Evaluation of the Physicochemical Quality of Raw Bovine and Goat Milk Marketed in the Steppic Region of Djelfa (Algeria)

Mourad HAMIROUNE^{1*}, Sounia DAHMANI¹, Zineb KASMI¹, Abdelhamid FOUGHALIA^{2,3}, Mahmoud DJEMAL⁴

¹ Department of Agro-Veterinary Sciences, Faculty of Nature and Life Sciences, Ziane Achour University, Moudjbara Road, BP 3117, Djelfa, Algeria.

² Laboratory of Microbial Ecology, Faculty of Nature and Life Sciences, Abderrahmane Mira University, Béjaia, 06000, Algeria.

³ Center for Scientific and Technical Research on Arid Regions, University Campus, B.P. 1682, R.P Biskra, 07000, Algeria.

⁴ Laboratory of Hygiene and Quality Control, B.P. H02, Dar El Beida, Algiers, Algeria.

* corresponding author: mouradhamiroune@gmail.com

Bulletin UASVM Veterinary Medicine 76(1)/2019

Print ISSN 1843-5270; Electronic ISSN 1843-5378

doi:10.15835/buasvmcn-vm: 2018.0050

Abstract

This research was conducted to study the key physicochemical parameters of samples of raw bovine and goat milk collected in the steppic region of Djelfa. One hundred and six samples of raw milk were collected from April 2018 to May 2018, at points of sale and analyzed. The results showed that cow's milk had $3.66 \pm 0.89\%$ fat, $11.4 \pm 1.56\%$ solid not fat, $4.35 \pm 0.61\%$ protein, $6.35 \pm 0.89\%$ lactose and a density of 1.0360 ± 0.0056 with a freezing point of -0.380 ± 0.053 °C. While goat's milk had $3.43 \pm 0.65\%$ fat, $10.2 \pm 0.92\%$ solid not fat, $3.88 \pm 0.36\%$ protein, $5.66 \pm 0.52\%$ lactose and a density of 1.0317 ± 0.0035 with a freezing point of -0.348 ± 0.044 °C. This proves that cow's milk has a slightly higher physicochemical quality than goat's milk. In addition, the present study showed that 100% raw goat milk is wet against 97.1% raw bovine milk. This indicates the presence of cases of fraud requiring disciplinary procedures. Moreover, in the majority of the cases, the storage temperatures of the milk far exceed the values recommended by the Algerian standards ($+6^{\circ}\text{C}$). It is necessary to establish a program of control and popularization of all the actors of the sector in order to improve the quality and the quantity of raw milk produced.

Key-words: raw milk, physicochemical parameters, fraud detection

Introduction

Milk is the integral product of the total, uninterrupted milking of a healthy, well-fed, non-overworked dairy cow. It must be collected cleanly and not contain colostrum (Arrêté interministériel, 1993). It is an important source of all the basic nutrients required for mammals, including humans (Gakkhar *et al.*, 2015). Overall in Algeria, the production of raw milk is based on raw

bovine milk and the quantity of raw milk produced is insufficient. Given its availability, bovine milk is the most consumed than that of raw goat milk.

Algerian consumption of milk has been increasing since independence. The lack of local production has forced the country to resort for several years to massive imports of milk powder. Admittedly, many efforts have been made by the various actors in the dairy sector, notably the

dairy policy based on the importation of improved breeds, but the knowledge available on breeding systems and constraints limiting the performance of animals remain largely unknown (Remane Benmalem *et al.*, 2016). For information, of the 4.5 billion liters of milk needed by the Algerian market, domestic production of this staple was only 3.52 billion liters in 2017 according to the latest figures from the Ministry trade, generating a deficit of nearly 1 billion liters. To cover this huge production gap, the government is using imports of milk powder, which weighs on the overall bill of food imports which is rising. Just for imported milk powder, the bill was 1.5 billion dollars in 2017, and may be salty for the current fiscal year (Journal algerie-eco.com, 2018). Given the importance of their role, researchers, inspection services and quality control have become an integral part of milk production to protect consumers and ensure that controlled products are of acceptable quality and can be marketed with profit. The main objective of this study was to first establish a comparison between the parameters of the physicochemical quality of raw milk bovine and goat produced and marketed in the region of Djelfa, then to detect milk and finally, to study the influence of the storage temperature of milk in order to know if there is a risk or not on the health of consumer. This work aims to propose the necessary corrective measures to improve the physicochemical quality of raw milk in production and marketing and to preserve the health of the consumer and to limit the dependence of the country against abroad for imports of milk.

Material and methods

Study zone

The wilaya of Djelfa is located in the central part of Algeria, the chief town of wilaya is 300 kilometers south of the capital. It is between 2 ° and 5 ° east longitude and between 33 ° and 35 ° north latitude. It is bounded on the north by the wilayas of Medea and Tissemsilt, on the east by the wilayas of M'Sila and Biskra, on the west by the wilayas of Laghouat and Tiaret and on the south by the wilayas of Ouargla, El Oued and Ghardaïa (ANDI, 2013).

Sampling

The analyzed samples are raw whole milk mixes between the period of April 2018 and May 2018. A total of 106 samples were collected five

times a week from outlets in the Djelfa region (1st point of sale: Bab Cherf 1, the 2nd point of sale: Bab Cherf 2, the 3rd point of sale: Market and the 4th point of sale: Bendjarma). Samples were taken each time at the same points of sale. Furthermore, sampling was extended from Sunday to Thursday, except for heat days (Friday, Saturday) and holidays.

For each animal species, the milk collected is raw mixed milk from a farm or farms whose animals are of one or different breeds, age, stage of lactation, yield, etc. In addition, the milk is distributed in sales bridges by a distributor. Samples were taken after the arrival of the milk at the point of sale. In parallel, the milk temperature was recorded at the time of sampling. The measurement was performed using a food-grade digital thermometer (WT-1) equipped with a 22.5 cm long stainless steel probe to measure core temperature from -50°C to 300°C.

Each raw milk sample was labelled with the date and place of receipt. The flasks were instantly delivered to a cooler in the dark under the cold regime (ice in the cooler) at the analytical Laboratory of the Faculty of Nature and Life Sciences at Ziane Achour University in Djelfa which is close to the points of sale. Their contents are analyzed as soon as they arrive at the laboratory according to the standard.

Physicochemical analysis

As soon as raw milk samples arrive at the laboratory, the pH is measured using a HANNA pH-meter. The latter, according to the instructions of the apparatus, was first calibrated in calibration solutions at pH 7 and 4 by dipping into a small volume of milk taken from a beaker. The physicochemical quality parameters were determined by the FUNKE GERBER LactoStar analyzer (Hossain and Dev, 2013), a new fully automatic zero point calibration milk analyzer for fast and accurate milk analysis. These parameters are: fat (%), solid not fat (%), protein (%), lactose (%), density and freezing point (°C).

After feeding the analyzer and calibrating the zero point, the sample suction pipe was immersed in a jar with the milk to be analyzed, the measurements start and the result is simultaneously displayed. Between each sampling pass to the device, rinsing is mandatory, in order to have the most accurate results possible. Rinsing was repeated at will. Before stopping the appliance, clean it to remove any milk residue inside it.

The results of the storage temperature were compared to the criteria required by the interministerial decree N ° 85/1999, relative to the temperatures and processes of preservation by refrigeration, freezing or deep-freezing of the foodstuffs. Temperature of conservation of the raw milk of + 6°C (Arrêté interministériel, 1999).

The detection of milk frauds or wetting was carried out by comparing the freezing point values of the milk examined with those of normal milk (from -0.520°C to -0.550°C for raw cow's milk and from -0.550°C to -0.583°C for raw goat milk) (FAO, 1995). Measurement of this parameter will make it easy to detect wetting if appropriate. Any variation greater than -0.520°C (bovine milk) and -0.550°C (goat milk) being a wetting index.

Statistical analysis

Physicochemical parameters and temperature were measured by animal species and weekly sampling. The animal species (cow and goat), mean milk storage temperature, physicochemical indicators and sampling weeks (W1 to W5) were used as a source of variation. A factor analysis of the single factor variance (ANOVA) was used to compare the measurement results of the physicochemical parameters of the raw milk of each animal species according to sampling weeks. The *Student's* test was used to make a comparison between the average values of the physicochemical indicators for the raw milk of the two animal species. It was also used to make a comparison between the freezing point of the raw milk of the two animal species with the threshold of acceptability for normal raw milk and not wet.

The Pearson correlation test (Pearson Correlation Matrix) was used to estimate the significant relationship between the different physicochemical parameters of the raw milk of each animal species. The correlation coefficient (*r*) was calculated from the physicochemical parameters of the raw milk of each animal species to estimate the link between the different physicochemical indicators and the storage temperature of the samples. A link is considered significant at the 5% threshold. Confidence intervals were calculated for the weekly evolution of the physicochemical parameters of each animal species. Calculations were made using the XLSTAT 2009 statistical software and Microsoft Office Excel® 2007 software.

Results and discussions

Comparative study of the physicochemical parameters of raw bovine and goat milk

The results of the physicochemical parameters analysis of raw milk from two animal species are shown in Table 1.

In the light of the results obtained, it appears that raw bovine milk is slightly rich in fat ($3.66 \pm 0.89\%$), solid not fat ($11.4 \pm 1.56\%$), protein ($4.35 \pm 0.61\%$) and lactose ($6.35 \pm 0.89\%$) than that of goats ($3.43 \pm 0.65\%$, $10.2 \pm 0.92\%$, $3.88 \pm 0.36\%$ and $5.66 \pm 0.52\%$, respectively for fat, solid not fat, protein and lactose). In addition, the average density of raw bovine milk (1.0360 ± 0.0056) is higher than that of goat raw milk (1.0317 ± 0.0035). On the other hand, the freezing point of goat raw milk ($-0.348 \pm 0.044^\circ\text{C}$) is higher than that of cattle ($-0.380 \pm 0.053^\circ\text{C}$). While the average pH of raw milk of both animal species are almost identical. Statistical analyzes showed a significant difference between raw bovine and goat milk for solid not fat, proteins, lactose and densities ($p < 0.001$). On the other hand, an insignificant difference was recorded between the milk of the two animal species for pH and fat ($p > 0.05$). In addition, there is a significant difference between the freezing points of raw bovine and goat milk ($p < 0.05$).

Study of the correlations between the physicochemical parameters of raw bovine and goat milk

The correlation matrices for the seven parameters measured during the study period for the two animal species are shown in Table 2 for bovine and goat milk. The correlation makes it possible to give the nature of the relationship between the physicochemical indicators studied for the milk of the two species (if $\alpha = 0.05$, H_0 is rejected: no significant correlation between the variables).

The values in bold indicate the significant correlations (these values are different from 0 to a level of significance $\alpha = 0.05$); pH: Hydrogen potential; SNF: Solid not fat; FP: Freezing point ($^\circ\text{C}$).

For raw bovine milk, significant associations were observed. Some are negative between the freezing point and the five other physicochemical indicators: fat ($r = -0.698$, $p < 0.0001$), solid not fat ($r = -0.871$, $p < 0.0001$) protein ($r = -0.855$, $p < 0.0001$), lactose ($r = -0.886$, $p < 0.0001$) and density ($r = -0.873$, $p < 0.0001$).

Table 1. Distribution of physicochemical quality parameters of raw milk according to animal species

Indicators		Extreme values		Mean $\pm$ SD	P value	SA
		Minimum	Maximum			
pH	BV	5.94	6.90	6.64 $\pm$ 0.18	0.944	NSD
	GT	4.84	6.89	6.63 $\pm$ 0.34		
Fat (%)	BV	2.10	7.93	3.66 $\pm$ 0.89	0.176	NSD
	GT	2.68	6.63	3.43 $\pm$ 0.65		
SNT (%)	BV	7.46	15.85	11.4 $\pm$ 1.56	<0.0001	***
	GT	8.11	12.02	10.2 $\pm$ 0.92		
Protein (%)	BV	2.86	6.03	4.35 $\pm$ 0.61	<0.0001	***
	GT	3.10	4.59	3.88 $\pm$ 0.36		
Lactose (%)	BV	4.17	8.80	6.35 $\pm$ 0.89	<0.0001	***
	GT	4.52	6.70	5.66 $\pm$ 0.52		
Density	BV	1.0222	1.0491	1.0360 $\pm$ 0.0056	<0.0001	***
	GT	1.0239	1.0391	1.0317 $\pm$ 0.0035		
FP (°C)	BV	-0.537	-0.242	-0.380 $\pm$ 0.053	0.002	**
	GT	-0.490	-0.267	-0.348 $\pm$ 0.044		

pH: Hydrogen potential; SA: Statistical analyzes; SNF: Solid not fat; FP: Freezing point (°C); BV : Bovine; GT : Goat; NSD: $p > 0.05$; **: $p < 0.05$; ***: $p < 0.001$.

Table 2. Correlation matrix (Pearson) between the physicochemical parameters of bovine and goat milk

1. Bovine milk							
	pH	Fat	SNF	Protein	Lactose	Density	FP
pH	1						
Fat	0.221	1					
SNF	0.115	0.788	1				
Protein	0.108	0.772	0.968	1			
Lactose	0.152	0.770	0.967	0.960	1		
Density	0.114	0.689	0.953	0.948	0.981	1	
FP	-0.153	-0.698	-0.871	-0.855	-0.886	-0.873	1
2. Goat milk							
	pH	Fat	SNF	Protein	Lactose	Density	FP
pH	1						
Fat	0.063	1					
SNF	-0.231	0.422	1				
Protein	-0.226	0.428	0.987	1			
Lactose	-0.227	0.421	0.988	0.999	1		
Density	-0.255	0.339	0.869	0.879	0.879	1	
FP	0.093	-0.137	-0.580	-0.541	-0.538	-0.526	1

Table 3. Frequency distribution of normal and wet milk according to animal species

Milk	Cattle	Goat	Total n (%)
Normal milk n (%)	2 (2.86 %)	0 (0 %)	2 (1.89 %)
Wet milk n (%)	68 (97.1 %)	36 (100 %)	104 (98.1 %)
Total n	70	36	106

%; Prevalence; n: number.

Table 4. Variation of the physicochemical parameters of raw bovine and goat milk according to sampling weeks

Week		pH	Fat (%)	SNF (%)	Prot. (%)	Lact (%)	Density	FP (°C)
W1	BV	6.64	3.44	11.6	4.44	6.49	1.0370	-0.396
	GT	6.67	3.45	10.6	4.08	5.95	1.0332	-0.352
W2	BV	6.62	3.40	11.1	4.32	6.32	1.0364	-0.383
	GT	6.74	3.18	10.1	3.83	5.62	1.0318	-0.385
W3	BV	6.70	3.94	11.3	4.30	6.28	1.0350	-0.375
	GT	6.42	3.97	10.6	4.00	5.84	1.0325	-0.352
W4	BV	6.63	3.71	11.2	4.26	6.22	1.0351	-0.366
	GT	6.72	3.33	9.71	3.71	5.42	1.0296	-0.321
W5	BV	6.60	3.76	11.8	4.43	6.48	1.0368	-0.385
	GT	6.61	3.32	9.87	3.77	5.50	1.0315	-0.331
Mn	BV	6.64±0.18	3.66±0.89	11.4±1.56	4.35±0.61	6.35±0.89	1.0360 ±0.0056	-0.380 ± 0.053
	GT	6.63 ±0.34	3.43 ±0.65	10.2 ±0.92	3.88 ±0.36	3.88 ±0.36	1.0317 ±0.0035	-0.348 ± 0.044
CI95	BV	[6.60; 6.68]	[-0.74; 8.06]	[3.95; 18.85]	[-0.43; 9.13]	[0.64; 12.06]	[1.0347; 1.0373]	[-0.392 ; -0.368]
	GT	[6.52; 6.74]	[-2.52; 9.38]	[0.31; 20.09]	[-2.43; 10.19]	[-2.43; 10.19]	[1.0306; 1.0328]	[-0.362; -0.334]
P	BV	0.654	0.509	0.736	0.898	0.899	0.788	0.604
	GT	0.484	0.225	0.226	0.233	0.225	0.380	0.046
SA	BV	NSD	NSD	NSD	NSD	NSD	NSD	NSD
	GT	NSD	NSD	NSD	NSD	NSD	NSD	**

pH: Hydrogen potential; SNF: Solid not fat; Prot : Protein ; Lact : Lactose ; FP: Freezing point (°C) ; W : Week; Mn : Mean ; CI 95 : Confidence interval; BV : Bovine; GT : Goat ; SA: Statistical analyzes; NSD: p> 0.05; **: p <0.05.

While the others are positive between fat and solid not fat ($r = 0.788$, $p < 0.0001$), fat and protein ($r = 0.772$, $p < 0.0001$), fat and lactose ($r = 0.770$, $p < 0.0001$), fat and density ($r = 0.689$, $p < 0.0001$), solid not fat and protein ($r = 0.968$, $p < 0.0001$), solid not fat and lactose ($r = 0.967$, $p < 0.0001$), solid not fat and density ($r = 0.953$, $p < 0.0001$), protein and lactose ($r = 0.960$, $p < 0.0001$), protein and density ($r = 0.948$, $p < 0.0001$), lactose and density ($r = 0.981$, $p < 0.0001$).

Whereas for raw goat milk, the parameters for which Pearson's positive correlation coefficients are highest, which means strong positive associations, are: solid not fat and protein ($r = 0.987$, $p < 0.0001$), solid not fat and lactose ($r = 0.988$, $p < 0.0001$), solid not fat and density ($r = 0.869$, $p < 0.0001$), protein and lactose ($r = 0.999$, $p < 0.0001$), protein and density ($r = 0.879$, $p < 0.0001$), lactose and density ($r = 0.981$, $p < 0.0001$). In parallel, there are significant negative correlations between the freezing point and four physicochemical indicators: solid not fat ($r = -0.580$, $p = 0.000$), protein ($r = -0.541$, $p = 0.001$), lactose ($r = -0.538$, $p = 0.001$) and the density ($r = -0.526$, $p = 0.001$).

Fraud detection

Table 3 shows the frequency of milks defrauded according to the animal species. In light of the results obtained, goat milk (100%) is more likely to be wet compared to bovine milk (97.1%).

The comparison between the freezing point of the raw milk of the two animal species with respect to the acceptability threshold, showed the existence of a non-significant difference ($p > 0.05$) for the two types of raw milk studied.

Breakdown of results by sampling weeks

The rates of the physicochemical indicators are varied according to the animal species and according to the weeks. During the first week, the protein, lactose and density levels are the highest (protein = 4.44%, lactose = 6.49% and density = 1.0370 for bovine milk and protein = 4.08%, lactose = 5.95% and density = 1.0332 for goat milk), followed by the third week when the fat content is highest (3.94% for bovine and 3.97% for goat milk). While the highest freezing point was reported during the fourth week (-0.366°C for bovine milk and -0.321°C for goat milk) (Table 4).

Statistical analyzes showed that the physicochemical parameters of the raw milk of the two animal species did not vary significantly from one

week to another ($p > 0.05$), with the exception of the freezing point of raw milk goat, which varied significantly from one sampling week to the next ($p < 0.05$).

Storage temperature of raw milk in the various sales outlets

The mean storage temperature of raw bovine and goat milk in the various outlets varied irregularly over the five weeks, with a minimum of 16.4°C in the third week for raw bovine milk and 17.7°C at the first week for goat raw milk, compared to a maximum of 22.0°C in the second week for raw bovine milk and 21.96°C in the first week for goat raw milk. Mean storage temperatures were $18.7 \pm 7.87^{\circ}\text{C}$ for raw bovine milk and $19.7 \pm 5.27^{\circ}\text{C}$ for raw goat milk.

For both animal species, the temperature of the majority of samples of raw milk has significantly exceeded the temperature recommended by Algerian standards ($+ 6^{\circ}\text{C}$).

Relationship between physicochemical indicators and storage temperature of raw milk

Table 5 reports the relationship between the seven physicochemical indicators and the storage temperature of raw milk from two animal species.

Statistical analyzes showed that the storage temperature has slightly weak correlations with the seven physicochemical parameters of goat raw milk. Of these, five are negative (fat and storage temperature: $r = -0.3527$ and $R^2 = 0.1244$; solid not fat and storage temperature: $r = -0.3228$ and $R^2 = 0.1042$, protein and storage temperature: $r = -0.3264$ and $R^2 = 0.1065$, lactose and storage temperature: $r = -0.3283$ and $R^2 = 0.1078$, density and storage temperature: $r = -0.3074$ and $R^2 = 0.0945$) and two are positive, one for pH ($r = 0.2279$ and $R^2 = 0.0519$) and the other low for the freezing point ($r = 0.1975$ and $R^2 = 0.0390$).

On the other hand, for raw bovine milk, the majority of the correlations are largely weak and negative except for the fat which appears slightly negatively correlated with the storage temperature of the raw milk ($r = -0.2635$ and $R^2 = 0.0694$).

Currently, milk occupies an important place in the national and international market since it is a basic nutrient in food and feed.

Milk processing processes in dairy industries lead to new products to improve the efficiency of conventional products and to create new products to expand the dairy market (Hariri *et al.*, 2017).

Table 5. Correlation between physicochemical parameters of raw milk and storage temperature

Relationship between parameters		r	R ²
pH-ST	Bovine	0.0216	0.0005
	Goat	0.2279	0.0519
Fat-ST	Bovine	-0.2635	0.0694
	Goat	-0.3527	0.1244
SNF-TS	Bovine	-0.0268	0.0007
	Goat	-0.3228	0.1042
Protein-ST	Bovine	-0.0238	0.0006
	Goat	-0.3264	0.1065
Lactose-ST	Bovine	-0.0216	0.0005
	Goat	-0.3283	0.1078
Density-ST	Bovine	-0.0098	9.6361 10 ⁻⁵
	Goat	-0.3074	0.0945
FP-ST	Bovine	-0.0538	0.0029
	Goat	0.1975	0.0390

pH: Hydrogen potential; SNF: Solid not fat; FP: Freezing point (°C) ; ST : Storage temperature ; r: Coefficient of correlation; R²: Coefficient of determination.

The study of the results obtained made it possible to point out the importance of wet raw milk and the non respect of the storage temperature of the raw milk of the two species in the different sales outlets. Generally, this temperature greatly exceeds the value recommended by the standard, which constitutes a major risk to the health of consumers.

Overall, with the exception of pH, raw bovine milk is slightly rich in fat ($3.66 \pm 0.89\%$), solid not fat ($11.4 \pm 1.56\%$), protein ($4.35 \pm 0.61\%$) and lactose ($6.35 \pm 0.89\%$) than that of goat raw milk ($3.43 \pm 0.65\%$, $10.2 \pm 0.92\%$, $3.88 \pm 0.36\%$ and $5.66 \pm 0.52\%$ respectively for fat, solid not fat, protein and lactose). In addition, the average density of raw bovine milk is higher than that of goats. These results can be explained by several factors, however, including, in particular, the feeding of dairy cows that are fed by specific foods that promote the increase in the quality and quantity of raw milk production (such as corn, straw, hay, silage, bran, soy, etc.). In contrast, in the majority of cases, goats are raised extensively and feed on natural vegetation by preferring all that and suspended and removed from the

ground, and do not receive additional feeds for improved production milk. In addition, in Algeria, the activities of breeders are based on cattle farms for the production of raw milk in order to meet the needs of local consumers according to the regions. This explains the increase in production of raw bovine milk compared to raw goat milk in the national market. This favors the increase in the price of goat milk compared to bovine milk.

The exploitation of the obtained results made it possible to note that the average values of pH of the raw milk of the two animal species are almost identical (pH = 6.64 ± 0.18 for the raw milk bovine and 6.63 ± 0.34 for goat raw milk). These results are superior to those found by Legesse *et al.* (2017) on samples of raw bovine and goat milk in the regional state of Somalia, Ethiopia with average values of 6.30 ± 0.15 and 6.38 ± 0.08 , respectively. But, they remain comparable to those of Asif and Sumaira (2010) in Pakistan, Debouz *et al.* (2014) in Ghardaia (Algeria) and Kaouche-Adjlane and Mati (2017) in the mid-northern region of Algeria, who reported that the average pH values of raw bovine milk are 6.64 ± 0.02 , 6.62 ± 0.13 and 6.69 ± 0.1 , respectively. On the other hand, they remain

slightly higher than those of Salhi and Medjoudj (2013) on raw milk collected at the Amizour dairy in Bejaia (Algeria) which found an average value of 6.56 ± 0.54 .

According to Labioui *et al.* (2009), pH variability is related to climate, lactation stage, food availability, water intake, cow health, and milking conditions. In addition, fresh cow's milk has a pH between 6.5 and 6.7. Values greater than 6.7 indicate mastitis milk and values below 6.5 indicate the presence of colostrum or bacteria (considerable acidic development is normally due to bacterial activity (O'Connor, 1995). Therefore, the average pH values of milk collected at retail outlets in Djelfa could probably be explained by the fact that milk remains fresh and by the absence of acid production resulting from the growth and multiplication of bacteria.

Lipids depend on the breed, the rank of milking, which affects the fat content. They are classified as constituents of milk the most variable qualitatively and quantitatively (Debouz *et al.*, 2014). In our samples, the solid not fat and fat content obtained from raw bovine milk is equal to $11.4 \pm 1.56\%$ and $3.66 \pm 0.89\%$, respectively. These values appear slightly higher relative to that of raw goat milk which is respectively of the order of $10.2 \pm 0.92\%$ and $3.43 \pm 0.65\%$. Close fat results were obtained on samples of raw bovine milk ($3.86 \pm 0.60\%$) at Shkodra (Preka and Bekteshi, 2016) and raw goat milk in Pakistan (Asif and Sumaira, 2010). The values obtained in fat remain however higher than those reported by Legesse *et al.* (2017) on samples of raw milk in Ethiopia with averages of $5.54 \pm 0.65\%$ and $6.79 \pm 0.38\%$, respectively cattle and goats, showing that in our region, efforts are imperatively to be made to improve the lipid composition of the raw milk of the two animal species. In addition, they always remain superior to those of Millogo *et al.* (2018) in Burkina Faso found a level of $1.3 \pm 0.8\%$ fat in the raw bovine milk of the sellers.

Reduced protein levels in raw milk may be due to differences in race, udder health, and lactation (Asif and Sumaira 2010). In addition, this decrease is related to the season and the number of lay-outs (Debouz *et al.*, 2014). The analysis of our samples shows that raw bovine milk ($4.35 \pm 0.61\%$) contains higher protein content than goats ($3.88 \pm 0.36\%$). These results are superior to those of Preka and Bekteshi (2016) in Shkodra and Lai *et*

al. (2016) in Malaysia that reported protein levels of $3.22 \pm 0.14\%$ in raw bovine milk and $2.31 \pm 0.13\%$, respectively, in goat raw milk. On the other hand, they remain inferior to those of Legesse *et al.* (2017) who found a rate of $4.62 \pm 0.56\%$ in goat raw milk.

Lactose is the main sugar present in milk, a lactic acid fermentation substrate for lactic acid bacteria (Labioui *et al.*, 2009). In addition, the consumption of fermented milk products has increased in recent years, mainly because of its excellent nutritional and therapeutic properties (Hariri *et al.*, 2018). Our study showed that the average concentration of raw lactose bovine milk is $6.35 \pm 0.89\%$. It exceeds that of goat raw milk ($5.66 \pm 0.52\%$). These rates are higher than those described by Preka and Bekteshi (2016) in Shkodra and Asif and Sumaira (2010) in Pakistan, which have mean values of $4.08 \pm 0.22\%$ for raw bovine milk and $4.39 \pm 0.34\%$ for goat raw milk respectively. In addition, they remain significantly higher than those of Millogo *et al.* (2018) in Burkina Faso who reported a level of $2.2 \pm 1.0\%$ of lactose in raw bovine milk from vendors.

Density is one of the physicochemical parameters of raw milk. It helps to diagnose the quality of the milk. It is varied according to the milk content in dry matter, fat, temperature and diet of the animal (Debouz *et al.*, 2014). Our results (1.0360 ± 0.0056 for raw bovine milk and 1.0317 ± 0.0035 for goat raw milk) are in agreement with those of Labioui *et al.* (2009) in the Mnasra region of Morocco and Salhi and Medjoudj (2013) on raw bovine milk collected at the Amizour dairy in Bejaia (Algeria), reporting an average value of 1.030 ± 0.001 and 1.033 ± 0.004 . On the other hand, they are slightly higher than those announced by Debouz *et al.* (2014) in the region of Ghardaia in Algeria (1.028 ± 0.00).

With regard to the freezing point considered as an index of detection of defrauded milk and varies according to their water content, our results show average values of $-0.380 \pm 0.053^\circ\text{C}$ and $-0.348 \pm 0.044^\circ\text{C}$ respectively for raw milk bovine and goat. These are, on the one hand, far superior to the results of Preka and Bekteshi (2016) in Shkodra ($-0.52 \pm 0.02^\circ\text{C}$) and Debouz *et al.*, (2014) in Ghardaia in Algeria (-0.558) for raw bovine milk, and on the other hand, to those of Gakkhar *et al.* (2015) in India with an average value of -0.542 for goat raw milk. According to

Codou (1997) cited by Debouz *et al.*, (2014), the freezing point decreases by the acidification of milk or the addition of mineral salts. In addition, Parcuel *et al.* (1994), noted that the lowest values of freezing points are obtained during periods of high production and the highest values during periods of low production.

Defrauded milk is generally characterized by a high rate of water. It is wet milk where water has been added to increase its volume. To discover this fraudulent operation, we based ourselves on the calculation of the freezing point. Our results showed that almost all (98.1%, 104/106) of the raw milk analyzed was wet (97.1% raw bovine milk and 100% raw goat milk). According to Parcuel *et al.* (1994), wetting is related to the lack of use of milking or refrigeration equipment.

Generally, the physicochemical indicators of the raw milk of the two animal species are unstable and are not improved from one week to the next. These results can be explained, on the one hand, by the lack of a regular monitoring program of the diet by the farmers and the necessary measures to improve the quality and the quantity of the raw milk produced and, on the other hand, by the addition of water by the sellers as well as instability in the method of work. The storage temperature of food plays a major role in bacterial growth. Our study shows that most vendors store milk in storage tanks at different temperatures and the majority of samples from both animal species have significantly exceeded the temperature recommended by Algerian standards (+ 6°C). These results reflect the non-respect of the cold chain at the different points of sale. In addition, the majority of samples were well above the temperature of 10°C. This temperature is considered a threshold from which *S. aureus* bacteria can begin to produce the enterotoxin responsible for the disease (Hennekinne, 2009).

In addition, the mode of consumption of milk varies according to the inhabitants. There are people who consume raw milk directly without any heat treatment or fermentation. On the other hand, there are people who consume milk after heat treatment or form fermented as ben, which reduce or eliminate the dangers on the health of consumer.

In order to know if there is a relationship between the milk storage temperature and the physicochemical indicators of the raw milk of

the two animal species, correlations have been calculated. Our results showed that, the correlation between the storage temperature with the seven physicochemical parameters of raw goat milk was slightly low, two correlations were positive for pH ($r = 0.2279$) and freezing point ($r = 0.1975$), and negative for five others: fat ($r = -0.3527$), solid not fat ($r = -0.3228$), protein ($r = -0.3264$), lactose ($r = -0.3283$) and the density ($r = -0.3074$). Conversely, for raw bovine milk, the fat content appears slightly negatively correlated with the storage temperature ($r = -0.2635$), the majority of the correlations are largely weak and negative.

It should be noted that any increase in temperature degrades certain physicochemical parameters. According to Sboui *et al.* (2009) cited by Sboui *et al.*, (2016), the fragility of the physicochemical equilibrium of raw milk (fat emulsion, colloidal suspension of proteins) can easily lead to destabilization by the physical route, in particular under the action of mechanical and thermal shocks.

In addition, the milk's ability to coagulate depends on its initial pH, then its content of colloidal calcium and caseins, which play a key role in gel placement (Hurtaud, 2001). In addition, temperature plays an important role in the fermentation of raw milk. The latter results from the conversion of lactose into lactic acid. This leads to acidification of the milk and coagulation of the milk thereafter.

Conclusion

This study led us to confirm that all the parameters tested were higher in cow's milk than in goat's milk except for the pH which was similar in the milk of the two animal species. In addition, this work confirms the importance of wetting milk in retail outlets. This necessitates a systematic control of raw milk throughout the dairy chain in order to limit all cases of fraud and to cut disciplinary instructions.

In parallel, the results obtained make it possible to discover the poor storage conditions of raw milk by evaluating the storage temperature at the point of sale. This factor is essential in group food poisoning in case of consumption of raw milk without any heat treatment, especially, with changes in the Algerian food practice and development of the fast food sector.

The respect of the food conditions of the two animal species, the cold chain and the hygienic conditions during the production of the raw milk, can make it possible to improve the quality and the quantity of the raw milk. Control should not be limited to the finished product, but it is essential to control the entire production process throughout the food chain according to the concept of "barn to table".

In addition, it will be very useful to carry out a program of improvement of the food ration in all the farms of the country; this will help to improve the production of raw milk but would also improve Algeria's independence against abroad in terms of milk imports, ultimately providing benefits for the country's economy as a whole.

Acknowledgments. The authors thank all the staff of the laboratory of the Faculty of Nature and Life Sciences of the University of Djelfa and all sellers at the point of sale.

Conflicts of interest: The authors declared no conflict of interest.

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