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

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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

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 (bioMerieux) (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 $3 \times 10^5$ CFU/mL.

![Prevalence and contamination level of staphylococcus spp. in raw camel milk.](image)

The rates of contamination found were lower than those reported by Aher 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>
<thead>
<tr>
<th>Samples (N = 20)</th>
<th>L. grayi N (%)</th>
<th>L. innocua N (%)</th>
<th>L. seeligeri N (%)</th>
<th>L. monocytogenes N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence</td>
<td>1 (33.3%)</td>
<td>1 (33.3%)</td>
<td>1 (33.3%)</td>
<td>0</td>
</tr>
</tbody>
</table>

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.


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**References**


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