1.66
T3	1	43.33	23.92	25.0	6.12	1.63
	45	42.34	26.15	26.8	3.0	1.71
	90	41.0	27.75	27.6	1.88	1.77
T4	1	44.75	24.24	20.0	9.41	1.60
	45	43.75	27.43	22.45	4.96	1.69
	90	42.65	28.07	24.78	2.78	1.72
T5	1	45.0	25.20	19.0	9.27	1.53
	45	44.35	27.75	21.5	4.83	1.57
	90	43.75	29.02	23.8	1.8	1.63
LSD	----	*4.88	*4.37	*6.22	*2.79	*0.452

Where: C = control-treated cheese, and T1 = cheese treated with full-fat buffalo milk, and T2 = cheese treated with substituted sorting buffalo milk fat with vegetable fat, and T3 = cheese treated with partially substituted cow's milk with 25% buffalo milk and T4 = cheese treated with 50% partially substituted cow's milk buffalo milk and T5 = cheese treated with 75% partly replaced cow's milk from buffalo milk

These results agree with what was found by (El-Soda et al, 1990, Hofi et al, 1991, El-Sissi and Neamat-Allah, 1996), which indicated a decrease in the moisture content in different types of semi-dry cheeses with the progression of the ripening period.It is clear from the statistically analyzed results that there are non significant differences at (0.05 p ≤ p) on the first day and during the ripening period.

Protein percentage: The results in Table (1) show the percentage of protein for the different Monterey cheese treatments during the three-month ripening period. The results were taken in three stages (1, 45, 90 days), where the percentage of protein for the control treatment C for the first day was 22.84 %, and for the treatment of full fat buffalo milk T1 is 24.88% and for the treatment of buffalo milk replaced with vegetable fat T2 it was 23.60%, while for the treatments in which cow's milk was replaced with different percentages of buffalo milk (T3, T4, T5), it was 23.92, 24.24, 25.20%, respectively.This result is identical to what was reached by El-Soda et al (1990), El_Shafei and Ezzat (1991), and the protein percentage we reached are among the protein levels recorded in the semi-dry cheeses mentioned by Al-Shrajee (2002).It is also noted from the results that the percentage of protein was higher for the treatments of cheese produced from buffalo milk compared to its percentage for the control treatment in which cheese was made from cow's milk, as well as the replacement treatments for buffalo milk in different proportions.The reason for this may be due to the chemical composition of buffalo milk, which is characterized by a higher percentage of protein, especially casein, in comparison to cow's milk (Murtaza et al, 2008). Tahira et al indicated (2014).The large differences between species in the concentration and types of caseinate and milk contents are reflected in the characteristics of the cheese produced.It is also noted from the results that the protein ratios of all the cheese treatments increased with the progression of the ripening period, where the values after 45 days for the treatments (C, T1, T2, T3, T4 and T5) were 24.30, 25.52, 24.90, 26.15, 27.43, 27.75 percent, respectively. After 90 days, the treatments (C, T1, T2, T3, T4, T5) were 26.15, 27.0, 26.80, 27.75, 28.07, 29.02%, respectively. This result is identical to what was found by (El-Soda et al, 1990 Shafei, -Ezzat 1991 El) of the increase in the percentages of protein with the progression of the ripening age of the cheese due to the decrease in the moisture levels in the treatments with the progression of ripening. This result is consistent with what was mentioned by Licitra et al, (2000), which indicated a high percentage of Coda cheese protein during the ripening period.It is noticed from the statistically analyzed results that there are no significant differences between the treatments (0.05 ≤ P) compared with the control treatment (C) on the first day and with the progression of the ripening period.

Fat percentage: The results shown in Table (1) show the percentage of fat in the different monterey cheese treatments, as the percentage of fat for treatment C is 26.8%, for treatment T1 30.5%, for treatment T2 it is 29.0%, and for replacement treatments 25.0, 20.0, 19.0% Respectively. The reason for this discrepancy in the percentage of fat is due to the difference in the values of moisture content between treatments (Ezzat El-, 1991; Shafei, Lane and Fox 1996; El-Batawy et al, 1992), Souza et al (2012) indicated that cheeses that contain More fat in whey keeps less water in the product.It is also noted that cheese manufacture from full-fat buffalo milk has a higher yield and greater fat content compared to cheese manufacture from cow's milk.The reason for this may be due to the fact that the buffalo milk used in the replacement was filtered milk, in addition to the fact that the fat loss of buffalo milk with whey is relatively less than that of cow's milk fat (Aly and Gala, 2002).It is also noted from the results that the percentage of fat increases with the advancing age of puberty; The percentage of fat after 45 days for the treatments (C, T1, T2, T3, T5, T4) was 27.7, 31.5, 30.1, 26.8, 22.45, 21.5 percent, respectively. at the end of the ripening period of 90 days, the percentages of fat for the treatments (C, T1, T2, T3, T5, T4) were 29.2, 32.5, 30.1, 27.6, 24.78, 23.8%, respectively.The reason for the increase in the percentage of fat with the advancing age of ripening is due to the decrease in the percentage of moisture and therefore the increase in the percentage of total solids, including fat (Gafaour, et al, 2020).It is also noticed from the statistically analyzed results that there are no significant differences between treatments compared with the control treatment, except for treatment T4 and T5 on the first day, significant differences appeared (P≤ 0.05).

The percentage of fat in the cheese of the replacement treatments was less than the control and the cheese of the full-fat treatments made from full-fat buffalo milk or buffalo milk whose fat has been replaced with vegetable fat, and the reason for this is due to the screening processes that were conducted for buffalo milk designated for replacement in different proportions, as well as its high moisture content.

Ash percentage: The results in Table (1) show the percentage of ash in the different cheese treatments mentioned previously, where this percentage on the first day of the control treatment C was 1.30%. They were 1.63, 1.60, 1.53 %, respectively.It is also noted from the results that the ash percentage of all treatments increased with the progression of the maturation period, as it was after 45 days for the treatments (C, T1, T2, T3, T4, T5) that they were 1.35, 1.40, 1.59, 1.71, 1.69, 1.75%, respectively. The reason for this may be due to the effect of replacing buffalo milk fat with vegetable fat or replacing cow’s milk with skim buffalo milk with different replacement rates, which leads to a higher ash content of cheese (El-Baz and Azza, 2013).After 90 days, the treatments (C, T1, T2, T3, T4, T5) were 1.40, 1.45, 1.66, 1.77, 1.72, 1.63%, respectively. The increase in ash percentage is due to the loss of part of the moisture during ripening, which leads to raise the percentage of total solids of which ash is one of its components.It is also noted from the statistically analyzed results that there are no significant differences between the treatments compared with the control treatment, except for treatment T2, in which significant differences (P≤ 0.05) appeared after the progression of the ripening process. Claeys et al., 2014 indicated that the minimum contents of total αs2-casein and beta-casein in buffalo milk are higher than those in cow's milk, so it is possible that the protein structure of buffalo milk has the ability to bind or the retention of fat and ash during protein coagulation, which leads to a high percentage of ash in cheese produced from buffalo milk or cheese in which cow's milk is partially replaced by buffalo milk.

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Carbohydrate percentage: The results in Table (1) show the carbohydrate percentage in the cheese of the different treatments mentioned previously, where the percentage on the first day for the cheese of the control treatment C was 6.61%, for the treatment T1 it was 1.13%, and for the treatment T2 it was 4.57%. And for coefficients T3, T4, T5 are 6.12, 9.41, 9.27 %, respectively. It is also noted from the results that the percentage of carbohydrates for all treatments decreased with the progression of the maturation period, so it was after 45 days for treatment C it was 5.32% and for treatment T1 it was 0.58 percent and for treatment T2 it was 2.96% while for treatments T3, T4, T5 it was 3.0, 4.96, 4.83% Respectively. The reason for the decrease in the percentage of carbohydrates during the stages of maturation may be due to the activity of reviving the starter under the conditions of ripening, which works to convert the sugar lactose into lactic acid, in addition to the loss of part of the carbohydrates with the exudative whey during ripening.But after 90 days, the treatments (C, T1, T2, T3, T4, T4, T5) were 2.75, 0.05, 1.04, 1.88, 2.78, and 1.8 percent, respectively. We note from the statistically analyzed results that there are non-significant differences between the treatments compared with the control treatment, except for treatment T1 and T5, at (0.05 P ≤).

pH: The results showed that there were noticeable changes in the pH values of the cheeses of the treatments during the stages of ripening. As for the T1 treatment, it was 5.9%. For treatment T2 it is 5.71%. As for treatments T3, T4 and T5, the values were 5.85, 5.67, 5.65.It is also noted from the results that the pH values decreased for all the treatments of Monterrey cheese with the progression of the ripening period, as it reached after 45 days for the treatments (C, T1, T2, T3, T4, T5), which are 5.89, 5.79, 5.64, 5.30, 5.56, and 5.53, respectively. But after 90 days, they were 5.01, 5.5, 5.10, 5.20, 5.40, and 5.33, respectively, for the aforementioned treatments.

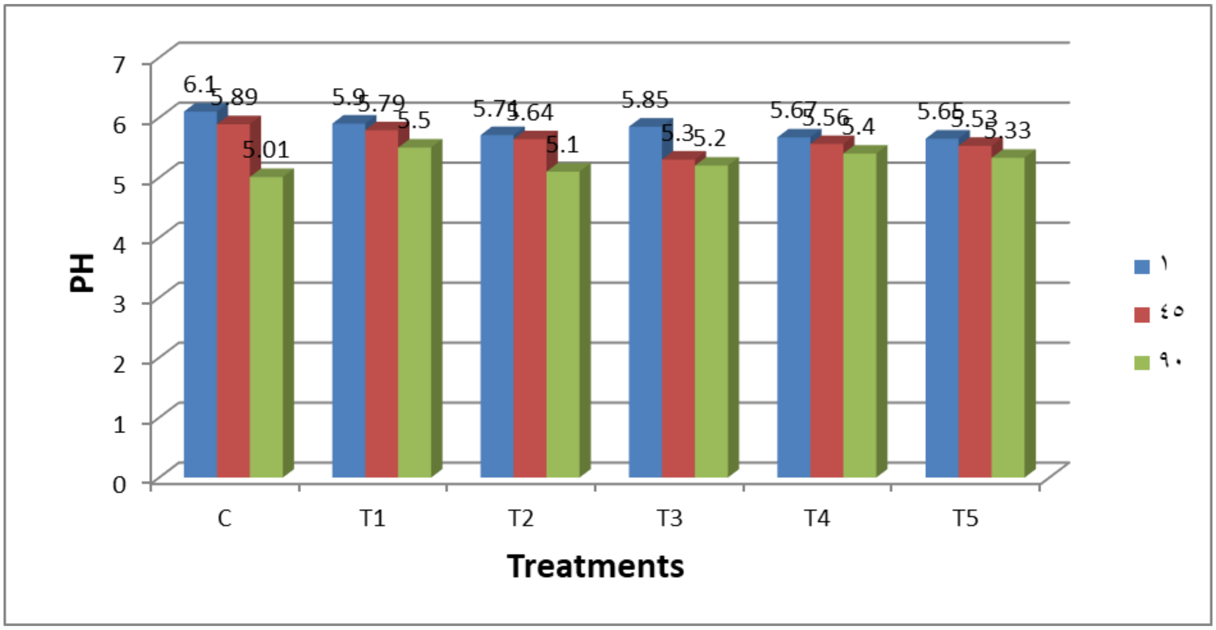

Figure 1: pH values of different cheese treatments after manufacturing and during ripening at (15°C) for a period of 90 days. Where: C = control-treated cheese, and T1 = cheese treated with full-fat buffalo milk, and T2 = cheese treated with substituted skim buffalo milk fat with vegetable fat, and T3 = cheese treated with partially substituted cow's milk with 25% buffalo milk and T4 = cheese treated with partially substituted 50% cow's milk buffalo milk and T5 = cheese treated with 75% partially substituted cow's milk from buffalo milk LSD value = *0.793 (P≤ 0.05.(

The reason for this decrease in the pH percentage for all treatments during the ripening period is the conversion of the remaining lactose sugar in the cheese into lactic acid, which leads to a lowering of pH. This result is consistent with what was found by Moussa et al, 2019), which indicated a decrease in the pH values of Monterrey cheese at the end of the ripening period. It is reported that the average of decrease in the pH was consistent with the average of increase in the percentage of acidity in the cheese during the ripening period. This is consistent with what was found by Hofi et al (1991)), which indicated that there is agreement between the decrease in the pH values and the increase in the percentage of the total acidity of the cheese.It is also noticed from the statistically analyzed results that there are no significant differences (0.05 P≤) between the treatments compared to the control treatment on the first day and during the maturation period.

Total acidity: The results in Figure (2) show the percentage values of acidity for the different monterey cheese treatments, Where it reached 0.42% on the first day of treatment C, and for treatment T1 it was 0.40% - and for treatment T2 it was 0.43%. As for the treatments T3, T4 and T5, they were 0.49, 0.48, and 0.47 percent, respectively. It is also noted from the results that the percentage of total acidity increased with the progression of the ripening period, as it reached after 45 days of ripening for the treatments (C, T1, T2, T3, T4, T5) which are 0.45, 0.41, 0.45, 0.52, 0.49, 0.49 %, respectively. It is worth noting that the high acidity was consistent with the moisture content of the cheese, as the highest acidity was observed in treatments T3, T4 and T5, where the acidity was between 0.45% to 0.50% in each of them, while it was in treatments C, T1 and T2 is between 0.42% to 0.48%This is due to the increase in the activity of the starter bacteria and the transformation of lactose into lactic acid in the treatments that were characterized by its high moisture content. The reason may be due to the high acidity ratio to the protein percentage, as the protein content has a significant impact on the acidity in milk at the end of the ripening period, the percentages for the treatments (C, T1, T2, T3, T4, T5) were 0.47, 0.44, 0.48, 0.54, 0.53, and 0.52 %, respectively. These results are consistent with what was found by (Al-Shrajee et al, 2002), which indicated that the acidity increased with the progression of ripening in cheese as a result of lactic fermentation.

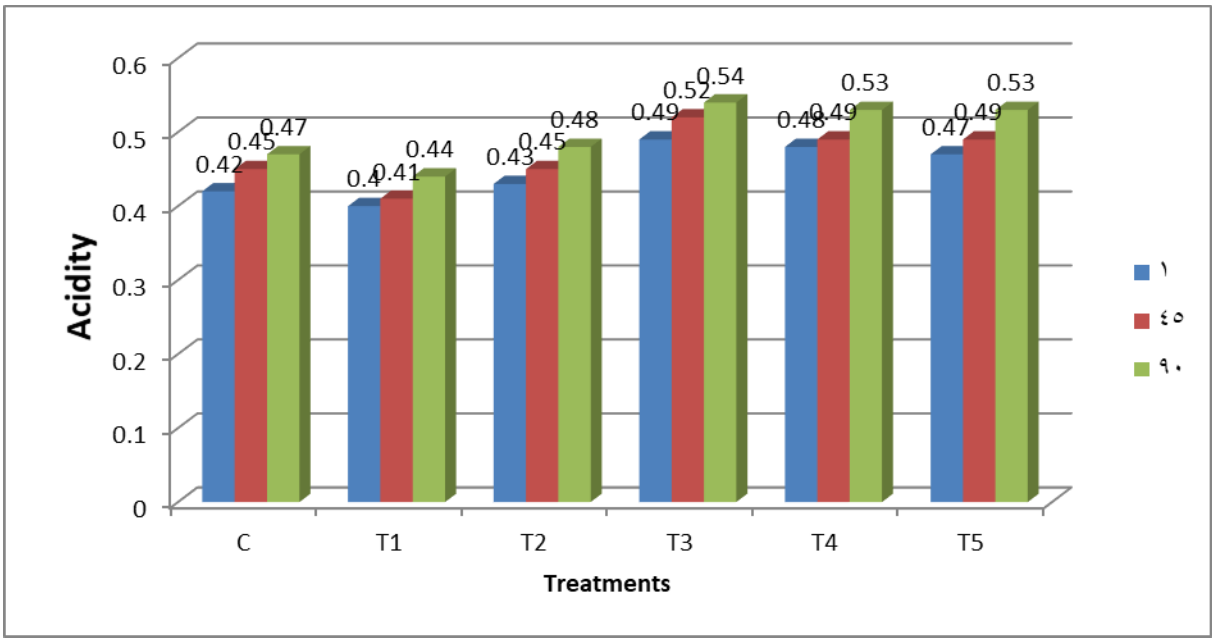

Figure 2: Total acidity percentage of different cheese treatments after processing and during ripening at (15°C) for a period of 90 days. Where: C = control-treated cheese, T1 = full-fat buffalo milk-treated cheese, and T2 = cheese treated with substituted sorting buffalo milk fat with vegetable fat, and T3 = cheese treated with 25% partially substituted cow's milk from buffalo milk and T4 = cheese treated with 50% partially substituted cow's milk with 50% buffalo milk and T5 = cheese treated with partially replaced cow's milk with 75% of buffalo milk. LSD value = *0.177 (P≤ 0.05 ·(

These results are also consistent with what was found by Al-Obaidi et al (1988) and Alshrajee (2002), which indicated that the acidity average of Monterrey cheese during the ripening period ranged between (0.45-0.50%).The reason for the high acidity of the Monterey cheese treatments with the progression of the ripening process is due to the conversion of the remaining lactose in the cheese to lactic acid by the action of the initiator bacteria. The increase in acidity is natural caused by the lactic acid bacteria present in the product (Buriti et al, 2005).It is also noted from the statistically analyzed results that there are non-significant differences in the different cheese treatments compared to the control treatment at (P≤ 0.05). dissolved nitrogen percentage to total nitrogen: The results in Table (2) show a clear increase in the ratios of dissolved nitrogen (SN) to total nitrogen (TN) in the cheeses resulting from replacing part of cow's milk with buffalo milk sorted by proportions 75,50, 25% compared to the control treatment cheese. These percentages increased with the progression of the maturation period, reaching their peak at the end of ripening. The values for dissolved nitrogen on the first day of treatment C were 0.005, and for treatment T10.009 and for treatment T2 were 0.002 and for the replacement treatments T3, T4, T5 0.004, 0.006, 0.007%, respectively, but after 45 days they were for treatments (C, T1, T2, T3 , T4, T5) are 0.043, 0.051, 0.013, 0.036, 0.041, 0.046 respectively, but after 90 days of transactions (C, T1, T2, T3, T4, T5) are 0.062, 0.083, 0.032, 0.0054, 0.066, 0.073 % respectively . It is also noted from the results that replacing part of cow's milk with buffalo milk has contributed to an increase in the degree of proteolysis, as proteolytic enzymes (proteases and peptidases) contribute to accelerating ripening, and this is consistent with what Kilcawley et al found (2000).The percentage of dissolved nitrogen obtained from this study is among the rates recorded in the semi-dry cheeses that were produced. It is also noticed from the statistically analyzed results that there are no significant differences (0.05 P≤) in the milk treatments compared to the control treatment on the first day and during the ripening period.

Table 2: Percentages of dissolved nitrogen and total nitrogen for the different treatments (C, T1, T2, T3, T4 and T5).

Treatment	Storage period (day)	Total nitrogen (TN)	Soluble nitrogen (SN)
C	1	3.58	0.005
	45	3.81	0.043
	90	4.2	0.062
T1	1	3.8	0.009
	45	4.0	0.051
	90	4.3	0.83
T2	1	3.7	0.002
	45	3.9	0.013
	90	4.2	0.032
T3	1	3.75	0.004
	45	4.10	0.036
	90	4.35	0.054
T4	1	3.80	0.006
	45	4.20	0.041
	90	4.40	0.066
T5	1	3.95	0.007
	45	4.35	0.046
	90	4.55	0.073
LSD	---	*0.502	*0.336

Where: C = control-treated cheese, and T1 = cheese treated with full-fat buffalo milk, and T2 = cheese treated with substituted skim buffalo milk fat with vegetable fat, and T3 = cheese treated with partially substituted cow's milk with 25% buffalo milk and T4 = cheese treated with partially substituted cow's milk

with 50% of buffalo milk and T5 = cheese treated with partially substituted cow's milk with 75% of buffalo milk.

Tissue analysis:

Hardness: Figure (3) shows the results of the hardness test for control treatment cheese made from whole cow's milk, treatment T1 cheese manufacture from full fat buffalo milk, and treatment T2 cheese manufacture from skim buffalo milk substituted fat with vegetable fat, and treatment cheese for cow's milk with different proportions of buffalo milk T3 and T4 and T5 on the first day and during the 90-day ripening period. Where the hardness values on the first day of treatment C were 59.8 g, for treatment T1 it was 70.4 g, and for treatment T2 it was 84 g, as for the replacement treatments T3, T4, T5, they were 95.6, 75.6, 123.9 g, respectively. This is consistent with what Romeih et al (2002) found when studying cheese that there is a higher hardness of cheese manufacture from sorted milk compared to cheese manufacture from whole milk, and the reason for the higher hardness of low-fat cheese is due to its high content of casein. The fat in full-fat cheeses performs the lubrication process and can penetrate inside the protein mold to make the cheese more soft (Koca and Metin, 2004), in addition to the fact that the fat granules in low-fat cheese are small in number and size compared to the fatty granules in cheese made from Whole milk (Sipahioglu and co., 1999).

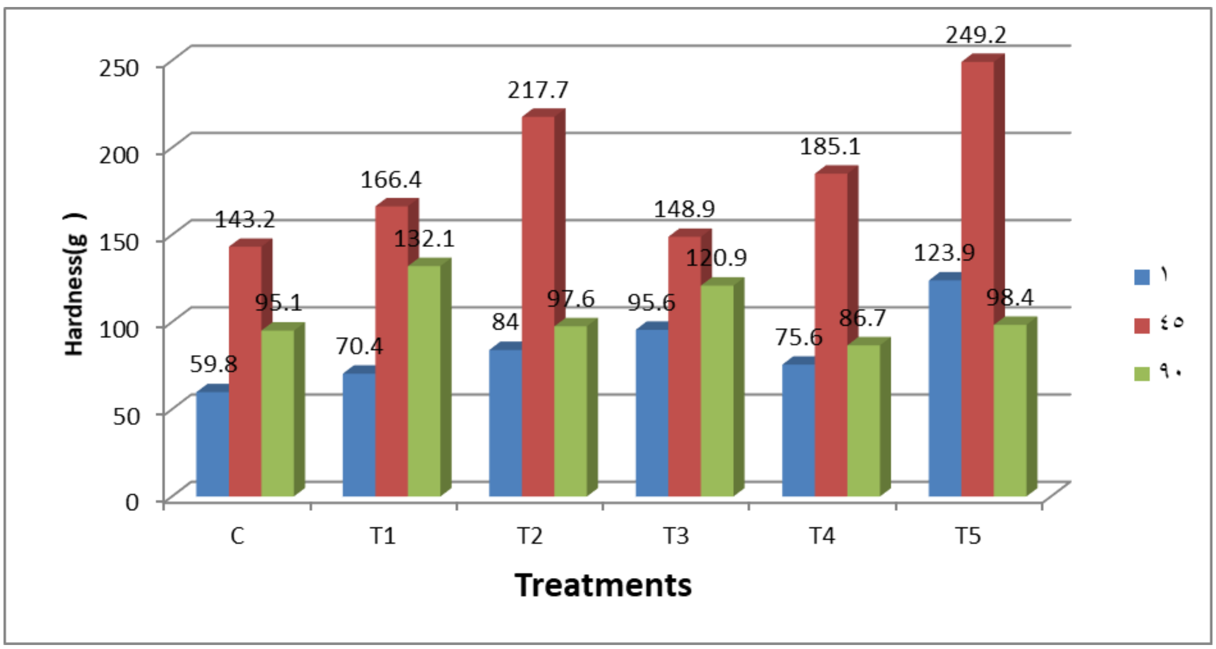

Figure 3: Hardness values for different cheese treatments after processing and during ripening at (15°C) for a period of 90 days. Where: C = control-treated cheese, T1 = cheese treated with full-fat buffalo milk, and T2 = cheese treated with skim buffalo milk substituted fat with vegetable fat, and T3 = cheese treated with partially substituted cow's milk 25% Buffalo's milk and T4 = cheese treated with partially substituted cow's milk at 50% Buffalo's milk and T5 = cheese treated with partially substituted cow's milk 75% Buffalo milk

The difference in the hardness of the cheese may also be due to the moisture, protein and fat content of the cheese samples. The moisture content of cheese affects the structural properties of cheese (Bongiolo and co., 2014). Cheese samples with low moisture are more resistant to deformation as in sample T3, which is less moisture content and higher hardness compared to control treatment.Also, the process of curd formation is affected by the acidity resulting from the addition of the initiator, which affects the pH of the cheese, and the hardness of the cheese increases with the decrease in pH,Where the high acidity leads to an increase in whey exudation and thus a decrease in the moisture content of the cheese and an increase in its hardness (Lucey et al, 2003), in addition to the fact that the texture of cheese with a high percentage of moisture is softer and smoother than cheese with low moisture.Where Abd El-Gawad et al (2012) indicated that the hardness of cheese manufacture from skim milk is much higher than cheese made from whole milk made in the traditional way. It is also noted from the statistically analyzed results that there were no significant differences (P≤ 0.05) between the different cheese treatments on the first day. It is also noted that the hardness values increased for all treatments with the progression of the ripening period up to the forty-fifth day of ripening, which was followed by a clear decrease in the hardness values. The values after 45 days for cheese of treatments C, T1, T2, T3, T4 and T5 were 143.2, 166.4, 217.7, 148.9, 185.1 and 249.2 g, respectively. But after 90 days, the treatments C, T1, T2, T3, T4 and T5 were 95.1, 132.1, 97.6, 120.9, 86.7, 98.4 g, respectively. It is noted from the statistically analyzed results that there are no significant differences (0.05 P≤) between the hardness of all the different treatments during maturation. It is also clear that the addition of the starter led to an increase in the acidity of the cheese and a decrease in the pH, which affected the moisture content and thus the hardness of the cheese curd (Fox and McSweeney, 2004). The reason for the high stiffness of substitution of cow's milk with buffalo milk may be due to the extent of the increased sub-correlations of casein with the increase of casein-moisture ratio, and thus even slight differences in moisture content can have significant effects on cheese texture (Gunasekaran and Mehmet 2002). Guinee et al (2001) indicated that when studying the effect of the fat content on the exact structure and texture of cheese, we concluded that the increase in the cheese's fat content leads to giving the cheese the appropriate texture and making it softer. Fox et al (2017) indicated that an increase in the casein content leads to a more solid cheese, and that the high fat and water content tends to weaken the protein structure in cheese and thus affect the texture and hardness of the cheese. It is also noticed from the results that the hardness values decrease with the progression of the ripening period, starting after the forty-fifth day and reaching the end of the ripening period on the ninetieth day.

It is also noted from the statistically analyzed results that there were no significant differences (P≤ 0.05) between the different cheese treatments on the first day. It is also noted that the hardness values increased for all treatments with the progression of the ripening period up to the forty-fifth day of ripening, which was followed by a clear decrease in the hardness values.The values after 45 days for cheese of treatments C, T1, T2, T3, T4 and T5 were 143.2, 166.4, 217.7, 148.9, 185.1 and 249.2 g, respectively. But after 90 days, the treatments C, T1, T2, T3, T4 and T5 were 95.1, 132.1, 97.6, 120.9, 86.7, 98.4 g, respectively. It is noted from the statistically analyzed results that there are no significant differences (0.05 P≤) between the hardness of all the different treatments during ripening . It is also clear that the addition of the starter led to an increase in the acidity of the cheese and a decrease in the pH, which affected the moisture content and thus the hardness of the cheese curd (Fox and McSweeney, 2004). The reason for the high stiffness of substitution of cow's milk with buffalo milk may be due to the extent of the increased sub-correlations of casein with the increase of casein-moisture ratio, and thus even slight differences in moisture content can have significant effects on cheese texture (Gunasekaran and Mehmet 2002). Guinee et al, (2001) indicated that when studying the effect of the fat content on the exact structure and cheese texture, we found that the increase in the cheese's fat content leads to giving the cheese the appropriate texture and making it softer.Fox et al, (2017) indicated that an increase in the casein content leads to a more solid cheese, and that the high fat and water content tends to weaken the protein structure in cheese and thus affect the texture and hardness of the cheese. It is also noticed from the results that the hardness values decrease with the progression of the ripening period, starting after the forty-fifth day and reaching the end of the ripening period on the ninetieth day. It is also noted from the statistically analyzed results that there are significant differences for all the different cheese treatments during the ripening period at (0.05P≤).The reason for the increase in cheese hardness due to the cracking of casein and the difference in its type in the substitution coefficients may be due to the presence of a difference in the properties of casein particles in buffalo milk compared to their properties in cow's milk, in addition to the increase in protein interactions after replacement (Morsi, 2014).

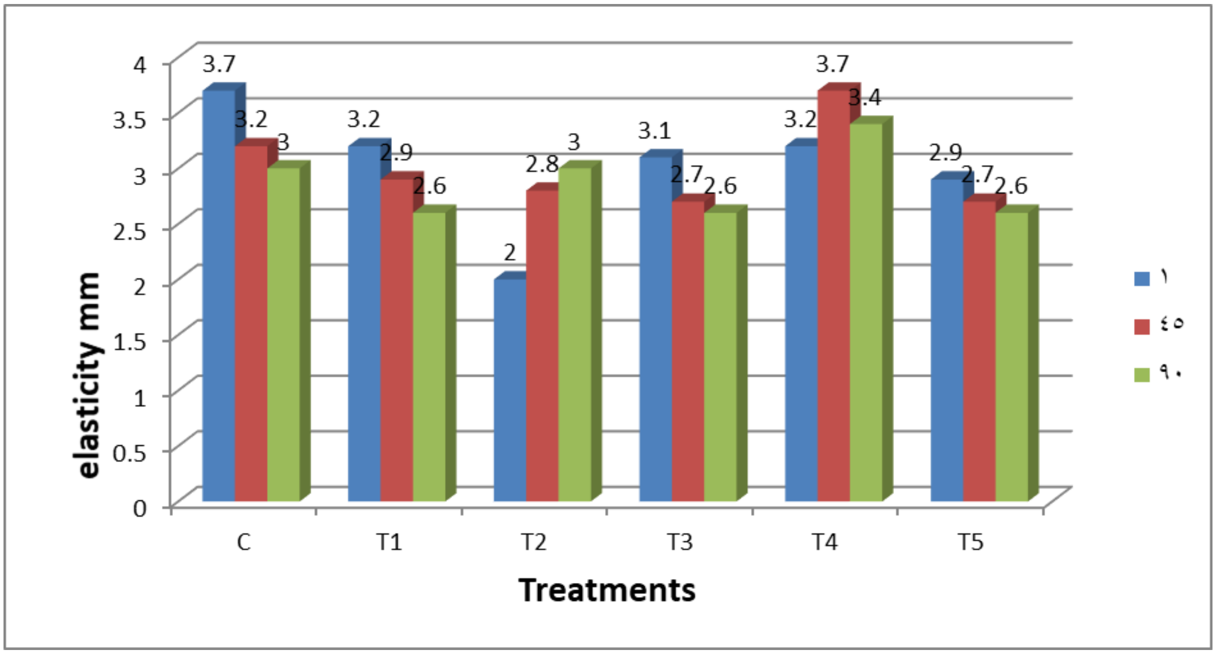

Figure 4: Elasticity values for different cheese treatments after processing and during ripening at (15°C) for a period of 90 days. Where: C = control treatment cheese, and T1 = cheese treated with full-fat buffalo milk, and T2 = cheese treated with skim buffalo milk substituted fat with vegetable fat, and T3 = cheese treated with partially substituted cow's milk 25% Buffalo's milk and T4 = cheese treated with partially substituted cow's milk at 50% Buffalo's milk and T5 = cheese treated with partially substituted cow's milk 75% Buffalo milk

Elasticity: The results shown in Figure 4 show the elasticity values for the aforementioned different Monterey cheese excelled. As for the control treatment on the first day, it was 3.7 mm, for treatment T1 it was 3.2 mm, for treatment T3 it was 2.0 mm, and for treatments T3, T4, T5 it was 3.1, 3.2, 2.9 mm.It is also noted from the results that the elasticity values of the control treatment were higher on the first day than the rest of the other treatments. It was also noted from the results that the stiffness values for the treatments were different with the progression of the ripening period, as the values were after 45 days for the treatments (C, T1, T2, T3, T4, T5).) are 3.2, 2.9, 2.8, 2.7, 3.7, 2.7 mm. It is also noted from the results that the elasticity values decreased for the control treatment and other treatments, except for the treatment in which the buffalo fat was replaced by vegetable fat and the partial replacement of cow's milk with low-fat buffalo milk, which was characterized by a high value of flexibility. It led to an increase in the elasticity value, as well as the partial replacement of cow's milk with treated buffalo milk (T4).It is also noticed from the statistically analyzed results that there were no significant differences (P≤0.05) in the milk treatments compared to the control treatment, except for treatment T2 on the first day.

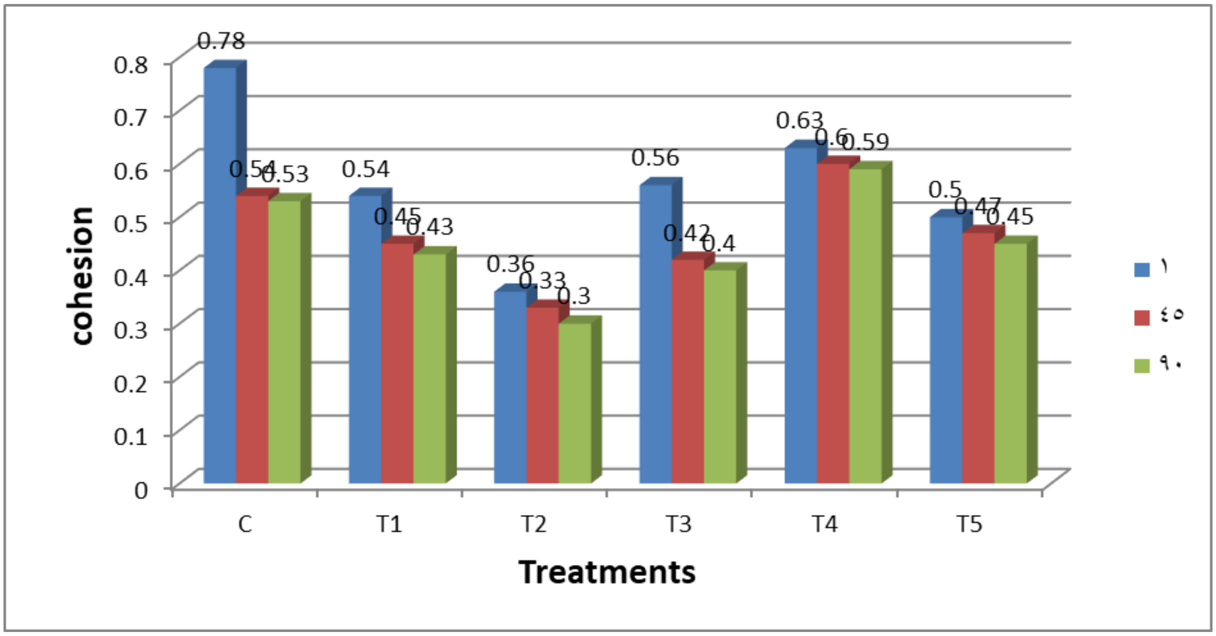

Figure 5: Cohesion values of different cheese treatments after processing and during ripening at (15°C) for a period of 90 days. Where: C = control-treated cheese, T1 = cheese treated with full-fat buffalo milk, and T2 = cheese treated with sorting buffalo milk substituted fat with vegetable fat, and T3 = cheese treated with partially substituted cow's milk 25% Buffalo's milk and T4 = cheese treated with partially substituted cow's milk at 50% Buffalo's milk and T5 = cheese treated with partially substituted cow's milk 75% Buffalo milk

cheese yield: The results in Table (3) show the cheese yield percentage of Monterrey cheese, the control treatment, the cheese made from full-fat buffalo milk, the treatment of cheese manufacture from buffalo milk, the skim replaced by vegetable fat, and the replacement treatments with buffalo milk in different proportions. The cheese yield percentage for treatment C on the first day was 10.4%, and for treatment T2 it was 11.5%, as the higher the percentage of fat, the higher the cheese yield percentage, and for treatment T3 it was 11.1%.As for the partial replacement treatments for buffalo milk, they were 9.6, 9.0, and 8.1%, respectively. It is noted from the results that the cheese yield percentage of the cheese of the two treatments T2 and T3 increased, and the reason for this was due to the high percentage of total solids in them, especially the percentage of fat.It is also noted that the cheese yield percentage decreased in the partial replacement of cow's milk with buffalo milk, gradually with the increase in the percentage of replacement. The reason for this is due to the low percentage of total solids in the buffalo replacement milk, which is skim milk, where the fat contributes a large cheese yield percentage. This is in agreement with what Scott et al (1998) mentioned that cheeses manufactured from skim milk are characterized by a low percentage of refinement due to their low content of total solids. Straining, because the fat makes up approximately 50% of the dry weight.

Table 3 :yield percentage of monterey cheese for different treatments (T5, T4, T3, T2, T1, C(

Treatment	% Yield
C	10.4

T1	11.5
T2	11.1
T3	9.6
T4	9.0
T5	8.1
(0.05)LSD	* 1.674

Where: C = control-treated cheese, and T1 = cheese treated with full-fat buffalo milk, and T2 = cheese treated with substituted sorting buffalo milk fat with vegetable fat, and T3 = cheese treated with partially substituted cow's milk with 25% buffalo milk and T4 = cheese treated with 50% partially substituted cow's milk buffalo milk and T5 = cheese treated with 75% partly replaced cow's milk from buffalo milk

Sensory evaluation: Table (4) shows the results of sensory evaluation for the traits of colour, flavour, texture, openings, consistency and bitterness of Monterey cheese produced from different treatments at the age of 1 and 45. 90 days of ripening. The sensory evaluation depends on the physical, physiological, and psychological responses of the consumer (Drake, 2007 Lawless; and Heymann 2010), where the table shows that there are no significant differences in the averages of the high scores given to the color trait. The averages of the awarded scores ranged between 8.00 and 10.00 for all treatments during the maturation period. The same table also shows the excelled of the degrees given to the flavor traits of the treatments in which milk was substituted, and that some flavor traits were common to all types of cheese. for example, the intensity of each trait was significantly different depending on the type of cheese, and ranged from detectable flavor to moderate intensity. Different flavor scores determined the intensity of each cheese. Descriptions represent the type of cheese, but may not identify exactly each individual cheese of that type, depending on differences in brand, ripening, production method, or storage conditions. With its clean flavour, free from any strange tastes, the highest grades were given to the cheese flavor of the treatment T5, then the treatment T4, T3 together, then the treatment of the control cheese.

Table 4: Sensory evaluation results for Monterrey cheese for the different treatments (T5, T4, T3, T2, T1, C(

Treatment	Storage period (day)	Colour (10)	Flavor (10)	Texture (10)	Coherence (10)	Bitterness (10)	Pores (10)
C	1	10	9.0	9.0	9.0	10	10
	45	10	9.0	8.5	9.0	10	9.0
	90	9.0	8.0	9.0	8.0	9.0	10
T1	1	10	9.0	9.0	9.0	10	10
	45	10	10	10	9.0	10	10
	90	10	9.0	8.0	8.0	9.0	9.0
T2	1	8.0	8.0	8.0	8.0	10	10
	45	8.0	8.0	9.0	9.0	9.0	9.0
	90	8.0	9.0	9.0	8.0	10	10
T3	1	10	9.0	8.0	8.0	10	10
	45	10	9.0	9.0	9.0	10	10

	90	**10**	**9.0**	**10**	**8.0**	**9.0**	**10**
T4	**1**	**10**	**9.0**	**9.0**	**9.0**	**10**	**10**
	45	**10**	**9.0**	**9.0**	**9.5**	**10**	**10**
	90	**10**	**9.0**	**10**	**9.0**	**10**	**10**
T5	**1**	**10**	**10**	**9.0**	**10**	**10**	**10**
	45	**10**	**9.0**	**10**	**10**	**9.0**	**10**
	90	**10**	**8.0**	**9.0**	**9.0**	**10**	**10**
LSD	**---**	***1.69**	***1.75**	***1.72**	***1.66**	**NS1.17**	**NS1.09**

Where: C = control-treated cheese, and T1 = cheese treated with full-fat buffalo milk, and T2 = cheese treated with substituted sorting buffalo milk fat with vegetable fat, and T3 = cheese treated with partially substituted cow's milk with 25% buffalo milk and T4 = cheese treated with partially substituted cow's milk with 50% of buffalo milk and T5 = cheese treated with partially substituted cow's milk with 75% of buffalo milk.

The same table also shows the excelled of the scores given to the flavor trait for the treatments in which milk was replaced in the early stages of ripening, as T3, T4, and T5 on the first day, the average score was 9.00 between 8.0 to 10.0. These results were in agreement with what was indicated by (Kosikowski and Iwasaki, 1974, Kosikowski and Sood, 1979 and El-Soda et al 1990) when they used microbial enzymes to accelerate the ripening of cheddar cheese. The table also shows the increase in the degrees given to the flavor characteristic by increasing the ripening age. Al-Shrajee (2002) indicated that the flavor development was due to the increased proteolytic and lipolytic in cheese to which proteolytic and lipolytic enzymes were added to accelerate ripening.It is also noted from the same table that the grades granted to the trait of texture increased with the progression of the ripening period for all treatments. The texture characteristic is affected by the decomposition of caseinate and fat as well as the physical changes caused by the change of acidity and the distribution of salt particles in the cheese. The same table showed that the averages of the degrees given for cohesion ranged between 8.0 and 10.0. As for evaluating the trait of openings, the grades given to them were high in sensory evaluation of all treatments from the beginning of ripening to its end, which indicates that this trait was one of the good traits. The averages for this trait ranged between 9.0 and 10.0,This indicates the absence of mechanical openings and the absence of contamination with gas-producing microorganisms such as colon bacteria after manufacturing. The results indicated that no bitter taste appeared in the cheeses produced in this study, and the average scores given for the trait of bitterness ranged between 9.0 and 10.0.Visser et al (1983) indicated that the main reason for the formation of bitterness in cheese may be the result of proteolytic enzymes secreted by bacteria or rennet enzymes, which leads to the breakdown of protein into peptides, and in the case of one or more of these peptides containing terminal amino acids once appears The bitter taste is removed by breaking these peptides, the beginning of the appearance of a small percentage of bitterness in the first treatment at day 90 and 45 for some treatments, as the scores decreased significantly from 10.0 to 9.0. ($P \leq 0.05$).

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