# STUDY OF THE PHYSICOCHEMICAL QUALITY OF RAW MILK FROM SHEEP FARMS IN A PASTORAL REGION OF ALGERIA AND ITS IMPACT ON PUBLIC HEALTH

**HAMIROUNE[1)*] Mourad, Mohamed KOUSKOUS[1)], Abderrazek Nezzar KEBAILI[1)], Abdelhamid FOUGHALIA[2,3)]**

*[1)]Department of Agro-Veterinary Sciences, Faculty of Natural and Life Sciences, Ziane Achour University, Route Moudjbara, B.P. 3117, Djelfa, Algeria*

*[2)]Department of Biology Sciences, Faculty of Natural and Life Sciences, Biskra University, 07000, Algeria*

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

* Corresponding author: mouradhamiroune@gmail.com

**Abstract.** Raw milk is a source of nutrients necessary for human survival and health. The present study is based on the appreciation of the physicochemical quality of raw sheep milk as the most dominant livestock in the pastoral region of Djelfa in Algeria. One hundred and one (101) raw milk samples were taken from sheep farms and analyzed. The results showed that the average values of the physicochemical indicators of the raw milk of sheep's udder had 3.70 ± 1.54% of fat (FT), 9.06 ± 5.24% of non-fat dry matter (NFDM), 3.45 ± 2.01% of proteins (PR), 5.04 ± 2.93% lactose (LC) and a density (DS) of 1.0253 ± 0.0207 with a freezing point (FP) of -0.307 ± 0.168 ° C and a pH of 6.63 ± 0.18 ° C. In addition, the temperature (TS) measurement results of raw milk at the time of analyzes identified an average value of 9.70 ± 2.19 ° C. At the same time, in the majority of cases, the TS values greatly exceed the values recommended by Algerian standards (+ 6 ° C). This indicates the presence of risk on the health of the consumer. In addition, TS is weakly correlated with the seven physicochemical indicators of raw milk. Finally, the improvement in the quality and quantity of raw sheep's milk remains based on the establishment of an adequate feeding, control and popularization program for all members of the sector.

**Keywords:** Algeria, Sheep, physicochemical indicators, pastoral region, raw udder milk

## INTRODUCTION

Raw milk is a nutrient rich food of animal origin for mammals which include humans. It is the integral product of the total and uninterrupted milking of a healthy, well-nourished and not overworked dairy female. It should be collected cleanly and not contain colostrum. It must be stored immediately after milking at a temperature less than or equal to six (06) degrees Celsius (Arrêté interministériel, 1993).

The wilaya of Djelfa is characterized by an agro-pastoral activity where sheep breeding occupies a preponderant place (ANDI, 2013). In addition, in the Algerian steppe environment, sheep's milk is generally intended for breastfeeding lambs first, then it is consumed by breeders in the region either in nature, or often transformed into smen (traditional butter) or milk. fermented (l'ben) or even in djeben (fresh cheese) to a lesser degree. Therefore, the maintenance of this breeding and its extension are dependent on food. The latter is ensured from the routes first, from the contribution of

cereal growing afterwards and from the concentrated feed finally. Transhumance is another source for those who practice it (Yabrir *et al.,* 2011).

Algerian consumption of milk has increased since independence. The lack of local production has forced the country to resort for several years to massive imports of powdered milk. Certainly, many efforts have been made by the various actors in the dairy sector, in particular the dairy policy based on the importation of improved breeds, but the knowledge available on breeding systems and the constraints limiting breed performance (Remane Benmalem *et al.,* 2016).

The objective of our study is to determine the physicochemical quality of raw sheep milk on certain farms in the pastoral region of Djelfa by assessing different physicochemical indicators. Next, we will study the influence of certain intrinsic (animal-related factors) and extrinsic (temperature) factors on the rate of change of physicochemical parameters. Finally, we will try to estimate the risk of consuming raw milk on consumer health. In addition, this work aims to propose the corrective measures necessary to improve the physicochemical quality of raw milk in production and preserve the health of the consumer in order to limit the country's dependence on foreign countries for milk imports.

## MATERIAL AND METHODS

### Study area

The wilaya of Djelfa is located in the central part of northern Algeria beyond the southern foothills of the Tellien Atlas from the North, whose capital of Wilaya is 300 kilometers south of the capital, it is between 2 ° and 5 ° East longitude and between 33 ° and 35 ° North latitude Erected at the Wilaya range thanks to the administrative division of 1974, this part of the territory with a total area of 32,194.01 km² representing 1,36% of the total area of the country. The wilaya of Djelfa is bounded to the north by the wilayas of Médéa and Tissemsilt, to the east by the wilayas of M'Sila and Biskra, to the west by the wilayas of Laghouat and Tiaret and to the south by the wilayas of Ouargla, El Oued and Ghardaïa.

Due to the conditions of its natural environment and the extent of its territory, the wilaya of Djelfa is a steppe wilaya where extensive sheep farming predominates. Its main vocation is pastoral with 95.74% of rangelands (including the alfa) in relation to the total agricultural area (Figure 1) (Annuaire économique des wilayas, 2015).

### Sampling and transport of samples

The samples analyzed are raw milk from sheep udders. A total of n = 101 samples were taken from some farms in the Djelfa region.

Sampling requires the use of sterile 60 ml bottles identified by significant codes, after washing and drying the udder with a clean towel, the first jets of milk are eliminated then the harvest directly in the bottle which is codified and then stored in the cooler for transported to the laboratory at the analysis laboratory of the Faculty of Nature and Life Sciences of Ziane Achour University of Djelfa under the cold regime. For this reason two vehicles are invested to achieve this stop. Their content is analyzed upon arrival at the laboratory.

At the same time, the data relating to the animals sampled were recorded at the time of sampling.

In addition, the sample, to ensure its transport to the analysis laboratory on the day of collection, should be preferably in the morning to have the advantage of starting the analysis of the samples as soon as possible.


**Fig. 1. Geographical location of the Djelfa region (Sba, 2017)**

**Physicochemical analysis**

Upon arrival of the raw milk samples at the laboratory, temperature (TS) and pH were measured using a HANNA-type pH meter and a thermometer. The latter, according to the instructions of the apparatus, was first calibrated in calibration solutions at pH 7 and 4 by soaking in a volume of milk taken.

The physicochemical quality parameters were determined by the LactoStar analyzer type FUNKE GERBER (Hossain and Dev, 2013). These parameters are: fat (FT), non-fat dry matter (NFDM), protein (PR), lactose (LC), density (DS) and freezing point (FP).

After powering the analyzer and zero point calibration, the sample suction tube has been immersed in a jar with the milk to be analyzed, the measurements start and the result is simultaneously displayed.

Between each passage of sampling through the device, rinsing is mandatory, in order to obtain the most accurate results as possible. The rinsing was repeated at will. Before switching off the appliance, it should be cleaned to remove any milk residue inside it.

The results of the storage temperature were compared with the criteria required by Interministerial Order No. 87/1999, relating to temperatures and methods of storage by refrigeration, freezing or deep freezing of foodstuffs. The storage temperature of raw milk of + 6 ° C (Arrête interministériel, 1999).

**Statistical analysis**

Physicochemical parameters and temperature were measured by age, breed, breeding method and number of gestations.

Average milk temperature, physicochemical indicators, age, breed, breeding method and number of pregnancies were used as a source of variation.

Student's test was used to compare the values of the physicochemical indicators for raw sheep milk. It was also used to make a comparison between the physicochemical parameters of raw sheep milk according to the mode of animal husbandry.

Factor analysis of variance (ANOVA) was used to compare the results of measuring physicochemical parameters of raw sheep milk according to the age of the animals. It is also used to compare the results of measurement of the physicochemical indicators of raw sheep milk according to the breed and finally it is used to compare the results of measurement of the physicochemical parameters of raw sheep milk according to the number of gestations.

The Pearson correlation test (Pearson correlation matrix) was used to estimate the significant link between the different physicochemical parameters of raw sheep milk.

The correlation coefficient (r) was calculated from the physicochemical parameters of raw sheep milk to estimate the link between the various physicochemical indicators and the temperature of the samples.

Confidence intervals were calculated for the weekly change in the values of the physicochemical parameters.

The calculations were carried out using the statistical software XLSTAT 2009 and the software Microsoft Office Excel® 2007.

## RESULTS AND DISCUSSION

**Table 1**

**Distribution of the physicochemical quality parameters of raw sheep milk**

| Parameters | Extreme value | | Average | CI (95%) | p-values | SA |
|---|---|---|---|---|---|---|
| | Minimum | Maximum | | | | |
| FT (%) | 0.58 | 9.38 | 3.70±1.54 | [0.02 ; 7.38] | < 0.0001 | *** |
| NFDM (%) | 0.3 | 26.41 | 9.06±5.24 | [3.46 ; 14.66] | < 0.0001 | *** |
| PR (%) | 0.11 | 10.09 | 3.45±2.01 | [0.11; 7.01] | < 0.0001 | *** |
| LC (%) | 0.15 | 14.73 | 5.04±2.93 | [0.77 ; 9.31] | < 0.0001 | *** |
| DS | 0.9688 | 1.0906 | 1.0253±0.0207 | [1.0213 ; 1.0293] | < 0.0001 | *** |
| FP (°C) | -0.866 | -0.003 | -0.307±0.168 | [-0.340 ; -0.274] | < 0.0001 | *** |
| pH | 6.32 | 7.37 | 6.63±0.18 | [6.59 ; 6.67] | < 0.0001 | *** |
| TS (°C) | 4.1 | 14.7 | 9.70 ± 2.19 | [9.27 ; 10.13] | < 0.0001 | *** |

pH: potential Hydrogen; FT: Fat; NFDM: Non-fat dry matter; PR: Protein; LC: Lactose; DS: Density; FP: Freezing point; TS: Temperature; SA: Statistical analysis; ***: p <0.001.

**Overall results of the physicochemical parameters of raw sheep milk**

Table 1 shows the results of the analysis of the physicochemical parameters of raw sheep's milk.

In the light of the results obtained, it appears that the raw sheep milk is composed of 3.70 ± 1.54% of fat, 9.06 ± 5.24% of NFDM, 3.45 ± 2.01% of PR and 5.04 ± 2.93% of LC. While the mean values of pH, DS, FP and TS are respectively, 6.63 ± 0.18, 1.0253 ± 0.0207, -0.307 ± 0.168 ° C and 9.70 ± 2.19 ° C.

Statistical analyzes showed the existence of a clearly significant difference between the values of each physicochemical indicator of raw sheep milk ($p < 0.001$).

**Relationship between physicochemical indicators and the temperature of raw sheep milk**

The average temperature (TS) of raw sheep milk recorded during the physicochemical analyzes is 9.70 ± 2.19 ° C. It is between a minimum of 4.1 ° C and a maximum of 14.7 ° C.

**Table 2**

**Relationship between the physicochemical parameters of raw sheep milk and temperature**

| Relation entre les paramètres | r | $R^2$ |
|---|---|---|
| pH-TS | -0.0311 | 0.001 |
| FT-TS | -0.1285 | 0.0165 |
| NFDM-TS | -0.1576 | 0.0248 |
| PR-TS | -0.1592 | 0.0254 |
| LC-TS | -0.1574 | 0.0248 |
| DS-TS | -0.1973 | 0.0389 |
| FP-TS | 0.1555 | 0.0242 |

pH: potential Hydrogen; FT: Fat; NFDM: Non-fat dry matter; PR: Protein; LC: Lactose; DS: Density; FP: Freezing point; TS: Temperature; r: correlation coefficient; $R^2$: Coefficient of determination.

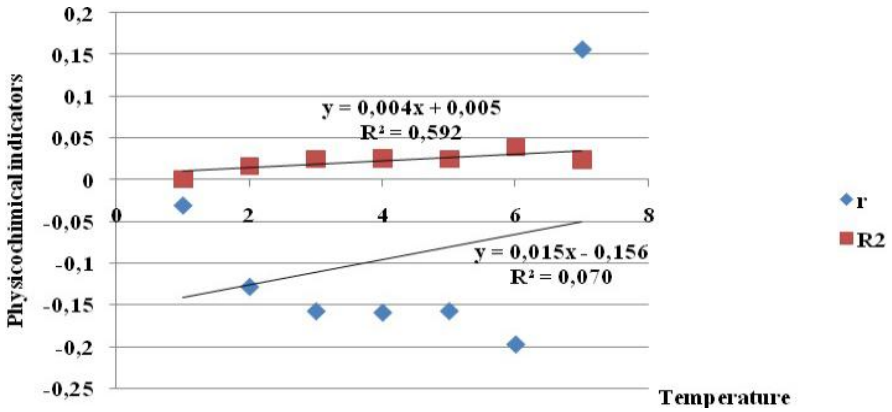


**Fig. 2. Correlation between the physicochemical parameters of raw sheep milk and temperature**

In addition, the temperature of the majority of the raw milk samples greatly exceeded the temperature recommended by Algerian standards (+ 6 ° C).

The study of the relationship between the physicochemical indicators and the temperature of raw sheep milk showed the existence of weak negative correlations between pH-TS (r = -0.0311; $R^2$ = 0.0010); FT -TS (r = -0.1285; $R^2$ = 0.0165); NFDM-TS (r = -0.1576; $R^2$ = 0.0248); PR-TS (r = -0.1592; $R^2$ = 0.0254); LC-TS (r = -0.1574; $R^2$ = 0.0248) and DS-TS (r = -0.1973; $R^2$ = 0.0389). On the other hand, a weak positive correlation was found between FP-TS (r = 0.1555; $R^2$ = 0.0242) (Table 2 and Figure 2).

**Table 3**

**p-value and correlation matrix (Pearson) between the physicochemical parameters of sheep milk**

| 1.1. Correlation matrix (Pearson) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | FT | NFDM | PR | LC | DS | FP | pH | TS |
| FT | **1** | | | | | | | |
| NFDM | **0.799** | **1** | | | | | | |
| PR | **0.795** | **1** | **1** | | | | | |
| LC | **0.794** | **1** | **1** | **1** | | | | |
| DS | **0.79** | **0.931** | **0.93** | **0.93** | **1** | | | |
| FP | **-0.821** | **-0.995** | **-0.994** | **-0.994** | **-0.938** | **1** | | |
| pH | **0.275** | **0.289** | **0.289** | **0.287** | **0.283** | **-0.304** | **1** | |
| TS | -0.129 | -0.158 | -0.159 | -0.157 | **-0.197** | 0.156 | -0.031 | **1** |
| Values in bold are different from 0 at significance level alpha = 0.05 | | | | | | | | |
| 1.2. p-values | | | | | | | | |
| | FT | NFDM | PR | LC | DS | FP | pH | TS |
| FT | **0** | | | | | | | |
| NFDM | **< 0.0001** | **0** | | | | | | |
| PR | **< 0.0001** | **< 0.0001** | **0** | | | | | |
| LC | **< 0.0001** | **< 0.0001** | **< 0.0001** | **0** | | | | |
| DS | **< 0.0001** | **< 0.0001** | **< 0.0001** | **< 0.0001** | **0** | | | |
| FP | **< 0.0001** | **< 0.0001** | **< 0.0001** | **< 0.0001** | **< 0.0001** | **0** | | |
| pH | **0.005** | **0.003** | **0.003** | **0.004** | **0.004** | **0.002** | **0** | |
| TS | 0.2 | 0.115 | 0.112 | 0.116 | **0.048** | 0.12 | 0.757 | **0** |
| Values in bold are different from 0 at significance level alpha = 0.05 | | | | | | | | |

Values in bold indicate significant correlations (these values are different from 0 at a significance level α = 0.05); pH: potential Hydrogen; FT: Fat; NFDM: Non-fat dry matter; PR: Protein; LC: Lactose; DS: Density; FP: Freezing point; TS: Temperature.

**Study of the correlations (correlation matrix (Pearson) between the physicochemical parameters of raw sheep milk**

The correlation matrices of the seven parameters measured during the study period for raw sheep milk are shown in Table 3. The correlation allows to give the nature of the relationship between the physicochemical indicators studied for raw sheep milk.

For the raw sheep milk analyzed, the results showed that the parameters for which the positive Pearson correlation coefficients are the highest, which means strong positive associations are: FT and NFDM (r = 0.799; p <0.0001), FT and PR (r = 0.795; p <0.0001), FT and LC (r = 0.794; p <0.0001), FT and DS (r = 0.790; p <0.0001), NFDM and PR (r = 1.000; p <0.0001) , NFDM and LC (r = 1.000; p <0.0001), NFDM and DS (r = 0.931; p <0.0001), PR and LC (r = 1.000; p <0.0001), PR and DS (r = 0.930; p < 0.0001), LC and DS (r = 0.930; p <0.0001).

On the other hand, the parameters for which the Pearson correlation coefficients are negative and significant are: FT and FP (r = -0.821; p <0.0001), NFDM and FP (r = -0.995; p <0.0001), PR and FP (r = -0.994; p <0.0001), LC and FP (r = -0.994; p <0.0001) and DS and FP (r = -0.938; p <0.0001).

**Breakdown of results according to breeding method**

The distribution of the average values of the physicochemical indicators according to the farming method is shown in Table 4 below.

Overall, the physicochemical indicators of raw milk from ewes reared in the semi-intensive system are high compared to those from ewes reared in the extensive system. Therefore, for farms reared in a semi-intensive system, the average values of the physicochemical indicators are: 3.86 ± 1.49%, 9.57 ± 5.15%, 3.64 ± 1.97%, 5.32 ± 2.89%, 1.0280 ± 0.0188, -0.327 ± 0.163 ° C, 6.65 ± 0.18 and 9.83 ± 2.30 ° C, respectively for FT, NFDM, PR, LC, DS, FP, pH and TS. While for farms reared in an extensive system, the average values of these indicators are respectively 1.61 ± 3.50%, 8.44 ± 5.34%, 3.21 ± 2.05%, 4.70 ± 2.98%, 1.0219 ± 0.0227, -0.282 ± 0.171 ° C, 6.61 ± 0.19, 9.54 ± 2.06 ° C.

Statistical analyzes showed that each physicochemical parameter of raw sheep milk did not vary significantly from one breeding method to another (p> 0.05).

**Table 4**

**Effect of the breeding method on the physicochemical parameters of sheep milk**

| Parameters | Extensive | Semi-intensive | p-values | SA |
|---|---|---|---|---|
| FT (%) | 1.61 ± 3.50 | 3.86 ± 1.49 | 0.252 | NSD |
| NFDM (%) | 8.44 ± 5.34 | 9.57 ± 5.15 | 0.284 | NSD |
| PR (%) | 3.21 ± 2.05 | 3.64 ± 1.97 | 0.294 | NSD |
| LC (%) | 4.70 ± 2.98 | 5.32 ± 2.89 | 0.296 | NSD |
| DS | 1.0219 ± 0.0227 | 1.0280 ± 0.0188 | 0.146 | NSD |
| FP (°C) | -0.282 ± 0.171 | -0.327 ± 0.163 | 0.179 | NSD |
| pH | 6.61 ± 0.19 | 6.65 ± 0.18 | 0.299 | NSD |
| TS (°C) | 9.54 ± 2.06 | 9.83 ± 2.30 | 0.517 | NSD |

pH: potential Hydrogen; FT: Fat; NFDM: Non-fat dry matter; PR: Protein; LC: Lactose; DS: Density; FP: Freezing point; TS: Temperature; SA: Statistical analysis; NSD: p> 0.05.

**Breakdown of results by age of ewes**

The results of the distribution of the average values of the physicochemical indicators according to age are mentioned in Table 5 below.

With the exception of the DS and the FP, the other indicators deprived with age. The average values of these indicators decrease by 3.72 ± 1.81%, 9.15 ± 5.93%, 3.48 ± 2.27%, 5.09 ± 3.32% and 6.64 ± 0.19 recorded during the age interval of [1 to 4

[years to 3.54 ± 1.52 %, 8.71 ± 4.73%, 3.32 ± 1.81%, 4.84 ± 2.65% and 6.62 ± 0.14 recorded during the age interval of [8 to 12 [years, respectively for FT, NFDM, PR, LC and pH.

Statistical analyzes showed that the physicochemical parameters of raw sheep milk did not vary significantly from one age group to another (p> 0.05).

**Table 5**

**Effect of age on the physicochemical parameters of sheep milk**

| Parameters | [1 to 4[ ans | [4 to 8[ ans | [8 to 12[ ans | p-values | SA |
|---|---|---|---|---|---|
| FT (%) | 3.72 ± 1.81 | 3.71 ± 1.20 | 3.54 ± 1.52 | 0.406 | NSD |
| NFDM (%) | 9.15 ± 5.93 | 9.03 ± 4.53 | 8.71 ± 4.73 | 0.747 | NSD |
| PR (%) | 3.48 ± 2.27 | 3.44 ± 1.74 | 3.32 ± 1.81 | 0.735 | NSD |
| LC (%) | 5.09 ± 3.32 | 5.02 ± 2.54 | 4.84 ± 2.65 | 0.739 | NSD |
| DS | 1.0246 ± 0.0240 | 1.0267 ± 0.0168 | 1.0224 ± 0.0200 | 0.795 | NSD |
| FP (°C) | -0.309 ± 0.191 | -0.307 ± 0.143 | -0.300 ± 0.149 | 0.918 | NSD |
| pH | 6.64 ± 0.19 | 6.62 ± 0.19 | 6.62 ± 0.14 | 0.634 | NSD |
| TS (°C) | 9.88 ± 1.97 | 9.22 ± 2.29 | 10.97 ± 2.45 | 0.455 | NSD |

pH: potential Hydrogen; FT: Fat; NFDM: Non-fat dry matter; PR: Protein; LC: Lactose; DS: Density; FP: Freezing point; TS: Temperature; SA: Statistical analysis; NSD: p> 0.05.

**Table 6**

**Effect of breed on physicochemical parameters of sheep milk**

| Parameters | Ouled Djellal | Rembi | Croisé Ouled Djellal | Croisé Rembi | p-values | SA |
|---|---|---|---|---|---|---|
| FT (%) | 4.26 ± 1.51 | 4.18 ± 0.98 | 3.09 ± 1.36 | 1.78 ± 1.33 | < 0.0001 | *** |
| NFDM(%) | 10.71 ± 5.07 | 12.01 ± 3.42 | 6.55 ± 4.89 | 5.05 ± 2.63 | < 0.0001 | *** |
| PR (%) | 4.08 ± 1.95 | 4.56 ± 1.29 | 2.49 ± 1.87 | 1.91 ± 1.01 | < 0.0001 | *** |
| LC (%) | 5.95 ± 2.85 | 6.70 ± 1.92 | 3.64 ± 2.74 | 2.86 ± 1.48 | < 0.0001 | *** |
| DS | 1.0327 ± 0.0188 | 1.0356 ± 0.0161 | 1.0173 ± 0.0165 | 0.9890 ± 0.0175 | < 0.0001 | *** |
| FP (°C) | -0.366 ± 0.159 | -0.396 ± 0.105 | -0.224 ± 0.156 | -0.157 ± 0.083 | < 0.0001 | *** |
| pH | 6.66 ± 0.17 | 6.67 ± 0.18 | 6.57 ± 0.16 | 6.72 ± 0.33 | 0,124 | NSD |
| TS (°C) | 9.34 ± 2.45 | 8.73 ± 2.67 | 10.31 ± 1.50 | 10.98 ± 1.01 | 0,019 | ** |

pH: potential Hydrogen; FT: Fat; NFDM: Non-fat dry matter; PR: Protein; LC: Lactose; DS: Density; FP: Freezing point; TS: Temperature; SA: Statistical analysis, ***: p <0.001; **: p <0.05; DNS: p> 0.05.

**Breakdown of results by breed of ewe**

Overall, the milk of purebred ewes (Ouled Djellal and Rembi) is rich in FT, NFDM, PR, LC and DS compared to the two other cross breeds (Croisé Ouled Djellal and Croisé Rembi). In addition, with the exception of FT, the milk of Rembi breed ewes is rich in NFDM (12.01 ± 3.42%), PR (4.56 ± 1.29%), LC (6.70 ± 1.92%) and DS (1.0356 ± 0.0161) (Table 6).

Statistical analyzes showed that the physicochemical parameters of raw sheep milk varied significantly from one breed to another (p <0.001), with the exception of the pH of the raw milk which did not significantly vary from one breed to another (p <0.001). race to another (p> 0.05).

**Breakdown of results according to the number of gestations of the ewes**

In the majority of cases, the results showed that with the exception of PC, the mean values of the physicochemical indicators of the fourth gestation period [9 to 12 [are low compared to those of the first three gestation stages. These values of the fourth bracket are: 2.78 ± 1.66%, 6.95 ± 4.97%, 2.65 ± 1.90%, 3.86 ± 2.77%, 1.0189 ± 0.0187 and 6.55 ± 0.15, respectively for FT, NFDM, PR, LC, DS and pH ( Table 7).

Statistical analyzes showed that the physicochemical indicators of raw sheep milk did not vary significantly from one gestation period to another (p> 0.05).

**Table 7**

**Effect of gestation number on the physicochemical parameters of sheep milk**

| Parameters | [1 to 3[ | [3 to 6[ | [6 to 9[ | [9 to 12[ | p-values | SA |
|---|---|---|---|---|---|---|
| FT (%) | 3.86 ± 1.85 | 3.57 ± 1.30 | 3.87 ± 1.21 | 2.78 ± 1.66 | 0.724 | NSD |
| NFDM (%) | 9.68 ± 6.01 | 8.71 ± 4.75 | 9.06 ± 4.61 | 6.95 ± 4.97 | 0.634 | NSD |
| PR (%) | 3.68 ± 2.30 | 3.32 ± 1.82 | 3.45 ± 1.77 | 2.65 ± 1.90 | 0.635 | NSD |
| LC (%) | 5.39 ± 3.36 | 4.84 ± 2.66 | 5.03 ± 2.59 | 3.86 ± 2.77 | 0.631 | NSD |
| DS | 1.0263 ± 0.0256 | 1.0250 ± 0.0168 | 1.0252 ± 0.0177 | 1.0189 ± 0.0187 | 0.595 | NSD |
| FP (°C) | -0.326 ± 0.194 | -0.296 ± 0.150 | -0.307 ± 0.145 | -0.244 ± 0.165 | 0.686 | NSD |
| pH | 6.64 ± 0.18 | 6.62 ± 0.18 | 6.65 ± 0.21 | 6.55 ± 0.15 | 0.275 | NSD |
| TS (°C) | 9.94 ± 2.00 | 9.03 ± 2.15 | 10.31 ± 2.51 | 11.08 ± 1.63 | 0.168 | NSD |

pH: potential Hydrogen; FT: Fat; NFDM: Non-fat dry matter; PR: Protein; LC: Lactose; DS: Density; FP: Freezing point; TS: Temperature; SA: Statistical analysis; NSD: p> 0.05

The main objective of this study was to evaluate the rate of the physicochemical parameters of the raw milk of the ewes of two pure breeds and two cross breeds in the pastoral region of Djelfa (Algeria) and to investigate the implication of the temperature. annual average as a risk factor on these indicators and on consumer health in order to propose corrective measures and guide future prevention proposals to produce milk of good quality and quantity.

The use of the results obtained on the physicochemical indicators of raw sheep milk showed the following average values: 3.70 ± 1.54% fat (fat), 9.06 ± 5.24% non-fat dry matter (NFDM), 3.45 ± 2.01% protein (PR), 5.04 ± 2.93% lactose (LC) and a density (DS) of 1.0253 ± 0.0207 with a freezing point (FP) of -0.307 ± 0.168 ° C and a pH of 6.63 ± 0.18 ° C. The values of LC, PC and pH appeared slightly higher than those found by Yabrir *et al.* (2011) of the order of 4.34%, -0.64 ° C and 6.49 respectively. On the other hand, they remain lower for the rest of the physicochemical indicators (ie: 6.19%, 10.64%, 5.38% and 1.034 ° C respectively for FT, DDE (degreased dry extract), PR and DS. These results can be explained by several factors, in particular, the feeding of the ewes which are fed by feeds which can promote the increase in the quality and the quantity of production of the raw milk.

The lipids depend on the breed, the rank of the milking, which influences the fat content. They are classified as the most variable constituents of milk in terms of quality and quantity (Debouz *et al.,* 2014). In addition, the reduction in protein levels in raw milk could be due to the difference in breed, the state of udder health and the stage of lactation (Asif and Sumaira, 2010). At the same time, according to Debouz *et al.* (2014), this decrease is related to the season and the number of births. Regarding lactose, it is the main sugar present in milk, a lactic fermentation substrate for lactic bacteria (Labioui *et al.,* 2009). With regard to the density and the freezing point are considered to be indicative of the detection of defrauded milk and varies according to their water content. According to, Debouz *et al.* (2014), the density is varied depending on the dry matter content of the milk, the fat, the temperature and the diet of the animal. While, Parcuel *et al.* (1994), noted that the lowest values of freezing points are obtained in periods of high production and the highest in periods of low production. Finally, according to Mathieu (1998), cited by Yabrir *et al.* (2011), the pH of milk varies from one species to another and depends, for a given species, on the richness of its milk in certain constituents, more particularly in phosphates, citrates and caseins. However, it is known that sheep's milk is particularly rich in these constituents than other ruminants (Mathieu, 1998; Chilliard and Sauvant, 1987, cited by Yabrir *et al.,* 2011)

The average temperature (TS) of raw sheep milk recorded during the physicochemical analyzes is 9.70 ± 2.19 ° C. It is weakly correlated with physicochemical indicators. According to Sboui *et al.* (2009), cited by Sboui *et al.* (2016), the fragility of the physico-chemical balances of raw milk (fat emulsion, colloidal suspension of proteins) can easily lead to physical destabilization, in particular under the action of mechanical and thermal shocks.

At the same time, temperature plays an important role in the fermentation of raw milk. The latter results from the transformation of lactose into lactic acid. This leads to acidification of the milk and subsequent coagulation of the milk.

In addition, in the majority of cases, it is largely exceeded the temperature recommended by Algerian standards (+ 6 ° C). It should be noted that this temperature plays a major role in bacterial growth. In addition, according to Hennekinne (2009), the temperature of 10 ° C is considered to be a threshold from which the bacteria *S. aureus* can begin to produce the enterotoxin responsible for the disease.

The distribution of the results according to the variation factors showed that the physicochemical indicators of the raw milk of the ewes are high in the semi-intensive system compared to those in the extensive system. Moreover, with the exception of SD and PC, the other indicators deprived with age and in the majority of cases, the results showed the mean values of the physicochemical indicators of the fourth gestation period [9 to 12 [ are low as well as, overall, the physicochemical composition of raw milk from purebred ewes (Ouled Djellal and Rembi) is good compared to the two other cross breeds (Croisé Ouled Djellal and Croisé Rembi).

According to Morand-Fehr *et al.* (2007), cited by Merlin Junior *et al.* (2015), the macro and micro nutrient composition of sheep's milk depends on the main production factors constituting the breeding system: animal genotype and health characteristics, agro-climatic conditions, socio-economic environment and breeding methods such as as feeding and milking. These factors have contributed directly or

indirectly to the synthesis of milk constituents by the secretory cells of the mammalian gland.

In parallel, Yabrir *et al.* (2011) have shown that the variability of the chemical composition of milk from one bioclimatic stage to another was considerable, it is significant for the density and protein variables and highly significant for the parameters pH, Dornic acidity, freezing point and dry extract defatted. The lactose, fat and defatted dry extract variables are independent of the floor.

Finally, efforts are needed to improve the physicochemical quality of the raw milk of the three species, such as the choice of animal, pasture, food, hygiene and the correction of all the factors that vary the quality of milk. milk.

## CONCLUSIONS

The present study confirmed that the physicochemical indicators of raw sheep milk vary according to the type of breeding, age, breed and number of gestations. In addition, the temperature of milk has weak correlations with physicochemical parameters. In addition, semi-intensive breeding is the most suitable breeding. In addition, this work confirms the risk of the temperature of the milk on the health of the consumer in the event of non-compliance with the cold chain. This requires systematic monitoring of the temperature of raw milk throughout the dairy production chain in order to limit all collective food poisoning.

Therefore, it will be very useful to carry out a program to improve the food ration in sheep farms; this will help to improve the quality and quantity of raw milk but would also improve the independence of Algeria vis-à-vis abroad in terms of milk imports, thus providing benefits for the whole country in the long term. economy of the country.

**ACKNOWLEDGMENTS.** The authors thank all the laboratory staff of the Faculty of Natural and Life Sciences of the University of Djelfa.

## REFERENCES

1. ANDI. (2013). Wilaya de Djelfa. Invest in Algeria. 25 p. Available online: www.andi.dz/PDF/monographies/Djelfa.pdf.

2. Annuaire économique des wilayas. (2015). Présentation de la wilaya de Djelfa & Secteurs économiques dans la wilaya de Djelfa (Agriculture et élevage dans la wilaya de Djelfa). Available online: http://monographies.caci.dz/index.php?id=1301

3. Arrêté interministériel. (1993). Relatif aux spécifications et à la présentation de certains laits de consommation, section I, Art. 3. 69:16 - 20. Journal Officiel de la République Algérienne N° 069 du 27/10/1993; p. 16. Available online: https://www.commerce.gov.dz/reglementation/arrete-interministeriel-du-18-aout-1993

4. Arrêté interministériel. (1999). Denrées alimentairres, temperatures maximales. Journal Officiel de la République Algérienne N° 087 du 08/12/1999; 3 p. Available online: http://www.sante.dz/jms2010/oms/arrete21-novembre.pdf

5. Asif M, Sumaira U. (2010). A Comparative Study on the Physicochemical Parameters of Milk Samples Collected from Buffalo, Cow, Goat and Sheep of Gujrat, Pakistan. Pakistan Journal of Nutrition, 9 (12): 1192-1197. Available online: https://www.researchgate.net/publication/49965934_A_Comparative_Study_on_the_Physicoch

emical_Parameters_of_Milk_Samples_Collected_from_Buffalo_Cow_Goat_and_Sheep_of_Gujrat_Pakistan

6. Chilliard Y, Sauvant D. (1987). La sécrétion des constituants du lait in le lait, matière première de l'industrie laitière. INRA-CEPIL. Paris, 13- 26. In : Yabrir B, Hakem (Ex. Akam) A, Laoun A, Si Ahmed S, Mati A. (2011). Caractérisation physico-chimique du lait cru ovin collecte localement en milieu steppique. Influence de l'étage bioclimatique. 1er Séminaire sur le Lait et ses Dérivées: « Entre Réalité de Production et Réalités de Transformation et de Consommation » Guelma les 4 et 5 Octobre 2011, 10 p. Available online: https://www.researchgate.net/publication/323129914_CARACTERISATION_PHYSICO-CHIMIQUE_DU_LAIT_CRU_OVIN_COLLECTE_LOCALEMENT_EN_MILIEU_STEPPIQUE_INFLUENCE_DE_L%27 ETAGE BIOCLIMATIQUE

7. Debouz A, Guerguer L, Hamid Oudjana A, Hadj Seyd AEK. (2014). Etude comparative de la qualité physicochimique et microbiologique du lait de vache et du lait camelin dans la wilaya de Ghardaïa. Revue ElWahat pour les recherches et les Etudes, 7(2) : 10-17. Available online: https://www.researchgate.net/publication/300060300_Etude_comparative_de_la_qualite_physico-chimique_et_microbiologique_du_lait_de_vache_et_du_lait_camelin_dans_la_wilaya_de_Ghardaia

8. Hennekinne JA. (2009). Nouvelles approches pour la caractérisation des toxi infections alimentaires à staphylocoques à coagulase positive. Thèse de Doctorat, Institut des Sciences et Industries du Vivant et de l'Environnement, Agro Paris Tech, 183 p.

9. Hossain MB, Dev SR. (2013). Physiochemical characteristics of various raw milk samples in a selected dairy plant of bangladesh. International Journal of Engineering and Applied Sciences, 1(3) : 91-96. Available online: https://www.researchgate.net/publication/320442605_PHYSIOCHEMICAL_CHARACTERISTICS_OF_VARIOUS_RAW_MILK_SAMPLES_IN_A_SELECTED_DAIRY_PLANT_OF_BANGLADESH

10. Labioui H, Elmoualdi L, Benzakour A, El Yachioui M, Berny E, Ouhssine M. (2009). Étude physicochimique et microbiologique de laits crus. Bull. Soc. Pharm. Bordeaux, 148 : 7-16. Available online: http://www.socpharmbordeaux.asso.fr/pdf/pdf-148/148-007-016.pdf

11. Mathieu J. (1998). Initiation à la physicochimie du lait. Tec. et Doc., Lavoisier, 220 p. In : Yabrir B, Hakem (Ex. Akam) A, Laoun A, Si Ahmed S, Mati A. (2011). Caractérisation physico-chimique du lait cru ovin collecte localement en milieu steppique. Influence de l'étage bioclimatique. 1er Séminaire sur le Lait et ses Dérivées: « Entre Réalité de Production et Réalités de Transformation et de Consommation » Guelma les 4 et 5 Octobre 2011, 10 p. Available online: https://www.researchgate.net/publication/323129914_CARACTERISATION_PHYSICO-CHIMIQUE_DU_LAIT_CRU_OVIN_COLLECTE_LOCALEMENT_EN_MILIEU_STEPPIQUE_INFLUENCE_DE_L%27 ETAGE BIOCLIMATIQUE

12. Morand-Fehr P, Fedele V, Decandia M, Le Frileux Y. (2007). Influence of farming and feeding systems on composition and quality of goat and sheep milk. Small Ruminant Res, 68:20-34. In : Ivandré Antonio Merlin Junior IA, Sifuentes dos Santos J, Grecco Costa L, Grecco Costa R, Ludovico A, De Almeida Rego FC, Walter de Santana EH. (2015). Sheep milk: physical-chemical characteristics and microbiological quality. Archivos Latinoamericanos De Nutricion, 65 (3), 193-198. Available online: http://ve.scielo.org/scielo.php?script=sci_arttext&pid=S0004-06222015000300009

13. Parcuel P, Corrot G, Sauvee O. (1994). Variations du point de congelation et principales causes du mouillage du lait de vache. Renc. Rech. Ruminants, 1 : 129-132. Disponible en ligne : http://www.journees3r.fr/IMG/pdf/1994_3_lait_11_parguel.pdf

14. Remane Benmalem Y, Bellal MM, Nouani A. (2016). Influence de quelques paramètres de production sur la qualité physicochimique et technologique du lait de vache dans les zones de plaines du haut cheliff en algérie. Revue « Nature & Technologie ». B- Sciences Agronomiques et Biologiques, 15 : 9-13. Available online: https://www.univ-chlef.dz/Revuenatec/issue-15/Article_B/B_Article%20342.pdf

15. Sba Bent El Heddi, Benrima Atika. (2017). Biodiversitéacridienne et floristique enmilieuxsteppiquesnaturels et reboisés dans la région de Moudjbara-Djelfa (Algérie). Revue Agrobiologia, 7(1): 321-333. Available online: http://agrobiologia.net/online/wp-content/uploads/2017/07/321-333_SBA-ET-BENRIMA.pdf

16. Sboui A, Touhami K, Djegham M, Belhadj O. (2009). Comparaison de la composition physicochimique dulait camelin et bovin du Sud Tunisien; variation du pH et de l'acidité à différentes températures. AfriqueScience: Revue Internationale des Sciences et Technologie, 5(2), 293-304. In : Sboui A, Arroum S, Hayek N, Mekrazi H, Khorchani T. Effet du traitement thermique sur lacomposition physicochimique du lait de chèvre. In : Napoléone M (ed.), Ben Salem H (ed.), Boutonnet JP (ed.), López-Francos A (ed.), Gabiña D (ed.). (2016). The value chains of Mediterranean sheepand goat products. Organisation of the industry, marketing strategies, feeding and production systems.Zaragoza : CIHEAM, 481-485 (Options Méditerranéennes : Série A. SéminairesMéditerranéens; n. 115). Available online: https://om.ciheam.org/om/pdf/a115/00007319.pdf

17. Yabrir B, Hakem (Ex. Akam) A, Laoun A, Si Ahmed S, Mati A. (2011). Caractérisation physico-chimique du lait cru ovin collecte localement en milieu steppique. Influence de l'étage bioclimatique. 1er Séminaire sur le Lait et ses Dérivées: « Entre Réalité de Production et Réalités de Transformation et de Consommation » Guelma les 4 et 5 Octobre 2011, 10 p. Available online: https://www.researchgate.net/publication/323129914_CARACTERISATION_PHYSICO-CHIMIQUE_DU_LAIT_CRU_OVIN_COLLECTE_LOCALEMENT_EN_MILIEU_STEPPIQUE_INFLUENCE_DE_L%27 ETAGE BIOCLIMATIQUE