ISSN 0101-2061 (Print)
ISSN 1678-457X (Online)
Food Science and Technology

DOI: https://doi.org/10.1590/fst.00620

Milk heat treatment affects microbial characteristics of cows' and goats' "*Jben*" traditional fresh cheeses

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Abstract

"*Jben*" is an Algerian traditional fresh cheese produced from raw or pasteurized milk of cows, goats and sheep, on a small scale during the period of milk abundance in a restricted area of the North-east and -West of Algeria. In this study, four *Jben*-type cheeses were produced: cheeses made from cow's milk subjected to 82 °C/10 sec treatment or without heat treatment, and its analogue goat's milk cheeses. We investigated the effects of "Heat treatment: raw or pasteurized" and "Species: cow or goat" on microbiological characteristics, pH and acidity of "*Jben*" cheese. Milk samples were collected across five breeding of cows and three breeding of goats in the northeastern Algeria and "*Jben*" cheeses were made. Results showed that more than 40% of raw and pasteurized milk have poor hygienic quality. However, in both species, "*Jben*" produced from pasteurized milk has better sanitary quality than "*Jben*" produced from raw milk. All cheese samples were safe according to the criteria of the regulation (EC) 1441/2007. Pasteurization did not affect acidity in both species. Data from this study may contribute to improve the cheese-making process in small scale, using milk from different species (cow and goat).

Keywords: "*Jben*" Cheese; microbiological characteristics; heat treatment; traditional cheese; goat, cow.

Practical Application: Algerian "*Jben*" cheese: his history, origin manufacturing processes and microbial characteristics.

1 Introduction

Cheese is one of the most popular milk products, which is most commonly produced from raw or pasteurized cow's milk, but also from other species such as sheep and goats (Bennett & Johnston, 2004; Johnson, 2017; Khattab et al., 2019), it can differ from each other by their making process, ripening time (if applied), type of milk used, texture, color, flavor, microbial counts and diversity, coagulation type (enzymatic and/or acid)… etc (Kamimura et al., 2019).

With respect to the relevant literature, the use of raw milk for the production of cheese has advantages and disadvantages. Raw milk cheeses tend to display greater variability in comparison to their counterparts made of pasteurised milk and they are characterised by a strong and unique organoleptic profile. This profile, sometimes, is highly appreciated by the consumers, as in the case of raw cows' milk cheese (Beuvier et al., 1997; Montel et al., 2014), or not always gaining the consumers' sensory acceptance, as in the case of raw goats' milk cheese (Mituniewicz–Małek et al., 2019). Cheeses from raw milk possess also some healthy qualities, since studies in populations with a similar genetic background have shown that children growing up on a farm have a lower risk of developing asthma and allergies due to the consumption of raw unpasteurized milk (Waser et al., 2007). This is especially true for those who consume goat milk, which has been identified as having more favourable allergenic characteristics (Ranadheera et al., 2019; Verruck et al., 2019).

Several studies have shown that cheese produced from raw milk contains a wide variety of microflora, including beneficial bacteria, especially lactic acid bacteria, which contribute to a more intense and stronger flavor production than that of pasteurized milk cheeses (Casalta et al., 2009; Grappin & Beuvier, 1997). These results have been attributed to several indigenous microbiota, such as *Lactococcus* spp., *Lactobacillus* spp., *Leuconostoc* spp., and *Enterococcus* spp. Moreover, indigenous microflora, especially lactic acid bacteria, can control the proliferation of many contaminating bacterial pathogens and thus protect the cheeses from microbiological risk, making raw milk cheeses superior in terms of microbiological safety, in comparison to cheeses made from pasteurized milk (Yoon et al., 2016).

However, among the disadvantages of using raw milk in cheese production is the presence of *Listeria monocytogenes*, verocytotoxin-producing *Escherichia coli*, *Staphylococcus Aureus*, *Salmonella* and *Campylobacter* and other pathogenic

Received 06 Jan., 2020
Accepted 27 Jan., 2020
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bacteria, which carry a potential health risk for the consumer (Cunha-Neto et al., 2020; Kousta et al., 2010; Verraes et al., 2015; Yoon et al., 2016). The degree of dangerousness depends, among others, on the pathogenicity of the strain present in the milk, the number of ingested microorganisms, the physiological state of the microorganism and the health condition of the consumer at the moment of ingestion (Verraes et al., 2015).

Pasteurization is considered as the most widely used method in the dairy industry, as a mean to avoid risk for human health from raw milk consumption. It consists of a process that heats raw milk with specified time and temperature combinations, designed to eliminate all known milk-borne pathogens and undesirable bacteria, resulting in a harmless product of constant quality. Also, heat treatment can slightly affect milk composition, physicochemical characteristics, nutritive profile and sensory properties (Alegbeleye et al., 2018).

In Algeria, as in all regions of the world, consumption of dairy products like cheeses is an old tradition linked to livestock farming. Dairy products are made using ancient artisanal processes, employing milk or mixtures of milk from different species (Boudalia et al., 2016; Leksir et al., 2019; Leksir & Chemmam, 2015; Shori, 2017). "*Jben*" is a traditional fresh cheese made with raw cow, sheep or goat milk, spontaneously acidified and coagulated by coagulating enzymes using plant (Ouadghiri et al., 2005), or animal rennet or acidifying starters (Hayaloglu, 2017). Also, "*Jben*" can be hand made without enzymatic coagulation; in this case, raw milk is only coagulated by spontaneous acidification (Benkerroum & Tamime, 2004).

We have recently published data about pasteurization effects on physicochemical parameters and yield of "*Jben*" cheese produced by cow and goat milk (Tadjine et al., 2019), and to our knowledge and up to now, no scientific data have been published concerning the evolution of "*Jben*" microflora produced from raw or pasteurized cows' or goats' milk from Northern Algeria. So, in this study, we aim to: i) characterize the traditional cheese "*Jben*" made from raw or pasteurized cow's or goat's milk collected from eight different farms in the Northeast region of Algeria, ii) evaluate the hygienic quality of the raw and pasteurized milk cheeses with the aim to assist small scale Algerian manufacturers in producing safe "*Jben*" cheese with the current microbiological safety criteria in European commission regulation (EC) 2004/24/EC and 1441/2007 (European. Commission, 2004, 2007).

2 Materials and methods

2.1 Data collection about the traditional preparation of "Jben"

A household survey focused on group discussion was performed in this study, according to Leksir et al. (2019). The present documentation of *"Jben"* preparation is based on the questionnaires and insight observation from farmers. A total of 20 people, including producers and sellers, were involved in the interviews and discussions, after taking their prior consent. The survey was conducted through face-to-face interaction to either heads or knowledgeable adults of households. During the data collection on *"Jben"*, especially while conducting the interviews, observations were made and the comments of responders and other people were noted.

The research protocol for the household survey have been developed and validated by the ethics committee of the University of Guelma-Algeria.

2.2 Milk and cheese samples collection

A total of twenty five samples of raw cow milk were collected from 5 cow farms and fifteen samples of raw goat milk were collected from 3 goat farms (5 samples from each farm) located in the Guelma area (North-East of Algeria). For cheese making and from each farm, a quantity of 1.3 l of pooled raw milk was collected in sterile flasks and then transported in a cooler with an ice-bath to a cheese factory in Ain Makhlouf (Guelma, Algeria). The transport times varied depending on the remoteness of the sampling sites and in order to take account of the real field conditions, no conservative was added. Upon arrival, the milk sample was divided equally into two halves, with the first half pasteurized at 82 °C for 10 seconds while the second half remained raw. All bottles used were previously autoclaved at a temperature of 121 °C, under pressure of 1 bar for 15 minutes.

For bacteriological analysis, a total of eighty samples of 60 ml of volume from raw (40 samples: 25 samples of raw cow milk + 15 samples of raw goat milk) and pasteurized milk (40 samples: 25 samples of pasteurized cow milk + 15 samples of pasteurized goat mil) as well as from cheese from raw (40 samples) and pasteurized milk (40 samples) were collected from sterile plastic vials at a temperature of 4 °C. The milk and cheese samples were collected by applying the aseptic rules and respecting the Good Laboratory Practices (GLP).

2.3 "Jben" cheese making

"*Jben*" Cheese was produced following traditional cheese-making practices using either raw or pasteurized cow's and goat's milk. For each cheese, a total of 0.5 L of milk was heated and inoculated by commercial lactic ferments *Lactococcus lactis sub. lactis*, *Lactococcus lactis sub. cremori* and *Lactococcus lactis sub. lactis* biovar *diacetylactis* (2 g/100 L, Dupont-Danisco, Dangé-Saint-Romain, France) according to the manufacturer's instructions. "*Jben*" was smoothed and matured for three hours, then rennet was added according to the manufacturer's instructions (Maison de Fournitures Industrielles (MAFI), Tunisia) (1:15000 strength) and left curdled for 13 h. Then this curd was molded for 24 h and finally, cheeses were demolded and drained for 24 h. The manufacturing process lasted for about three days. During the manufacture of cheeses, pH was measured in both milk and cheese by introducing the electrode directly into samples (pH meter Adwa, AD1000). Acidity was expressed on the basis of (°D) and was determined according to AOAC International method (Association of Official Analytical Chemists, 2002).

2.4 Microbiological analysis of milk and "Jben" cheese

A volume of 25 mL of milk or a quantity of 25 g of cheese was transferred aseptically to stomacher bags with 225 mL of sterile Buffered Peptone Water solution (BIOSCAN INDUSTRIE, Sétif, Algeria) and homogenized in a stomacher (Lab Blender 400; Seward, London, UK) for 60 s at room temperature.

Each homogenate was serially diluted with Ringer solution. All culture media were purchased from Biochem Chemopharma (Cosne-Cours-sur-Loire, France).

Samples preparation and dilutions were performed according to the recommendations of the International Dairy Federation (International Dairy Federation, 1991): 1). The Total Mesophilic Aerobic Flora (TMAF) were enumerated using Plate Count Agar (PCA) and incubated at 30 °C for 72 h according to ISO 4833-1:2013 (2013). 2). The Total Coliforms (TC) were determined using Lactose bile brilliant green agar incubated at 37 °C for 24 to 48h. 3). Faecal Coliforms (TTC) were determined using Schubert medium with the addition of Kovacs reagent incubated at 44 °C for 24h. 4). The enumeration of coagulase-positive Staphylococci suspected pathogens was conducted using a selective medium (Chapman) and incubated at 37 °C for 24. A positive culture of Staphylococci suspected pathogens is indicated by the formation of pigmented colonies surrounded by a yellow halo. 5). For *Salmonella* spp. count, two mediums were used to enumerate the colonies: Selenite-Cystine for enrichment at 37 °C for 12 h, and SS medium (*Salmonella-Shigella*) for isolation at 37 °C for 24 h. *Salmonella* appears like colorless and transparent colonies with or without a black center. 6). *Listeria monocytogenes* were enumerated on Blood agar after incubation at 37°C for 24 h. 7). Molds and yeasts were enumerated on Sabouraud chloramphenicol agar (SCA) after incubation at 22 °C for five days (International Organization for Standardization, 2008).

2.5 Statistical analyses

For bacteriological analysis, results were expressed as log of colony-forming units per milliliters (for milk) or grams (for "*Jben*" cheese) (International Organization for Standardization, 2013) in the form of mean ± SD (Standard Error). The experiments were carried out in triplicate. Normality and homogeneity of variances were verified using Shapiro-Wilk and Levene tests. For all analysis (pH, acidity and microbiological analysis), measures were analyzed using general linear model (GLM) for unbalanced sampling design (Warton et al., 2016); the fixed part of the model included the factors heat treatment (raw or pasteurized milk) and species (cow or goat) and their interaction. Significance was considered at $p < 0.05$ using MiniTab software [Minitab, Ltd, United Kingdom (Version 16)].

3 Results and discussion

The survey that was conducted among the local farmers of several farms in the northeastern of Algeria identified a common procedure for the "*Jben*" cheese production that is schematically represented in Figure 1.

Mean pH and acidity values are presented in Table 1. A significant effect of heat treatment (pasteurized or unpasteurized) and species (cow or goat) on milk pH was observed ($p = 0.0001$; $p = 0.007$). For the pH values of "*Jben*" cheese, a significant effect of heat treatment ($p = 0.008$) was recorded; However, for acidity values, no significant effect was recorded neither for milk nor for "*Jben*" cheese (Table 1).

For both species (cow and goat), cheese pH values are close to those reported by Benheddi & Hellal (2019) (4.42 and 4.90) for Algerian "*Jben*" cheese; while for titratable acidity values, the results are low to those reported by El Marnissi et al. (2013) for "*Jben*" cheese produced from raw milk in Morocco (80 °D). Moreover, titratable acidity recorder results are similar compared to "*Quesillo*" cow cheese produced in Argentine (43-45 °D) (Oliszewski et al., 2007), and "*Coalho*" goat cheese produced in Brazil (46 °D) (Moraes et al., 2018).

pH results are in agreement with those recorded for "*Anevato*" cheese produced in Greece (pH value 4.64-4.47) (Hatzikamari et al., 1999) and "*Picodon*" *goat* cheese produced in France (pH value 4.5) (Leclercq-Perlat et al., 2019) ; or ripened at the early stages of ripening, like in traditional Spanish cheese *Babia-Laciana* (pH value 4.44) (Franco et al., 2003). However, pH results are slightly lower compared to those recorded for Mexican cheese produced from raw milk "*Chihuahua*" (pH value 5.2) (Sánchez-Gamboa et al., 2018) ;"*Livanjski*" cheese produced from raw ewe and/or cow milk in Bosnia and Hercegovina (pH value 5.45) (Vladimír et al., 2020) ; or Brazilian cheese produced from raw or pasteurized milk "*Coalho*" (pH value 5.2) (Queiroga et al., 2013), and other raw goat's milk cheeses, either fresh like "*Vlasina*" produced in Serbia (pH value 5.1-5.2) (Terzic-Vidojevic et al., 2013).

Also, pH values are higher than those found in traditional homemade fresh goat cheeses from Northern Morocco (pH value 3.81 to 4) (El Galiou et al., 2015).

These pH variations can be explained by differences in the fabrication process such as the amounts of rennet used for coagulation, which cause very variable coagulation times. It can also be attributed to the increase in the proteolytic activity of rennet which is accentuated by the presence of the growing

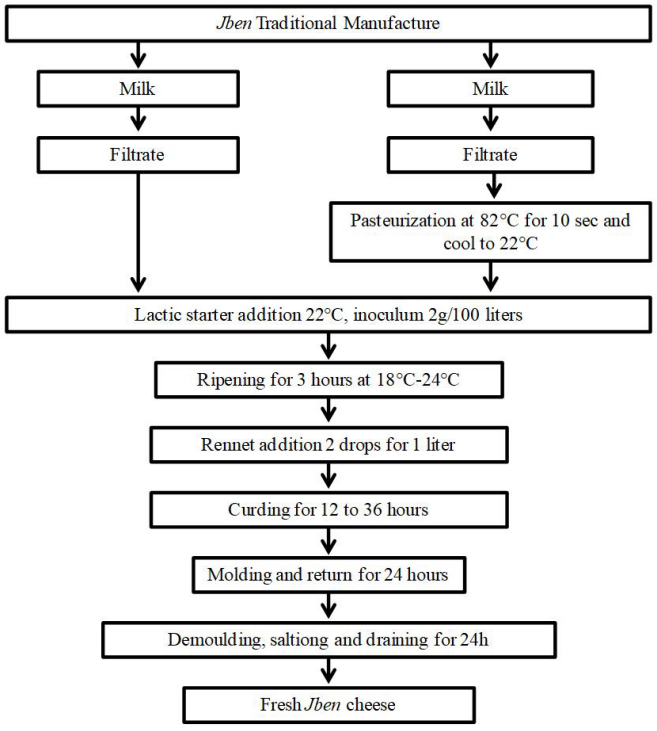

Figure 1. Protocol for the production of "*Jben*" cheese.

flora of milk (Cantor et al., 2004), or seasonal variations (Sánchez-Gamboa et al., 2018), microbial counts and diversity (Vladimír et al., 2020).

3.1 Microbiological analysis of milk

The results of the microbiological analysis of the raw and pasteurized milk samples collected from farms are presented in Table 2. Comparing with legislation (European Commission, 2005), overall, 42.5% (17/40) of samples in raw milk and 45% (18/40) of samples in pasteurized milk did not meet legal criteria for TMAF. Also, 15% (6/40) of samples from raw milk are above the standard and 30% of the samples contain a bacterial load of coagulase-positive *Staphylococcus* higher than the standard. The comparison between raw and pasteurized milk showed that pasteurization decreased the microorganisms found in raw milk with different percentages from one type of flora to another: in total mesophilic aerobic flora, the percentage of decrease was equal to 49.68%, while total and Faecal Coliform decreased with a percentage of, 99.94% and 99.92%, respectively. Moreover, Results showed that the rate of decrease of coagulase positive *Staphylococcus* was 79.99% and in yeast and mold organisms was 86.8%. According to the legal criteria applicable to the TTC, 15% (6/40) of samples from raw milk were above the standard. However, all samples analyzed of raw and pasteurized milk from both species show the absence of *Salmonella* and *Listeria* monocytogenes. Enumeration of the total aerobic mesophilic flora provided insight into the level of contamination and hygienic quality of milk; these results reflect the poor "hygienic practices" in farms.

Pasteurization had a significant effect on Total Coliforms, Faecal Coliforms Staphylococci, mold and yeast count in milk (p = 0.0001, 0.002, 0.0001, 0.003 respectively) (Table 2). Also, and despite a significant effect of "species" (cow and goat) on staphylococci, mold and yeast count in milk (p = 0.005, 0.019 respectively) (Table 2), the absence of cited species in samples demonstrates the advantages of milk pasteurization. These results are in agreement with the data from several studies, which advocate that pasteurization eliminate pathogenic microorganisms from milk used to make cheese (Benheddi & Hellal, 2019; Gould et al., 2014; Little et al., 2008). The Results showed a very high variability in raw milk quality, which is probably related to the poor compliance with one of the following hygiene conditions:

Table 1. pH and acidity (°D) of raw and pasteurized cow's and goat's milk as well as "*Jben*" cheese made from raw or pasteurized cow's and goat's milk.

	Cows		Goats		P-values		
	Raw milk	Pasteurized milk	Raw milk	Pasteurized milk	Heat treatment	Species	"Heat treatment × Species"
pH	6.77 ± 0.07	6.72 ± 0.07	6.74 ± 0.05	6.67 ± 0.05	**0.0001**	**0.007**	0.539
Acidity (°D)	18.7 ± 1.62	18.8 ± 1.58	18.2 ± 1.47	18.3 ± 1.45	0.767	0,172	0.941
	Raw milk cheese	Pasteurized milk cheese	Raw milk cheese	Pasteurized milk cheese	Heat treatment	Species	"Heat treatment × Species"
pH	4.69 ± 0.12	4.55 ± 0.12	4.60 ± 0.17	4.56 ± 0.15	**0.008**	0.220	0.192
Acidity (°D)	43.9 ± 10.2	46.9 ± 8.49	46.1 ± 8.45	45.7 ± 10.7	0.545	0.827	0.449

Bold data P-values indicate significant effects.

Table 2. Microbial counts (log cfu/g or mL) of raw and pasteurized cow's and goat's milk as well as "*Jben*" cheese made from raw or pasteurized cow's and goat's milk.

	Cows		Goats		P-values		
	Raw milk	Pasteurized milk	Raw milk	Pasteurized milk	Heat treatment	Species	"Heat treatment × Species"
Total Mesophilic Aerobic Flora (TMAF)	9.61 ± 10.30	9.29 ± 9.98	6.25 ± 6.39	5.25 ± 5.61	0.631	0.294	0.712
Total Coliforms	4.60 ± 4.76	2.71 ± 3.17	3.76 ± 3.82	0.00	**0.0001**	0.381	0.379
Faecal Coliforms	2.11 ± 1.54	0.11 ± 0.40	1.21 ± 1.62	0.00	**0.002**	0.303	0.304
Staphylococcus	3.37 ± 3.47	1.60 ± 2.11	0	0	**0.0001**	**0.005**	**0.005**
Mold and yeasts	4.50 ± 4.67	2.68 ± 3.06	3.78 ± 3.93	1.51 ± 2.11	**0.003**	**0.019**	0.091
	Raw milk cheese	Pasteurized milk cheese	Raw milk cheese	Pasteurized milk cheese	Heat treatment	Species	"Heat treatment × Species"
Total Mesophilic Aerobic Flora (TMAF)	7.75 ± 8.10	7.02 ± 7.33	7.89 ± 8.09	6.74 ± 7.11	**0.022**	0.141	0.146
Total Coliforms	4.84 ± 4.82	3.88 ± 4.45	3.04 ± 3.55	2.22 ± 2.81	**0.0001**	**0.003**	**0.011**
Faecal Coliforms	3.05 ± 3.58	0	1.56 ± 2.17	0	-	-	
Staphylococcus	3.21 ± 3.39	0	0	0	**0.002**	**0.016**	**0.013**
Mold and yeasts	5.24 ± 5.90	2.55 ± 3.05	4.19 ± 4.71	2.30 ± 2.88	0.261	0.434	0.444

Bold data P-values indicate significant effects.

milking hygiene, milking equipment, handling and storage equipment. Our results are consistent with those reported by (Matallah et al., 2017) in the region of El Tarf, northeastern of Algeria, who found that more than 50% of samples exceeded the microbiological standards. However, our results are lower than those reported by (Bousbia et al., 2018; Ghazi & Niar, 2011; Maïworé et al., 2018) who found that 81.2%, 88% and 90% of the samples were above standards (10^5 cfu /mL).

Regarding the enumeration of coliforms in raw milk, our results were lower than those reported by Matallah et al. (2017) with mean values of 4.7×10^4 cfu/mL and 1.1×10^4 cfu/mL for total and faecal coliforms. The number of samples contaminated by faecal coliforms in raw milk in both species were 24 out of 40 total examined samples. This contamination represents an indication of a poor hygienic handling. A total of 40 samples had a good sanitary quality regarding the presence of *Salmonella* and *Listeria* monocytogenes. However, the presence of coagulase positive *Staphylococcus* in raw milk causes a risk to the animal and human health (Thieulin et al., 1966). Generally, *Staphylococcus* Bacteria are very common in the commensal and pathogenic state with different sources of contamination: the animal skin, the teats and udders. Our results are in agreement with the results obtained by Afif et al. (2008) and those of Bachtarzi et al. (2015) for raw cow milk, with values between 0.8×10^3 ucf/mL and 5×10^3 ucf/mL in the Tadla region of Morocco and an average of 3.7×10^3 ucf/mL in a dairy from Constantine in Algeria, and in contrast to the results cited by (Lahrech et al., 2018) who found no signs of contamination in raw goat milk.

In pasteurized milk, the frequency of samples that had a poor hygienic quality for FMAT was 45% and the cause of this frequency was the large microbial load in the raw material. To obtain good quality hygienic milk, it is necessary to respect the good hygienic condition or to increase the temperature of pasteurization and also it is necessary to pass from the pasteurization to the sterilization. Our results were superior to those found by (Al-Mazeedi et al., 2013) who states that only one sample was above the standard versus 18 samples that we have found. A total of 3 samples of pasteurized milk were contaminated with total coliforms and 2 samples were contaminated with thermotolerant coliforms but there was no detection of feacal coliforms in all samples (Masiello et al., 2016). In addition, there were 2 samples (2/40) that were contaminated with coagulase positive *Staphylococcus*. Our results are different from those reported by Sissao et al. (2015) for raw and pasteurized cow milk in Burkina Faso, who found no contamination, and this may be due to the reluctance to of the farmers to comply with breeding conditions in Algeria.

3.2 Microbiological analysis of cheese

The microbiological characteristics of "*Jben*" cheeses produced using raw and pasteurized milk from cow and goat species are presented in Table 2. Data showed that the pasteurization of milk has a significant effect on Total Mesophilic Aerobic Flora (TMAF), Total Coliforms and Staphylococci counts in "*Jben*" cheese ($p = 0.022$, 0.0001, 0.002 respectively) (Table 2). Also, a significant effect of "species" (cow and goat) on Total Coliforms and Staphylococci counts in "*Jben*" cheese has been recorded ($p = 0.003$, 0.016 respectively) (Table 2). From literature, several studies have investigated the microbiological parameters of fresh cheese in Algeria (Derouiche & Zidoune, 2015; Lahrech et al., 2018; Leksir & Chemmam, 2015) and elsewhere in the world (Balezi & Mushagalusa, 2018; Bedia & Yasin, 2018; Buffa et al., 2001; Hadrya et al., 2012; Rhiat et al., 2011; Sánchez-Gamboa et al., 2018; Vladimír et al., 2020). In comparison with our study, El Marnissi et al. (2013) showed lower results to ours for raw cow cheese "*Jben*" from morocco province with an average FMAT of 7×10^6 ucf/g *vs*. 385.79×10^6 ucf/g, *S. Aureus* 21.2 ucf/g vs 0.1×10^4 ucf/g, but a higher Total Coliforms: 3.5×10^5 ucf/g *vs*. 0.48×10^4 ucf/g. Also, results collected for microbiological analysis of artisanal "*Chihuahua*" cheese reported that other factors may affect Coliform counts in a significant manner, such as sampling seasons. Sánchez-Gamboa et al. (2018) reported higher Coliform counts (7.58 log cfu/mL) from cheese produced during summer compared to other seasons.

Moreover, our results on microbiological parameters of goat cheese made from raw milk compared to another study carried out in Djelfa province (North-center of Algeria), showed higher results for FMAT: 78.89×10^5 ucf/g *vs*. 2.31×10^4 ucf/g, TC: 0.11×10^4 ucf/g vs. < to 10 ucf/g, but 2 samples contaminated with feacal Coliforms and 1 sample with coagulase positive *Staphylococcus* compared to this study that showed absence, but similar results on *Salmonella* (absence) (Lahrech et al., 2018). Furthermore, a study in Morocco performed on pasteurized fresh "*Jben*" showed higher FMAT (10^8 et 10^9 ucf/g), TC (54%), FC (22,5%) and similarly on *Salmonella*, coagulase-positive *Staphylococcus* (absence) (Hamama et al., 1995). In the four *Jben*-type cheeses (cheeses made from cow's milk with or without heat treatment, and its analogue goat's milk cheeses) there was neither *Salmonella* nor *Listeria monocytogenes* detected in all samples, which is in concordance with data from (Bontinis et al., 2008), where the authors argued that the traditional Greek cheese produced from raw goat's milk "*Xinotyri*" is free of *Salmonella* spp. and *L. monocytogenes* indicating a good safety status of the product. However, Cunha-Neto et al. (2020) reported the occurrence of the *Salmonella* Anatum, *S.* Infantis and *S.* Schwarzengrund serotypes (3/225 samples) in two types of Brazilian cheese (Prato and Mozzarella), which represents a risk to public health.

Listeria monocytogenes was detected in four samples of traditional homemade fresh goat cheeses, which is made with calf rennet and without milk cooling after milking in the North region of Morocco (El Galiou et al., 2015). This contamination from *L. monocytogenes* has probably occurred mostly during handling, and uncontrolled conditions during manufacturing, which promote their presence and growth (Rørvik & Yndestad, 1991).

This study has shown that the majority of "*Jben*" traditional cheeses made from raw or pasteurized cow or goat milk were of satisfactory or borderline microbiological quality according to criteria in EC Recommendations (European. Commission, 2004, 2005). The results are in accordance with those obtained in the study conducted by Little et al. (2008) concerning the evaluation of microbiological qualities of cheeses made from raw, thermized or pasteurized milk in the UK. Besides, our study comes to confirm the beneficial effect of "Heat treatment"

on "*Jben*" microbiological quality produced from cow and goat milk, which is in accordance with data published in Greece concerning several traditional cheeses (Batzos, Feta and Sfela) (Litopoulou-Tzanetaki & Tzanetakis, 2011).

4 Conclusion

In this study, we assessed the sanitary quality of milk and the traditional cheese "*Jben*" using raw and pasteurized milk from cows and goats in northeastern Algeria. Results reveal that (1) in milk more than 40% of the samples analyzed have poor hygienic quality in raw milk and even after pasteurization, (2) the main pathogen found is gram-positive *Staphylococcus*, (3) in "*Jben*" cheese samples, despite the poor quality of the raw material used, cheeses analyzed have a satisfactory hygienic quality.

"*Jben*" cheese occupies a very important socio-economic place established in the rural and peri-urban environment. Originally, "*Jben*" was traditionally the product of the processing of cow, goat and sheep milk, but the current trend seems to be towards the use of cow milk.

The Data from this study may contribute to improve the cheese-making process in small scale using milk with or without heat treatment. Further studies are needed to determinate the shelf life of milk and "*Jben*" cheese, as well as the nutritional quality of milk and cheese of both species from this region.

Acknowledgements

This work is part of the research activity carried out within the: i). ARIMNet2-BOVISOL (Coordination of Agricultural Research in the Mediterranean. EC FP7 project N°618127; www.arimnet2.net)-BOVISOL (Breeding and management practices of indigenous bovine breeds: Solutions towards a sustainable future) project funded by the Algerian Ministry of Higher Education and Scientific Research and Scientific Research and from the Directorate General for Scientific Research and Technological Development (DGRSDT). ii). "Dairy production: Optimization of production techniques, valorization and quality control" project funded by the Algerian Ministry of Higher Education and Scientific Research, grant agreement no: D00L01UN240120180001.

We thank the breeders from different provinces and different farms who provided the milk necessary for the realization of this study. We would like to thank all of the respondents for giving the valuable information from the survey study for the artisanal cheese making.

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