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#### Research Article

# Microbial Quality of Raw Camel Milk Collected from Different Regions of Southeastern Algeria

#### ASMA BOUGUERRA\*, DAOUD HARZALLAH, SABRINA BAKLI

Laboratory of Applied Microbiology, Department of Microbiology, Faculty of Nature and Life Sciences, University Ferhat Abbas, Setif 1,19000, Algeria.

ARTICLE DETAILS	ABSTRACT			
Article history: Received on 20 September 2021 Modified on 15 October 2021 Accepted on 19 October 2021	The present study was carried out to assess the microbial quality of Algerian racamel milk. A total of thirteen milk samples were collected singly from differe females under rigorous hygienic conditions. They were subjected determinations of pH, methylene blue reduction, total aerobic mesophilic flow			
<i>Keywords:</i> Camel Milk, Health Risk, Hygienic Conditions, Microbial Quality.	<i>Enterobacteriaceae, Enterococcus, Staphylococcus</i> spp. and total yeast and moulds counts. Results revealed that pH levels ranged between (6.46-6.77) and all milk samples reduced methylene blue after 4 hours indicating that the milk is probably of good microbiological quality. The log count per mL for total aerobic mesophilic flora, <i>Enterococcus, Staphylococcus</i> spp. and total yeast and moulds count ranged between: (1.69-3.25), (1.69-3.17), (00-3.39) and (0.95-2.3) respectively. <i>Enterobacteriaceae</i> are absent in 69.23% of the milk samples examined and do not exceed log 1.30 CFU/mL. The results obtained of this study show that even if the hygienic conditions of milking, storage and transport are improved; the presence of certain pathogenic microorganisms such as <i>Staphylococcus</i> spp. in camel milk with relatively high frequency limits its consumption in the raw state especially by immunocompromised persons.			
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#### INTRODUCTION

According to FAO statistics, the camel world population is around 35 million head <sup>[1]</sup>. In Algeria, the camel herd is distributed over three main breeding areas: the south-east, south-west and extreme south with respectively 52%, 18% and 30% of the total population estimated of 345.000 head until 2013 <sup>[2]</sup>. Camels support the survival of millions of people in arid and semi-arid areas, mainly by providing milk almost all year <sup>[3]</sup>.

Camel milk is rich in vitamins, minerals, proteins, carbohydrates and immunoglobulins. It is known for its health effects and many studies are focused on its characterization. Thus studies may contribute to the increasing use of camel milk for therapeutic reasons <sup>[4]</sup>.

Many pastoralists rank raw camel milk as safe. However, it contains abundant water, nutrients and has a nearly neutral pH which provides a

\*Author for Correspondence: Email: asma.bouguerra@univ-bba.dz good medium for the growth of many microorganisms <sup>[5, 6]</sup>.

The contamination of camel milk is possible during milking, storage and transport. Moreover, it can occur even the udders are infected <sup>[5]</sup>.

Several studies have indicated that the consumption of camel milk in the raw state is unsafe. They have linked this insecurity to poor hygienic conditions.

To this purpose, the objective of the current study is to evaluate the security of the consumption of camel milk in the raw state under strict hygienic conditions.

#### MATERIALS AND METHODES Sampling

13 samples of raw camel milk were collected from three different regions in the south-east of Algeria, M'sila (Maârif: 35° 24′ 55″ North latitude, 4° 20′ 39″ East longitude), Biskra (El Ghrous: 34° 42′ 19″ North latitude, 5° 17′ 7″ East longitude) and Oued Souf (Still: 34° 15′ 34″ North latitude, 5° 54′ 50″ East longitude) (Fig.1).



Figure 1: Location of camel milk sampling sites.

The udders of apparently healthy females were rigorously cleaned, disinfected with ethanol and dried. The elevators wore gloves after cleaning their hands. Then, milk was collected in sterile bottles, transported to the laboratory in an ice box (4°C) and analyzed within 24h.

# Estimation of Microbial Quality and Milk pH Values

To estimate the microbial quality of milk quickly, methylene blue reduction test is applied. A volume of 1mL of a methylene blue solution is transferred to tubes containing 10 mL of each milk sample and incubated at 37°C. Then, tubes are shaken every 30 min and controlled for the disappearance of blue color due to reducing of oxygen as a result of microbial activity. When the reduction time of methylene blue (t) is< 2 h: milk is contaminated, 2 h < t < 4 h: milk is poorly contaminated, t > 4 h: milk is of good quality <sup>[7-9]</sup>. The pH of all samples was measured using pH meter (HANNA instruments).

#### **Microbial Analysis**

Before microbial analysis, a dilution series was prepared for each milk sample using sterile physiological water (0.85%) up to 10<sup>-3</sup>. The media used for enumeration of microorganisms and the culture conditions are summarized in Table 1. Isolation and enumeration of the total aerobic mesophilic flora, *Enterobacteriaceae*, enterococci, *Staphylococcus* spp. and total yeast and moulds have been carried out according to the methods described by Guiraud (2003)<sup>[7]</sup>. The microbial count data were transformed to decimal logarithmic values (log).

Гаble 1: Media and	culture conditions	of microorganisms.
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Microbial groups	Medium	Incubation	
		(T°C)	Duration (h)
Total aerobic mesophilic flora (FAMT)	PCA (plating count agar)	30°C	72h
Enterobacteriaceae	VRBG (Violet Red Bile Glucose agar)	37°C	48h
Enterococcus	BEA (Bile esculin agar)	37°C	48h
Staphylococcus spp.	Chapman	37°C	48h
Yeast/Moulds	PDA (Potatoes Dextrose agar)	28°C	5 days

#### **RESULTS AND DISCUSSION**

# Estimation of Microbial Quality and Milk pH Values

All milk samples reduced the methylene blue after 4 hours of incubation, indicating that the milk is of good microbiological quality. The result obtained does not agree with that obtained by Siboukeur (2007) <sup>[10]</sup> who found that the methylene blue reduction time is of 2 hours for most of the samples tested. The pH value gives a measure of the true acidity of milk and to detect abnormal mastitis milk <sup>[8]</sup>. The pH values measured for camel milk samples are between (6.46-6.77) and the average is 6.64±0.08. These values are very close to those mentioned by FAO (1982) <sup>[11]</sup>: (6.5-6.7) which corresponds to that of fresh milk, as well as by other authors, Yam et al. (2014) <sup>[12]</sup> (6.4-6.7) and Meribai (2018) <sup>[13]</sup> (6.58-6.65). However, pH obtained is high compared to that mentioned by Siboukeur (2007) <sup>[10]</sup> (pH: 6.2) and Benyagoub and Ayat (2015) <sup>[14]</sup> (pH: 5.67).

### **Microbial Analysis**

The different microbial groups present in the milk samples examined are enumerated and the

results are shown in Table 2 and Fig. 2. Total mesophilic aerobic flora is a good indicator of contamination  $^{[15]}$ . Their average is 2.51 log CFU/mL. The result obtained is very close to that reported by Kaindi et al. (2011)  $^{[16]}$  (3.6x10<sup>2</sup> CFU/mL).

**Table 2:** Microbial counts of camel milk samples (log cfu/mL).

Groupes microbiens	Minimum	Maximum	Mean	SD
Total aerobic mesophilic flora (FAMT)	1.69	3.25	2.51	0.51
Enterobacteiaceae	ND	1.30	0.21	0.4
Enterococcus	1.69	3.17	2.49	0.5
Staphylococcus spp.	ND	3.39	2.17	0.89
Yeast/Moulds	0.95	2.3	1.60	0.34

ND: not determined, SD: Standard deviation



**Figure 2:** Scatter plot of total aerobic mesophilic flora (A), *Enterobacteriaceae* (B), *Enterococcus* (C), *Staphylococcus* spp. (D), yeast and moulds (E) present in all camel milk samples collected from different areas.

However, several authors: Benkerroum et al. (2003) <sup>[17]</sup>, El-Ziney, (2007) <sup>[18]</sup>, Omer and Eltinay (2008) <sup>[19]</sup>, Jrad et al. (2013) <sup>[20]</sup>, Merzouk et al. (2013) <sup>[21]</sup>, Yam et al. (2014) <sup>[12]</sup>, Benyagoub et Ayat (2015) <sup>[14]</sup>, Alaoui Ismaili et al. (2016b) <sup>[22]</sup>, Elhosseny et al. (2018) <sup>[23]</sup> and Makgoeng et al. (2018) <sup>[24]</sup> have reported higher levels.

*Enterobacteriaceae* were detected in four samples (30.76%) with an average of 0.21 log CFU/mL. Our findings are not in agreement with those obtained by: El-Ziney, (2007) <sup>[18]</sup>, Kaindi et al. (2011) <sup>[16]</sup>, Yam et al. (2014) <sup>[12]</sup>, and Elhosseny et al. (2018) <sup>[23]</sup> who reported very high values. The occurrence of *Enterobacteriaceae*, which are indicators of faecal contamination with a low frequency in milk, shows the good hygienic conditions during milking and transport of camel milk samples.

The total enterococci count ranged between 1.69 log CFU/mL and 3.17 log CFU/mL with an average of 2.49 log CFU/mL. This result is nearly similar to that found by Kaindi et al. (2011)<sup>[16]</sup> (1.7x10<sup>2</sup> CFU/ mL). While, Benkerroum et al. (2003)<sup>[17]</sup> and Alaoui Ismaili et al. (2016b)<sup>[22]</sup> reported a very high average (2.9x10<sup>4</sup>CFU/mL) and (3.7x10<sup>6</sup> CFU/mL) respectively.

Most enterococcal species are associated with the intestines of humans and domestic animals and their presence in milk indicate fecal contamination <sup>[25]</sup>. Furthermore, Benkerroum et al. (2003) <sup>[17]</sup>, Davati et al. (2015) <sup>[26]</sup> and Alaoui Ismaili et al. (2016a) <sup>[27]</sup> have determined a dominance of this genus in camel milk compared to other lactic acid bacteria with percentages of 58.8%, 51% and 53.6% respectively. It seems that the abundance of enterococci in camel milk is favored by its salinity because they are saltresistant.

Staphylococci are present in almost all samples with an average of 2.17 log CFU/mL. This value is nearly similar to that reported by Kaindi et al. (2011) <sup>[16]</sup>.

Merzouk et al. (2013) <sup>[21]</sup>, Yam et al. (2014) <sup>[12]</sup> have reported lower values. However, Omer and Eltinay (2008) <sup>[19]</sup> and Elhosseny et al. (2018) <sup>[23]</sup> have reported higher values. The relatively high frequency of staphylococci may be assigned to infected udders by clinical or subclinical mastitis <sup>[23]</sup>. It can also be associated with the medium used for enumeration which allowing the growth of other halotolerants present in camel milk characterized by its relatively high salinity <sup>[10]</sup>. The average value obtained of yeast and moulds is 1.60 log CFU/mL. This value is very close to that obtained by Kaindi et al. (2011) <sup>[16]</sup> and Omer and Eltinay (2008) <sup>[19]</sup>. However, Benkerroum et al. (2003) <sup>[17]</sup>, Yam et al. (2014) <sup>[12]</sup>, Benyagoub et Ayat (2015) <sup>[14]</sup> found higher values. The high level of yeasts and moulds in milk is rather rare because of the natural pH of the milk, which favors bacterial dominance <sup>[18, 22]</sup>.

## CONCLUSION

The methylene blue reduction test shows that the microbial load in all camel milk samples is low. This result was confirmed after an enumeration of different microbial groups cultured appropriate on media. The microbiological quality of the milk examined is better than those described in several studies. This can be associated with good sanitary practice. However, presumptive Staphylococcus spp. were recorded with a relatively high frequency in some samples. It is therefore important to treat camel milk by heat or fermentation before consuming it to avoid any health risk.

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