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EFFECT OF MILK NATURE AND STORAGE ON THE PHYSICOCHEMICAL, MICROBIOLOGICAL AND SENSORY FEATURES ON ALGERIAN SOFT RIPENED CHEESE "CAMEMBERT" TYPE

BENMEZIANE – DERRADJI Farida[1,2], HALLALA Hadjer [1], AMMI Sara[1], DJERMOUNE- ARKOUB Lynda[2,3]

1. Department of Agronomic Sciences, Faculty of Sciences of Nature and Life. Chadli Bendjedid University of El-Tarf. BP 73. El Tarf 36000, Algeria
2. Laboratory of Biomathematics, Biophysics, Biochemistry and Scientometry, Faculty of Sciences of Nature and Life, Bejaia University, Bejaia (06000), Algeria
3. Department of Process Engineering, Faculty of Technology, University of Bejaia, Bejaia, Algeria

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Abstract

Description of the subject: In Algeria the exploitation of goat's milk is limited to its consumption in the fresh state as milk. In order to enhance this natural resource and to diversify its uses, a trial was carried out for the manufacture of a ripened soft cheese.
Objective : The aim of the present work was to evaluate the aptitude of goat's milk (GM) to be transformed, alone or as a mixture with cow's milk (CM), into a soft ripened cheese "Camembert" type.
Methods : Five types of mature cheeses have been manufactured in the dairy industry, "Edough", Annaba (Algeria) followed by the product analysis.
Results : The GM cheese stood out by its highest fat content (27 g/L) as compared to other samples. The microbiological quality was acceptable according to standards recommended by the Algerian regulations. All cheeses were appreciated by tasters; However, the scores tended to drop during storage, especially for goat cheeses.
Conclusion : Goat's milk has been used advantageously in the manufacture of a soft cheese, moreover the mixture of cow's and goat's milk has given rise to quality ripened cheeses which allow successful commercialization, thus promoting the economy of the nation.
Keywords : Goat's milk, cow milk, soft ripened cheese, quality.

EFFET DE LA NATURE ET DU STOCKAGE DU LAIT SUR LES CARACTÉRISTIQUES PHYSICOCHIMIQUES, MICROBIOLOGIQUES ET SENSORIELLES DES FROMAGES ALGÉRIENS À PATE MOLLE TYPE «CAMEMBERT»

Résumé

Description du sujet : En Algérie, l'exploitation du lait de chèvre est limitée à sa consommation à l'état frais. Afin de valoriser cette ressource, un essai a été réalisé pour la fabrication d'un fromage à pâte molle affiné.
Objectifs : Le but du présent travail était d'évaluer l'aptitude du lait de chèvre à être transformé, seul ou en mélange avec du lait de vache, en un fromage affiné type "Camembert".
Méthodes : Cinq types de fromages affinés ont été fabriqués à la Laiterie, « Edough » -Annaba- (Algérie) suivi de l'analyse du produit.
Résultats : Le fromage de chèvre s'est démarqué par sa teneur en matière grasse la plus élevée (27 g/L) par rapport aux autres échantillons. La qualité microbiologique était acceptable selon les normes préconisées par la réglementation algérienne. Tous les fromages ont été appréciés par les dégustateurs. Cependant, les scores avaient tendance à baisser au cours du stockage, notamment pour les fromages de chèvre.
Conclusion : Le lait de chèvre a été utilisé avantageusement dans la fabrication d'un fromage à pâte molle ; Le mélange lait de vache et de chèvre a permi d'obtenir des fromages affinés de qualité permettant une commercialisation réussie, favorisant ainsi l'économie de la nation.
Mots clés : Lait de chèvre, lait de vache, fromage affiné à pâte molle, qualité.

* Auteur correspondant: BENMEZIANE – DERRADJI Farida, E-mail: benmezianefarida@yahoo.fr

INTRODUCTION

Milk and dairy products occupy a preponderant place in the food ration of Algerian consumers. They are classified among the products which provide the greatest share of protein of animal origin. This is why the production of dairy products has always occupied a prominent place in the Algerian tradition. Milk is a food that has a lot of properties, a rich composition; it has a lot of nutritional qualities. It is the liquid food best suited to human needs, it provides water, energy and all the nutritional elements necessary for his development, especially calcium and phosphorus, as well as vitamins such as riboflavin and vitamin B12 [1,2]. The milk secreted by the different species of mammals has common characteristics and contains the same criteria of components: water, proteins, lactose, fats, vitamins and minerals [3]. However, bovine milk is the most produced and consumed worldwide [1]. Goat's milk is less well-known and less used than cow's milk and yet it has much more important nutritional qualities than the latter. It constitutes a significant source of benefits for human health and deserves an appropriate and more important popularization [4]. Indeed, regular consumption of GM considerably improves body weight gain, better skeletal mineralization, increased blood levels of vitamins, minerals and hemoglobin in serum [5]. The smaller size of fat globules in GM gives it specific technological properties by giving the derivatives a smoother texture with a softer gel, greater water retention capacity and lower viscosity [4-6]. This opens the way to the transformation of GM into several derivatives, in particular into cheeses. Several scientific studies on the characterization of cheeses produced from mixtures of different species have been conducted and the interest in that studies increased from year to year. Technologically, cheese (fresh or ripened) is casein more or less free of other constituents of milk which is more or less processed. Among ripened cheeses, Camembert. Originating from a small village named Camembert which is found in the Normandy province of France, Camembert is a mold surface-ripened cheese and white in color [7]. It's known that Camembert is traditionally made from CM. Despite this, many attempts have been made to make Camembert based on other milks, and in particular goat milk, sheep milk and buffalo milk [7]. More recently, GM has increasingly attracted attention by researchers and cheese-makers for its use as total or partial substitute of CM in soft ripened cheese, such as Camembert, production due to its nutritional properties and especially its therapeutic importance. Indeed, from a nutritional point of view, cheeses, especially mature cheeses, have a considerable place in the food balance given their importance for health. Indeed, they constitute a significant source of minerals (Ca) and various trace elements (Zn, Mg ... etc). Cheeses are also rich in proteins and vitamins. However, their fat content is variable. Thus, in order to combine the beneficial health effects of GM and the ripened cheese derived from it, this work has been developed. The objective of the study was to develop a soft ripened cheese "Camembert" type based on GM and CM and their mixtures in different proportions and to assess its physicochemical, microbiological and sensory qualities throughout the shelf life estimated at 45 days of refrigerated storage.

MATERIAL AND METHODS

1. Raw Material

Three types of milk were used in this study; The goat's milk which was supplied to us by dairy products traders from Annaba (Eastern of Algeria); Whole and partially skimmed cow's milk which were supplied to us by the National Dairy Industry "Edough" - Annaba (Eastern of Algeria). Mixtures were prepared based on GM and partially skimmed CM in the following proportions: *(i)* 50% GM - 50% CM; *(ii)* 75% GM - 25% CM; *(iii)* 25% GM - 75% CM.

2. Experimental design

Before starting the production of ripened cheese, certain quality parameters were determined on the raw materials (goat's and cow's milk and their mixtures), namely density (thermo-lacto-density meter), pH (*Hanna* brand pH meter), acidity (titration with sodium hydroxide (N / 9)), fat content (GERBER method), dry matter (by difference in weight after drying in an oven at 103 ± 2 ◦C for 5 h, until constant weight) and finally the presence of antibiotic residues (with the *Beta-Star combo* test). The protocols followed are those applied in the dairy industry "Edough" - Annaba-. After ensuring that the raw materials are fit for use, the preparation of mature soft cheeses, "Camembert" type was then launched. For this, five types of cheese have been prepared as follows: *(i)* Cheese with 100% GM cheese (C1); *(ii)* Cheese with 100% whole CM (C2); *(iii)* Cheese with 50% GM - 50% partially skimmed

CM (C3);*(iv)* Cheese with 75% GM- 25% partially skimmed CM (C4); and *(v)* Cheese with 25% GM - 75% partially skimmed CM (C5).

3. Preparation of Camemberts' formulations

Cheese samples were prepared in the dairy laboratory of the dairy industry Edough - Annaba (Algeria) according to the manufacturer's guidelines for a standard ″Camembert″ followed within the same company with a modification relative to the total or partial substitution of CM by GM (Table 1; Fig. 1). The ripening is carried out by placing the cheeses in choppers in a room at a temperature of 12 - 13 °C and a relative humidity of 90 to 95 %. The cheeses were inoculated with *Penicilium candidum* and *Geotrichum candidum* by spraying with turning every other day. The down-like felting was white, characterizing the development of *Penicilum candidum*. It appears on all cheeses around the 4th or 5th day. By the 10th day, the mold is sufficiently developed and the surface is slightly tenderized by hand. The cheeses obtained after storage for 24 h was regarded as the final product. The cheeses were then stored at 6°C for 45 days, which corresponds to the expiry date of the camembert produced by the same company where the preparation was carried out.

Table 1: Experimental design of cheese formulations

Formulation	Cow's milk	Goat's milk	$CaCl_2$ (0.2g/L)	Ferments			Rennet
				M229	TPM2	Ripening flora	
F1	0 L	6L	0.6ml	0.12g	0.45g	0.042g	0.138g
F2	6L	0L	0.6ml	0.12g	0.45g	0.042g	0.138g
F3	3L	3L	0.6ml	0.12g	0.45g	0.042g	0.138g
F4	1.5L	4.5L	0.4ml	0.08g	0.3g	0.028g	0.092g
F5	4.5L	1.5L	0.4ml	0.08g	0.3g	0.028g	0.092g

M229: A mesophilic culture that contains: *Lactococcus lactis* subsp. *Cremoris* which contributes to acidification, *Lactococcus lactis* subsp *lactis* var *diacetylactis* which contributes to the flavoring of the product, *Leuconostoc cremoris* which is a flavoring and gas-producing ferment. TPM2: Lyophilized thermophilic strain of *Streptococcus salivarius* subsp. *Thermophilus*

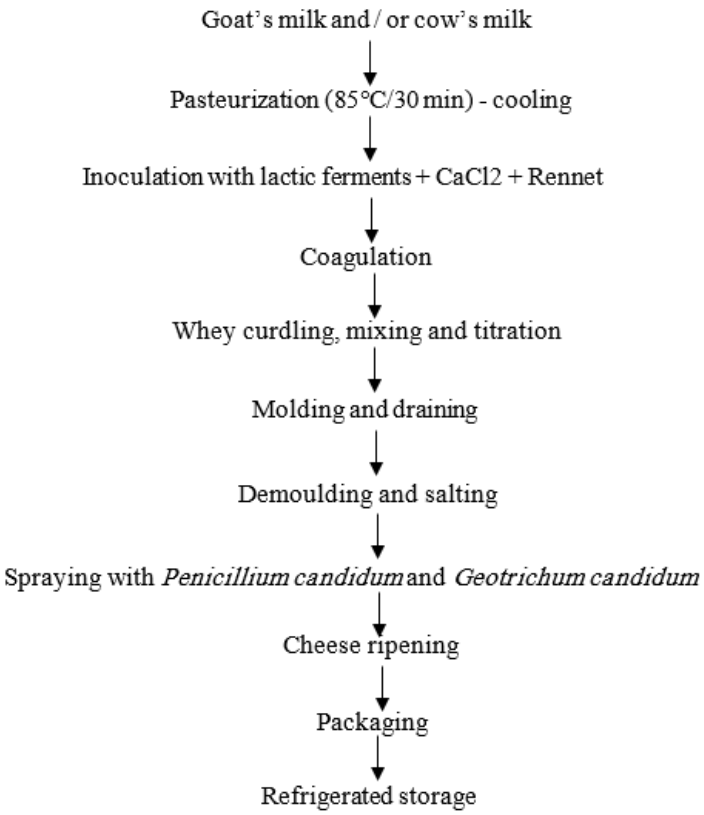

Figure 1: Flowchart of cheese manufacturing

4. Quality assessment of the produced ripened cheese

Ripened cheeses were analyzed during the entire storage period (45 days) with a time interval of 15 days (0, 15, 30 and 45 days of storage at 6 ± 2°C). At each sampling day, physicochemical, microbiological and sensory analyses were carried out.

5. Physicochemical quality

The cheeses produced were monitored throughout the storage period as to their physicochemical quality in terms of fat (GERBER method), dry matter (oven drying at 103 ± 2°C for 5 hours) and fat in dry matter (FDM) (determined as: fat content * 100 / dry matter content).

6. Microbiological analysis

The microbiological analyzes were carried out to ensure that the prepared cheeses are of superior hygienic and commercial quality. Cheese samples were analyzed for total coliforms, fecal coliform, *Staphylococcus aureus* and *Salmonella* according to the standard of the Official Journal of Algerian Republic (O.J.A.R) n◦39 [8] (Table 2).

Table 2 : Microbiological analyses

Germs sought	Culture media	Incubation temperature (°C)	Incubation time (hours)
Total coliform	Deoxycholate agar	37°C	24h à 48h
Fecal coliform	Deoxycholate agar	44°C	48h
Staphylococcus aureus	Giolitti/ Contoni agar	37°C	24h à 48h
Salmonelle	S-S agar	37°C	24h

7. Sensory assessment

The cheeses produced were tasted in small pieces (2 x 2 cm) by a panel of 32 semi-trained tasters who are part of the staff of the Camembert production department (laboratory technicians and production line operators) at Edough Dairy, Annaba. After explaining the course of the tasting session, the tasters are asked to evaluate the five types of cheese by noting, on a hedonic scale of five points (1: Don't like at all; 2: Don't like very much; 3: Indifferent; 4: Like a little and 5: Like a lot), their characteristics in terms of texture, flavor, aroma, color and viscosity. To maintain good sensitivity, the tasters are called upon to rinse their mouths with water at the beginning and after each tasting.

8. Statistical analysis

The statistical analysis was executed with Microsoft Office Excel 2007 for the measure of means and standard deviation. In order to compare means and to highlight significant differences between the cheese produced, one-way analysis of variance (ANOVA) at statistical significance $p \leq 0.05$ ($\alpha = 0.05$) with Fisher's least significant difference (LSD) was performed using Minitab version 17 Software (Minitab Inc., State College, PA, United States).

RESULTS

1. Physicochemical characteristics of milk used (GM, CM and the mixture of both)

The quality of the milk used in the manufacture of soft ripened cheese Camembert type is illustrated in Table 3. It turns out that the highest fat content is that of the mixture of CM and GM (50-50%) with a rate of 47.5 g/L. Regarding the dry matter, it is rather CM (whole and partially skimmed) which presented the highest rate (129 g/L); while the GM dry matter was the lowest (117 g/L). On the other hand, the density of the milks, did not vary considerably. Indeed, it was between 1030 to 1032 g/cm^3. Likewise for the pH which has not varied considerably, GM showed the highest pH of 6.65 which corresponds to the lowest acidity of 16 °D; while CM (whole and partially skimmed) presented the lowest pH of 6.62 which corresponds to the highest acidity of 18 °D. Finally, all the milks were free from antibiotic residues, which testifies their aptitudes to be transformed into other fermented products without however disturbing the activity of the ferments used.

Table 3: Milk quality used in the manufacture of cheese

	Density	Acidity °D	Fat (g/L)	pH	Dry matter (g/L)	ATB
GM	1031.6	16°D	43	6.65	117	(-)
Whole CM	1032	18°D	30	6.62	129	(-)
Partially skimmed CM	1030	18°D	15	6.62	129	(-)
50% GM - 50% CM*	1031.6	16°D	47.5	6.63	123.45	(-)
75% GM - 25% CM*	1032	16°D	33.7	6.64	120	(-)
25% GM - 75% CM*	1031.4	17°D	21	6.63	126	(-)

*ATB : antibiotic residues, CM : cow's milk, GM : goat's milk, *The last three mixes were prepared with partially skimmed cow's milk.*

2. Physicochemical characteristics of Camembert-type cheese

The characteristics of ripened cheeses depend on the nature and properties of the milk used, so, it must be of a good quality. The evolution of fat, dry matter and fat in dry matter (FDM) of prepared cheeses are illustrated in Figure 2.

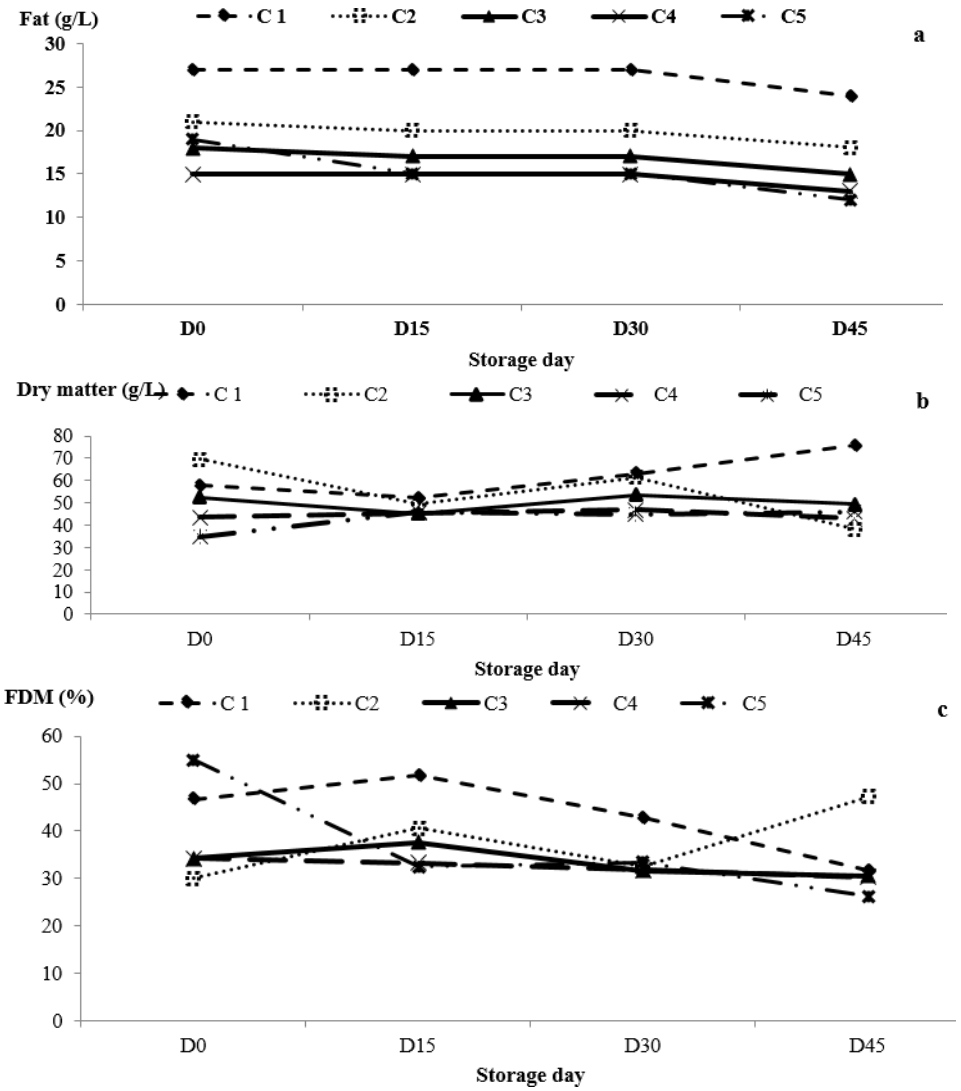

Figure 2: Evolution of the physicochemical characteristics of cheeses during storage

***C1** :100% GM ; **C2** : 100% CM ; **C3** : 50% GM - 50% CM ; **C4** : 75% GM- 25% CM ; **C5** : 25% GM - 75% CM ABS : Absence*

All the cheeses produced showed the same trend with regard to the evolution of their fat content. In fact, it remains stable or decreased slightly until 30th day, after which a rapid decrease at the end of storage was observed (Fig. 2a). Fat Camembert-type cheeses content ranged between 15 to 27 g/L. It's noted that the cheeses made from milk mixture have lower fat content than those made from cow's or goat's milk. Nevertheless, GM cheese differs from CM Camembert and milk mixtures (goat and cow) by a high fat content (27 g/L).

As for the dry matter evolutionn (Fig. 2b), it is clear that the ripened cheeses presented very distinct contents just after production, where the whole CM cheese presented the highest DM rate (69.62 %), this content varied between 69.62 and 38.18 % during the storage period. This can be explained by the CM used to make this cheese whoch was richer in DM (129 g/L) than GM (117 g/L). The lowest DM rate was presented by the cheese C5 (34.6 %), and this quota varied between 34.6 and 45.86 % during the storage period. DM content of C1 (100% GM) Camembert showed gradual increasing which indicated a transformation from a soft and elastic consistency to a hard and brittle body as a function of storage. At the end of storage, the cheese showed the highest DM content (75.70 %), which makes it harder than the others. Boukria et *al*. [9] come to the same conclusion. Inversly, the C2 (100% CM) cheese had the lowest DM content (38.18 %) which makes it the soft cheese comapring to the other samples. The rate of FDM has varied across a wide range from cheese to another (Fig. 2c). This variation is related to the nature and the composition of the raw material used to make the ripened cheese. Variations in the FDM of 46.61-31.7%; 30.16-47.15%; 34.24-30.43%; 34.27-30.28% and 54.91-26.16% were reported for C1, C2, C3, C4 and C5 cheeses, respectively.

3. Microbiological quality of Camembert-type cheese

The results of the microbiological analyzes of cheeses expressed in cfu/g are summarized in Table 4. The germs sought and counted in this work are considered as indicators of the hygienic quality of the product and reflect whether or not good hygienic practices are observed.

Table 4: Microbiological quality of Camembert cheeses during refrigerated storage

	C1	C2	C3	C4	C5
Day 0					
Total coliforms	72×10^2	12×10^2	28×10^2	63×10^2	42×10^2
Fecal coliforms	14×10^2	10^2	25×10^2	4×10^2	2×10^2
Staphylococcus aureus	ABS	ABS	ABS	ABS	ABS
Salmonelles	ABS	ABS	ABS	ABS	ABS
Day 15					
Total coliforms	76×10^2	15×10^2	31×10^2	67×10^2	46×10^2
Fecal coliforms	19×10^2	5×10^2	30×10^2	8×10^2	5×10^2
Staphylococcus aureus	ABS	ABS	ABS	ABS	ABS
Salmonelles	ABS	ABS	ABS	ABS	ABS
Day 30					
Total coliforms	80×10^2	20×10^2	37×10^2	73×10^2	50×10^2
Fecal coliforms	23×10^2	7×10^2	32×10^2	10×10^2	7×10^2
Staphylococcus aureus	ABS	ABS	ABS	ABS	ABS
Salmonelles	ABS	ABS	ABS	ABS	ABS
Day 45					
Total coliforms	89×10^2	34×10^2	45×10^2	80×10^2	63×10^2
Fecal coliforms	26×10^2	11×10^2	38×10^2	13×10^2	9×10^2
Staphylococcus aureus	ABS	ABS	ABS	ABS	ABS
Salmonelles	ABS	ABS	ABS	ABS	ABS

***C1** :100% GM ; **C2** : 100% CM ; **C3** : 50% GM - 50% CM ; **C4** : 75% GM- 25% CM ; **C5** : 25% GM - 75% CM ABS : Absence*

It's important to note the total absence of pathogenic germs (*Staphylococcus aureus* and *Salmonella*) in the cheeses during the entire storage period (up to 45 days). At the end of the maturation, the Cheese C1 (100% GM) had the most total coliforms count (72×10^2 cfu/g) than the others, this was followed by C4 cheese (75% GM - 25% CM) (63×10^2cfu/g). Cheeses can be classified from most to least contaminated as follows: C1> C4> C5> C3> C2.

This situation was noticed throughout storage period where cheeses keep the same order of classification in terms of total coliforms. For fecal coliforms, it is rather C3 cheese (50% GM - 50% CM) which presented the most significant load of 25×10^2, 30×10^2, 32×10^2, 38×10^2 cfu/g during D0, J15, J30 and J30, respectively, this was followed by C1 (100% GM) with loads of 14×10^2, 19×10^2, 23×10^2 and 26×10^2 cfu/g during D0, J15, J30 and J30, respectively.

4. Changes in physicochemical and microbiological qualities over storage time

The storage had a significant impact (p <0.05) on the parameters studied (fat and dry matter) with the exception of the FDM (p> 0.05) (Table 5). During storage, the fat content of all Camembert-type cheese was decreased significantly (p<0.05) by 11.11, 14.29, 16.67, 13.33 and 36.84% for C1, C2, C3, C4 and C5, respectively.

Likewise, storage had a significant impact (p <0.05) on the DM rate. In fact, it varied between 42.83 and 62.25 %. The dry extract complements the 100 % water content. It depends on the DM content of the milk and the amount of drainage, as the removal of whey results in a large increase in the DM content of the cheese. It was observed that the DM content of GM cheese and C5 (25 % GM-75 % CM) cheese had increased by 23.99 and 24.55%, respectively. On the other hand, the storage did not have a significant impact (p>0.05) on the FDM. This varied between 32.40 and 43.19 %. Even this, a decrease of 31.98, 11.13, 11.64 and 52.63 % for C1, C3, C4 and C5 cheeses, respectively was observed during storage. While, a rise was noted in the whole CM based cheese. The decrease of FDM in C5 (25 % GM - 75 % CM) Camembert was concomitant with the decrease in fat (36.84 %) and an increase in DM (+24.55 %). From the results in the Table 5, it can be seen that based on the mean content of FDM, all the produced cheeses belong to a group of soft half fat cheeses (45 – 50 % fats in the dry material) according to Popovic-Vranje et *al*. [10].

Table 5: Means of the physicochemical and microbiological qualities of different chesse formulations during all the storage period (45 days)

Formulation	C1	C2	C3	C4	C5
	Physicochemical quality				
Fat (g/L)	26.25±1.5 ^{a} (-11.11%)	19.75±1.26^{b} (-14.29%)	16.75±1.26 ^{c} (-16.67%)	14.50±1.00 ^{c} (-13.33%)	15.55±2.87^{c} (-36.84%)
Dry matter (%)	62.25±10.00 ^{a} (+23.49%)	54.62±13.77^{a,b} (-45.16%)	50.15±3.81 ^{a,b} (-6.24%)	44.74±1.80 ^{b} (-1.94%)	42.83±5.51 ^{b} (+24.55)
FDM (%)	43.19±8.47 ^{a} (-31.98%)	37.61±7.75 ^{a} (+36.03%)	33.51±3.18 ^{a} (-11.13%)	32.40±1.72 ^{a} (-11.64%)	36.78±12.52 ^{a} (-52.36%)
	Microbiological qualitiy				
Total coliforms	79.25±7.27 ^{a} (+19.10%)	20.25±9.74 ^{d} (+64.51%)	35.25±7.50 ^{c} (+37.78%)	70.75±7.41 ^{a} (+21.25%)	50.25±9.11 ^{b} (+33.33%)
Fecal coliforms	20.50±5.20 ^{b} (+46.15%)	6.00±4.16 ^{c} (+90.91%)	31.25±5.38 ^{a} (+34.21%)	8.75±3.77 ^{c} (+69.23%)	5.75±2.99 ^{c} (+77.78%)
Staphylococcus aureus	ABS	ABS	ABS	ABS	ABS
Salmonelles	ABS	ABS	ABS	ABS	ABS

Means that do not share a letter are significantly different. The values in brackets indicate the rate of increase or decrease between the first (D0) and the last day of storage (D45); (+): increase; (-): decrease **C1** :100% GM ; **C2** : 100% CM ; **C3** : 50% GM - 50% CM ; **C4** : 75% GM- 25% CM ; C**5** : 25% GM - 75% CM. *ABS: absence.*

As for the microbiological quality, it has been noted that the storage had a significant impact (p<0.05) on the cheese microbiological quality (Table 5). All cheeses showed initial comparatively low counts (total and fecal coliforms) but increased their levels relatively during the storage period. In fact, the rates of increase, for total coliforms, were 19.10, 64.51, 37.78, 21.25 and 33.33% for cheeses C1, C2, C3, C4 and C5, respectively and those of fecal coliforms were 46.15, 90.91, 34.21, 69.23 and 77.78% respectively for C1, C2, C3, C4 and C5 cheeses.

5. Sensory evaluation

The statistical study showed that the type of milk had a slight significant influence on the organoleptic quality of the cheeses produced (Table 6). Indeed, on D15, no significant difference (p> 0.05) was recorded between the cheeses for all the sensory attributes evaluated. Furthermore, milk type used had no significant differences on the global acceptability between cheeses during each analysis day. As expected, significant differences were perceived for the aroma and flavor of the cheeses. In fact, C5 cheese (25% GM - 75% CM) was the most appreciated for its aroma during D0 and D30 with respective scores of 4.875 and 3.625; while the C1 (100% GM) was the least appreciated with respective scores of 3.75 and 2.625. As for the flavor, it was the most appreciated for C4 (75% GM- 25% CM) during D0 with a complete score (5), C2 (100% whole CM) during D30 and D45, respectively,

with scores of 3.375 and 2.25. Finally, the cheeses were all accepted by the tasters without significant differences ($p > 0.05$) on D15, D30 and D45, with the exception on D0, where C5 was the most popular Camembert (score of 5) while C1 was the least appreciated compared to other cheeses (4.25).

Unlike the effect of the type of milk used which did not differ greatly, storage had a significant effect ($p < 0.05$) on all sensory attributes studied (Table 6). In fact, all the scores tend to decrease with the lengthening of the storage period. All Camembert-type cheeses had high scores during D0 (between 3.75 and 5), which decreased to reach values between 2.875 and 4.375; 2.375 and 3.875; 1.25 and 3.125 during D15, D30 and D45, respectively, indicating that the panelists did not like at all or were indifferent to these cheeses.

DISCUSSION

The composition of the milk depends on several factors including the species of origin. The highest fat content in the mixture of CM - GM (50 - 50%) may be due to the contribution of the GM (with a rate of 43 g/L) to raising the fat content of the mixture. Milks can be classified according to their fat content as follows: GM – CM (50-50%) > GM (100%) > GM- CM (75-25%) > whole CM (100%) > GM- CM (25-75%) > partially-skimmed CM (100%). As for the density, results from the current study were in the standard as Parmar et *al*. [11] stated that the density varied from 1.0338 g/cm^3 at 0.5 °C to 1.0296 g/cm^3 at 20 °C. The absence of antibiotic residues in milk is considered a crucial factor in technological suitability for milk processing. Indeed, the residues interfere with any maturation of the lactic ferments, during the manufacture of fermented milks or ripened cheeses, thus generating enormous economic losses Aoues et *al*. [12].

The lower fat content of cheeses made from milk mixture can be explained by differences in biochemical composition of the initial mixed milk and to the processing stages as stated by Niro et *al.* [13] who found a similar results as they have indicated that the CM-GM mixture had lower fat than CM cheese. The high fat content in GM cheese can clearly be explained by the initial content of GM which was 43 g/L. Thus, during the preparation this large part of the fat was concentrated in the curd being formed.

In the Sudanese Mozzarella Cheese from CM, GM and a mixture of both, the percentage of fat content ranged from 15.07 to 24.87, from 16.53 to 21.17 and from 14.03 to 24.12 at first day, 15th day and 30th day of storage period, respectively [14]. Close results have been obtained previously by Queiroga et *al*. [15] where authors observed that fresh Coalho cheese made with CM displayed a lower fat content compared with cheese made with GM or a mixture of both (50% -50%) during the entire storage period, suggesting that manufacturing differences can influence the final cheese composition independent of the milk source; Furthermore, Sant'ana et *al*. [16] have noted that the fat content had decreased in fresh cheese made from GM (16.44 g/L) compared to fresh cheese made from CM or made from mixtures of milks (17.44 g/L and 17.78 g/L, respectively). Batty et *al.* [17] have highlighted that cheese-making recipes had an influence on the composition and characteristics of Camembert-type cheese, particularly fat, where the author noted a rate ranging between 21.75 and 23.66 % of fat content. it's known that fat plays an important role in cheese organoleptic quality as it's the source of fat-soluble aromatic compounds, hence its contribution to the sensory quality of the cheese, it also plays an important role in the firmness of the cheese.

The dry extract is the complement of the water content at 100%. It depends on the dry matter content of the milk and the importance of draining, as the elimination of whey greatly increases the dry matter content of the cheese. Indeed, the quantity of amount of water evacuated allows the microbiological quality of the cheese to be preserved by reducing the water activity, thus avoiding the development of undesirable bacteria. The increase in dry matter observed in C1, C3, C4 and C5 cheeses may be explained by the loss of moisture. The same tendence was observed by Medjoudj et *al*. [18], where the DM of traditional Algerian Bouhezza goat'milk cheese evolved, respectively, from 13.50% to 51.95% from the day 0 to 72 days of ripening. Popovic-Vranje et *al.* [10] arrived to the same results on the GM cheese, Camembert-type.

Table 6: Effect of milk used and storage time on the sensory attributes of different soft ripened cheese formulations.

Storage day	**D0**					**D15**				
Type of cheese / Sensory attributes	**C1**	**C2**	**C3**	**C4**	**C5**	**C1**	**C2**	**C3**	**C4**	**C5**
General aspect	4.75± 0,46^{a,b,A}	4.5±0.53^{b,A}	4.375±0.52^{b,A}	4.75±0.46 ^{a,b,A}	5.0±0.00^{a,A}	3.625±1.51$^{a, B}$	3.625±1.51^{a,A,B}	4.375±0.92^{a,A}	3.25±1.58^{a,B}	3.125±1.64^{a,B}
Texture	4.5±0.76 ^{a,A}	4.5±0.76 ^{a,A}	4.625±0.74 ^{a,A}	5.0±0.00 ^{a,A}	5.0±0.00^{a,A}	3.875±1.64^{a,A,B}	3.75±1.58^{a,A,B}	4.00±1.41^{a,A,B}	3.5±1.51^{a,B}	3.625±1.30^{a,B}
Color	4.625±0.25^{a,A}	4.625±0.74 ^{a,A}	4.875±0.35^{a,A}	4.875±0.35^{a,A}	5.0±0.00^{a,A}	4.00±1.07^{a,A}	4.125±1.13^{a,A,B}	4.25±1.16^{a,A,B}	3.875±1.36^{a,B}	3.875±1.60^{a,B}
Aroma	3.75±1.75^{b,A}	4.25±0.89^{a,b,A}	4.125±0.83^{a,b,A}	4.625±0.52^{a,b,A}	4.875±0.35 ^{a,A}	2.875±1.36^{a,A}	3.125±1.8^{a,A,B}	3.5±1.69^{a,A}	3.00 ±1.60^{a,B}	3.75±1.58^{a,B}
Flavor	4.125±1.36^{b,A}	4.625±0.52^{a,b,A}	4.75±0.71^{a,b,A}	5±0.00^{a,A}	4.875±0.35^{a,b,A}	3.5±1.51^{a,A,B}	4.125±0.46^{a,A,B}	4.00±0.93^{a,B}	3.625±1.41^{a,B}	3.875 ± 1.25^{a,B}
Overall acceptability	4.25 ± 1.39^{b,A}	4.875 ± 0.35^{a,b,A}	4.875 ± 0.35^{a,b,A}	4.875 ± 0.35^{a,b,A}	5.0 ± 0.00^{a,A}	4.00±1.07^{a,A}	4.25±0.89^{a,A}	4.375 ±0.92^{a,A}	3.625±1.77^{a,B}	3.375 ± 1.85^{a,B}
Storage day	**D30**					**D45**				
Type of cheese / Sensory attributes	**C1**	**C2**	**C3**	**C4**	**C5**	**C1**	**C2**	**C3**	**C4**	**C5**
General aspect	3.125±0.64^{a,B}	3.375±0.74^{a,B}	3.375±0.74^{a,B}	3.0±0.93^{a,B}	3.25±0.71^{a,B}	1.625±0.52^{a,C}	1.375±0.52^{a,C}	1.5±0.53^{a,C}	1.375±0.52^{a,C}	1.5±0.53^{a,C}
Texture	3.125±0.99 ^{a,B}	3.25±0.89 ^{a,B}	3.375±0.74^{a,B}	3.0±0.76^{a,B}	3.0±0.53^{a,B,C}	3.0±1.20^{a,B}	3.125±1.13^{a,B}	3.125±1.13^{a,B}	2.875±0.99^{a,B}	2.75±0.89^{a,C}
Color	3.0±0.76^{b,B}	3.375±0.74^{a,b,B}	3.875±0.35^{a,B}	3.5±0.76^{a,b,B,C}	3.75±0.46^{a,B}	2.75±0.46^{a,B}	2.5±0.53^{a,C}	2.75±0.46^{a,C}	2.75±0.46^{a,C}	2.75±0.46^{a,C}
Aroma	2.625±0.92^{b,A,B}	3.375±0.52^{a,b,B}	3.125±0.64 ^{a,b,A}	3.125±0.99^{a,b,B}	3.625±0.74^{a,B}	1.375±0.52^{a,B}	1.25±0.46^{a,C}	1.375±0.74^{a,B}	1.5±0.53^{a,C}	1.5±0.53^{a,C}
Flavor	2.625±1.06^{a,b,B,C}	3.375±0.74^{a,B,C}	2.375±0.74^{b,C}	2.5±1.07^{a,b,C}	2.375±0.74^{b,C}	1.75±0.46^{a,b,C}	2.25±0.89^{a,C}	1.25±0.46^{b,D}	1.25±0.46^{b,D}	1.375±0.52^{b,D}
Overall acceptability	2.375±0.74^{a,B}	3.125±0.99^{a,B}	2.75±0.89^{a,B}	2.625±1.19^{a,B,C}	2.75±1.28^{a,B}	1.375±0.52^{a,B}	1.875±0.35^{a,C}	1.625±0.52 ^{a,C}	1.5±0.53^{a,C}	1.375±0.52^{a,C}

Different letters in the same row indicate a significant difference (p<0,05) ; a and b letter indicate the differences between the five Camembert-type cheese on the same day of analysis ; A, B, Cand D letters : show differences between the same cheese according to the day of storage ; Results are ranked in descending order ; a>b>c / A>B >C>D;

***C1** :100% GM ; **C2** : 100% CM ; **C3** : 50% GM - 50% CM ; **F4** : 75% GM- 25% CM ; **F5** : 25% GM - 75% CM*

According to Sanchez-Macıas et *al*. [19], the level of FDM directly contributes to the organoleptic properties, in particular the smoothness which is characterized by the greasy feel of a product. The right choice of raw material and respect for the manufacturing technique allow the generation of products in a wide range of textures: from fluid to firm and from spreadable to sliceable. A diminution has been observed during the storage for the cheeses C1, C3, C4 and C5, this can be explained by the loss in humidity during ripening which led to an increase in DM so a decrease in FDM.

As for the microbiological quality, the cheeses produced comply with the standards dictated by the national regulations relating to the microbiological quality of foodstuffs (Official Journal of the Algerian Republic n° 39 of the year 2017). The absence of pathogenic germs (*Staphylococcus aureus* and *Salmonella*) in all cheeses samples attests to the effectiveness of milk pasteurization. These results are in agreement with the data from previous studies, which preconize that pasteurization gets rid of pathogenic microorganisms from milk used to make cheese [20, 21].

The total coliform counts increased as the storage period lengthens and the cheese made from GM was the most charged in terms of these bacteria. This may be probably due to the initial loads brought by GM which is known to be the most contaminated compared to other milks as indicated by Montel et *al*. [22]. Results from the present study were not in accordance with those reported by Benheddi & Hellal [20] on traditional Algerian fresh cheese (Jben) where authors have noted the absence of total coliforms in fresh cheese (24 h) and an amicrobial load < 30 cfu/g in fresh cheese after one week of production. Faecal coliforms were present in all cheeses and throughout the storage period, however, values recorded remain lower than the values set by national regulations (official journal of the Algerian Republic n ° 39 of 2017), where a number of 10^2-10^3 cfu of total and fecal coliforms is tolerated in g of product. Nevertheless, the respective loads of all cheeses produced exceeded the lower limit of 10^2 cfu/g. Therefore, in application of the provisions of the interministerial decree of 04 October 2016 setting the microbiological criteria for foodstuffs, published in the Official Journal No. 39 of 02 July 2017, it is concluded that the cheeses produced are of acceptable microbiological quality.

These figures are close to those reported by Tadjine et *al*. [21] who concluded that despite the poor quality of the raw material used, cheeses analyzed have a satisfactory hygienic quality.

It was noted that the physicochemical quality of cheeses was impacted by the storage time. The same trend was found by Sulieman et *al*. [14] with a decrease in fat content at the 30^{th} day of storage period (last day). This decrease may be due to the lipolysis of triglycerides to free fatty acids which continue relatively during storage period as stated by Guizani et *al*. [23] whom observed a little lowring in the fat content by 7.20% dring 30 days of ripening of standrad goat cheese.

The important increase in DM of GM cheese and C5 (25 % GM-75 % CM) cheese indicates a faster loss of moisture during the conservation period in summer as stated by Serrapica et *al*. [24]. Guizani et *al*. [23] arrived to the same conclusion and explained this increase in DM by a surface evaporation and the exchange of volatile products (water, ammonia, fatty acids, etc.) between the cheese and its environment.

As for the effect of storage on the FDM, our outcomes were not supported by those of Popovic-Vranje et *al*. [10] whom found an increase in DM and FDM contents in Camembert cheese during maturation until 45 days. The same results have been noted by Medjoudj et *al*. [18] on Algerian traditional Bouhezza cheese made using raw GM with a rise in fat and FDM until 72 of ripening days. Sant'Ana et *al*. [16] concluded that Minas fresh cheese produced with CM, GM, and a mixture of the two demonstrated similar physicochemical properties during 21 days of storage.

The increase in total and fecal coliforms loads during storage is probably due to the development of contaminating bacteria during storage which is in turn due to an increase in the pH of the cheeses following deamination under the action of the ripening flora. The presence of unwanted side microflora in Camembert-type cheeses may disturb the normal course of the maturing processes and even may affect the sensory profile of the cheese. An increase in the number of psychrotrophic microorganisms was reported by Ivanova et *al*. [25] on the Kashkaval cheese from 2.2±0.04.104 cfu/g to 3.4±0.05.106 cfu/g during the 60-day maturation period. Our findings were not in agreement with those previously reported by Benheddi & Hellal [20],

who noted a total absence of those bacteria in fresh cheese (24h) and after 7 days. The detection of those flora, in the current study, indicated that cheeses were not produced respecting the rigorous hygienic practices (application of hygiene rules during production and compliance with these rules by staff).

The aroma and the flavor of cheese made from GM showed the lowest scored. This is due to the fact that GM has a very characteristic flavor and aroma, which must have persisted in the cheese, often not appreciated by the majority of consumers. Our findings were not in agreement with those reported by Mohamed et *al.* [26] where they stated that sheep milk positively affected all sensorial properties of sheep processed cheese compared to cow processed cheese.

It was observed a decrease in scorses as the storage period lenghten; This decrease was concomitant with the variations in the physicochemical properties observed. Cheeses made from a blend of the two milks had high to intermediate scores compared to cheeses made from CM or GM alone. This may be attributable according to Sant'Ana et *al.* [16] to the highest contents of short-chain FA favoring the aroma and flavor typical of dairy products made from GM, thus indicating the perception of the typical aspects of GM.

CONCLUSION

In summary, Camembert-type cheese made from cow's milk, goat's milk and a mixture of both showed a variation in physicochemical and microbiological properties during 45 days of storage. Despite the presence of total and fecal coliforms, cheeses were of an acceptable microbiological quality. As well, Camembert-type cheeses manufactured with cow's milk, goat's milk and a mixture of both advertised some similar sensory attributes; However, they differed in flavor and aroma which is due to the use of goat's milk which accentuated the flavor and aroma typical of this milk. The type of milk used and the storage had an impact on the specific physicochemical, microbiological and sensory characteristics of cheeses produced. The development of Camembert-type cheese where cow milk is totally or partially substituted with goat's milk is feasable and can be a viable alternative for marketable, high-quality dairy products in order to take advantage of the nutritional virtues of goat's milk and meet the expectations and desires of Algerian consumers.

Finally, It is recommended incitating dairy industries in Algeria to produce Camembert cheese from both cow's and goat's milk and a mixture of both.

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