



Assessment of Contamination of Raw Camel Milk by *Listeria* spp. and *Staphylococcus* spp. †

Sara Lezzoum-Atek ^{1,2,*} , Chahrazed Belhout ¹ , Hadir Bouchenafa ¹ and Leila Bouayad ¹

¹ HASAQ Laboratory, High National Veterinary School, Issad Abbes Avenue, Oued Smar, El Harrach, Algiers 16270, Algeria; c.belhout@etud.ensv.dz (C.B.); h.bouchenafa@etud.ensv.dz (H.B.); l.bouayad@ensv.dz (L.B.)

² Faculty of Sciences, University of Ben Youcef Benkhedda, Algiers 16000, Algeria

* Correspondence: saralezzoum@gmail.com

† Presented at the 10th International Seminar of Veterinary Medicine: Camelids in Algeria & Maghreb, Constantine, Algeria, 20–21 December 2022.

Abstract: Camel milk is a valuable food choice, representing a primary need in the diet of people in dry zones. Camel milk is rich in nutrients, which makes it a favorable environment for the development of microorganisms. *Staphylococcus* and *Listeria* are significant opportunistic pathogens in humans, dairy cattle, and camels. The presence of these bacteria could present a potential public health issue. In the present study, 20 milk samples collected from camel farms in M'sila were investigated for the presence of *Staphylococcus* spp. and *Listeria* spp. *Staphylococcus* enumeration, and a search for *Listeria* spp. was performed according to the recommendations of ISO 6888-1(2004) and ISO 11290-1(2017) methods, respectively. The results show a contamination prevalence of 62% of *staphylococcus* spp. with an estimated average bacterial load of 2.7.102 cfu/mL, while for *Listeria* spp., only three samples were positive, with a prevalence of 14.28%. For each species, identification using API *Listeria* strips confirmed the presence of *Listeria grayi*, *Listeria innocua*, and *Listeria seeligeri* species, but no *Listeria monocytogenes* were recovered in these samples. According to the current results, we could conclude that the percentage of contamination with *Staphylococcus* in the tested camel milk samples was relatively high compared to the level of contamination with *Listeria*. There is no Algerian regulation setting microbiological criteria for raw camel milk; however, these results suggest that the hazard to the consumer cannot be excluded.

Keywords: camel's milk; *Staphylococcus* spp.; *Listeria* spp.; prevalence; foodborne pathogens



Citation: Lezzoum-Atek, S.; Belhout, C.; Bouchenafa, H.; Bouayad, L. Assessment of Contamination of Raw Camel Milk by *Listeria* spp. and *Staphylococcus* spp.. *Biol. Life Sci. Forum* **2023**, *22*, 9. <https://doi.org/10.3390/blsf2023022009>

Academic Editors: Amira Leila Dib, Said Boukhechem, Hithem Bougherara and El-Hacene Bererhi

Published: 31 March 2023



Copyright: © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Camels are important to the lifestyle of several communities, particularly those of the Middle East and Africa [1]. Camel milk is one of the main components of diet in these arid and semiarid zones, where feed resources are scarce [2]. Camel's milk is rich with vitamins including B1, B2, and C [3]. Compared to cow's milk, camel milk contains three to five times more vitamin C, which makes it an important part of the diet in arid areas where accessibility to green foods is limited [4]. The camel milk is traditionally consumed predominantly in its raw state without any heat treatments [5], and in general the milk secreted by healthy cells has historically been considered sterile [6]. Its high content of antibacterial factors (Lactoferrin, Lactoperoxidase, and Lysozyme) gives it a particular capacity to be stored for a few days at relatively high temperatures (around 25 °C). However, it can be contaminated by pathogenic microorganisms of endogenous origin (*Staphylococci*, *Streptococci*, or *Escherichia coli*), following excretion from the udder of an infected animal or exogenous origin (*Bacillus*, *Clostridium*, *Micrococcus*, *Salmonella*, and *Listeria*) through direct contact with infected herds or through the environment (e.g., utensils, personnel) [7]. Microbiological criteria for raw cow's milk are well defined by regulations, yet there are no such criteria for camel milk, and published data on its bacterial hazards are also scarce.

Therefore, the objective of this research was to enumerate *Staphylococcus* spp. and isolate *Listeria* spp. from raw camel milk. These bacteria are often associated with the raw milk of other animal species, and have been directly linked to human and animal infections.

2. Material and Methods

Twenty camel milk samples were gathered from different farms in M'sila, which is a steppic zone located 200 km south of Algiers. The raw milk samples were obtained and stored in labeled screw-top bottles and were kept in an ice box under cold conditions during their direct transfer to the laboratory. *Staphylococci* were enumerated by using the spread plate technique in accordance with the EN ISO 6888-1 (2004). Presumptive staphylococcal colonies on Baird-Parker agar were confirmed using conventional methods, including colony morphology (black colony surrounded by a light halo) and catalase testing. The investigation of *Listeria* spp. was conducted according to the EN ISO 11290-1 method (ISO, 2017). Species identification of *Listeria monocytogenes* was performed based on the characteristic appearance of colonies on Aloa agar (bioMérieux) (green surrounded by a slight halo). All other species (not surrounded by a halo) were identified using API *Listeria* strips (BioMérieux).

3. Results and Discussion

This study assessed the prevalence of *Staphylococcus* spp. and *Listeria* spp. in raw camel milk. The overall prevalence of *Staphylococcus* spp. was 62% (Figure 1), with the average level of staphylococcal contamination in positive samples reaching 3×10^2 CFU/mL.

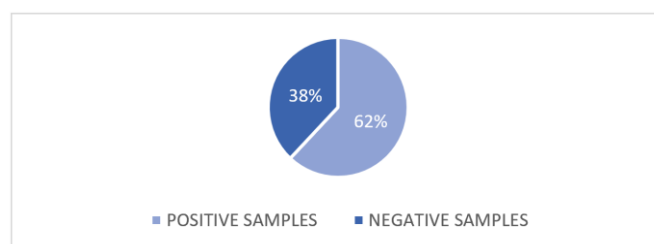


Figure 1. Prevalence and contamination level of *staphylococcus* spp. in raw camel milk.

The rates of contamination found were lower than those reported by Abera et al. [8] (89.8%), who investigated raw milk from 126 camels. In another survey on the microbiological quality of camel's milk in Algeria, Mosbah et al. [9] reported an overall prevalence of staphylococci of 2.8%, which is much lower than that identified in our results for the prevalence of *Listeria* spp. in raw camel milk (Table 1). *L. monocytogenes* was not detected, which corroborates the results of Debbouz et al. [10] and Ghardaia and Ibrahim Rahimi et al. [11], who found all camel milk samples from camel breeding farms were negative for *Listeria monocytogenes*. The results of this study could be related to a lack of compliance with good production and hygiene practices during milking.

Table 1. Prevalence of *Listeria* species in raw camel milk.

Samples (N = 20)	<i>Listeria</i> Species			
	<i>L.grayi</i> N (%)	<i>L.innocua</i> N (%)	<i>L.seeligeri</i> N (%)	<i>L.monocytogenes</i> N (%)
Prevalence	1 (33.3%)	1 (33.3%)	1 (33.3%)	0

N: number, %: prevalence.

4. Conclusions

The Algerian regulation does not consider camel milk in the microbiological criteria set for foods. Nevertheless, the results show high contamination by *Staphylococcus* spp. and significantly lower contamination by *Listeria* spp., which suggests that the danger for the consumer cannot be excluded. The information obtained from this study could

be useful for epidemiological studies on *Staphylococcus* spp. and *Listeria* spp. for public health considerations.

Author Contributions: Conceptualization, S.L.-A., C.B., H.B. and L.B.; methodology, S.L.-A.; validation, S.L.-A., C.B. and L.B.; investigation, S.L.-A., C.B., H.B. and L.B.; writing—original draft preparation, S.L.-A., C.B. and L.B.; writing—review and editing, S.L.-A., C.B. and L.B.; supervision, L.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Mirkena, T.; Waleign, E.; Tewolde, N.; Gari, G.; Abebe, G.; Newman, S. Camel production systems in Ethiopia: A review of literature with notes on MERS-CoV risk factors. *Pastoralism* **2018**, *8*, 1–17. [[CrossRef](#)] [[PubMed](#)]
2. Farah, Z. *Camel Milk: Properties and Products*; Swiss Centre for Development Cooperation in Technology and Management: St. Gallen, Switzerland, 1996.
3. Singh, R.; Mal, G.; Kumar, D. Camel Milk: An Important Natural Adjuvant. *Agric. Res.* **2017**, *6*, 426–434. [[CrossRef](#)]
4. Ereifej, K.I.; Alu'datt, M.H.; Alkhalidy, H.A.; Alli, I.; Rababah, T. Comparison and characterisation of fat and protein composition for camel milk from eight Jordanian locations. *Food. Chem.* **2011**, *127*, 282–289. [[CrossRef](#)]
5. Handling, Preservation and Utilization of Camel Milk and Camel Milk Products in Shinile and Jijiga Zones, Eastern Ethiopia. Available online: <http://www.lrrd.org/lrrd19/6/seif19086.htm> (accessed on 30 May 2022).
6. Swelum, A.A.; El-Saadony, M.T.; Abdo, M.; Ombarak, R.A.; Hussein, E.O.S.; Suliman, G. Nutritional, antimicrobial and medicinal properties of Camel's milk: A review. *Saudi. J. Biol. Sci.* **2021**, *28*, 3126. [[CrossRef](#)] [[PubMed](#)]
7. Brisabois, A.; Lafarge, V.; Brouillaud, A.; de Buyser, M.L.; Collette, C.; Garin-Bastuji, B.; Thorel, M.F. Pathogenic organisms in milk and milk products: The situation in France and in Europe. *Rev. Sci. Tech.* **1997**, *16*, 452–471. [[CrossRef](#)] [[PubMed](#)]
8. Abera, T.; Legesse, Y.; Mummed, B.; Urga, B. Bacteriological quality of raw camel milk along the market value chain in Fafen zone, Ethiopian Somali regional state. *BMC Res. Notes* **2016**, *9*, 1–6. [[CrossRef](#)] [[PubMed](#)]
9. Qualité Microbiologique du lait de Chamelle (*Camelus dromedarius*) Élevée en Systeme Semi Intensif dans la Localite de Ghardaïa. *Revue des Bio-Ressources*. Available online: <https://journals.univ-ouargla.dz/index.php/RBR/article/view/1371> (accessed on 1 June 2022).
10. Debouz, A.; Guerguer, L.; Hamid Oudjana, A.; Hadj Seyd, A.E.K. Etude comparative de la qualité physico-chimique et microbiologique du lait de vache et du lait camelin dans la wilaya de Ghardaïa. *Rev. ElWahat Pour Les Rech. Et Les Etudes.* **2014**, *7*, 10–17.
11. Rahimi, E.; Momtaz, H.; Behzadnia, A.; Baghbadorani, Z.T. Incidence of *Listeria* species in bovine, ovine, caprine, camel and water buffalo milk using cultural method and the PCR assay. *Asian Pac. J. Trop. Dis.* **2014**, *4*, 50–54. [[CrossRef](#)]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.