Research Note

A Preliminary Microbiological Assessment of Process Hygiene of Traditional Outdoor Camel Slaughter in Sahrawi Refugee Camps†

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ABSTRACT

The aim of this study was to investigate the hygiene performance of a camel (Camelus dromedarius) slaughtering process as carried out with the traditional method in the Sahrawi refugee camps located in southwestern Algeria. The camel slaughtering process in this region differs significantly from that carried out in commercial abattoirs. Slaughtering is performed outdoors in desert areas, and dehiding of the carcass is approached via the dorsoventral route rather than the classic ventrodorsal route. Samples were taken from 10 camel carcasses from three different areas: the hide, the carcass meat immediately after dehiding, and the meat after final cutting. Enterobacteriaceae counts (EC) were enumerated employing conventional laboratory techniques. Carcass meat samples resulted in EC below the detection limit more frequently if the hide samples from the same carcass had also EC counts below the detection limit. Because of the low number of trials, the calculation of statistical significance of the results was not possible. Further experimental research is needed in order to validate the results presented in this study. The comparison of the microbiological hygiene performance between dorsal dehiding and traditional ventral dehiding of slaughtered animals could serve to validate the hypothesis of the potential positive impact of the dorsal dehiding method in carcass meat hygiene.

The Sahrawi people live as refugees in a desert area called hammada, in southwestern Algeria. Since 1976, approximately 120,000 people have been living in the camps. Livestock kept in the camps consists mainly of small ruminants (sheep and goats) and, in smaller number, camels (Camelus dromedarius). The livestock census carried out in 2007 by the Sahrawi Veterinary Direction reported the presence of 1,657 dairy camels (2). An average number of 3,500 camels locally bred or imported from neighboring areas (i.e., Western Sahara, Algeria, Mauritania) are slaughtered each year. Fresh camel meat is marketed locally within hours from slaughtering, without any system of cold storage and/or other means of preservation. Traditional camel slaughter is done outdoors as no slaughterhouses are locally available. Slaughtering is performed a few kilometers away from inhabited areas.

The microbiological hygiene performance of the camel slaughtering process in the Sahrawi camps has never been investigated. Previous studies carried out in other Saharan countries cannot provide comparable data, because they focused on different conditions, in which slaughtering took place in dedicated indoor facilities like slaughterhouses (1, 7, 8). The aim of this study was to carry out a preliminary assessment of the microbiological process hygiene performance of traditional camel slaughtering undertaken outdoors in Sahrawi refugee camps.

MATERIALS AND METHODS

Camel slaughter process in the Sahrawi refugee camps. In the Sahrawi refugee camps, camels are traditionally slaughtered according to Muslim ritual. The animal is killed by cutting the major vessels of the neck, without prior stunning.

The slaughtering process takes place as follows:

(i) The camel is immobilized to the ground, in sternal recumbency (i.e., the prone position), with head and neck turned toward one side.

(ii) The jugular veins are cut.

(iii) After bleeding is completed and keeping the sternal recumbency position of the camel carcass, the hide is removed from the trunk, starting from the vertebral column (i.e., dorsal area) and removal proceeds laterally along the sides toward the abdominal area.

(iv) The hide is stretched on the ground and employed as a surface over which evisceration and further slaughter and cutting operations are carried out, thus protecting the carcass meat from the sand.

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(v) The fat tissue of the hump is removed, as well as the distal parts of the limbs and the abdominal organs.

(vi) An excision is done in the lateral part of the abdomen between the last rib and the caudal region, and the gastrointestinal tract is removed and dropped on the hide.

(vii) The ribs are cut with an axe close to the vertebral column, leaving an opening through which the thoracic viscera are removed.

(viii) The hind legs are disarticulated from the trunk in the pelvis, and the forelegs at shoulder level.

(ix) The trunk is halved by cutting the column behind the costal arch with an axe.

(x) Finally, the neck and head are skinned and detached from the anterior part of the trunk.

**Sampling sites and bacteriological analysis.** During May 2010, 10 slaughtered camels were sampled during 10 different days or sessions (i.e., one camel was slaughtered and sampled per day or session) at 10 different locations (i.e., each day, a new, clean slaughtering location was used). This numerical limitation, because of technical and financial constraints, hampered further detailed statistical data analysis. However, it should not impact the preliminary findings reported in this study.

Samples were collected from the carcass of each of the animals by swabbing over an area of 100 cm², with sterile cotton swabs. The area was delimited by a metal frame that was sterilized with 96% (vol) ethanol between samples.

Sampling regions of the carcass were chosen based on approaches and methodologies that were followed in similar published studies (1, 3, 5, 10). The general aim of those previous studies was to assess the hygiene performance of the slaughter process by comparing bacterial loads on the hide with that of the resultant carcass meat. The sampling regions chosen for our study were dorsal to the tip of the shoulder and caudal to the wound inflicted in the lower third of the neck. Three samples were collected in this region from each carcass, in order from: the hide before any incision was done; carcass meat surfaces below hide, immediately after dehiding; and meat surfaces immediately lateral-proximal to the previous one after evisceration and partial cutting of the carcass.

After sampling, swabs were placed in ice in thermal containers and transferred to the laboratory. Traveling time between the slaughter place and the laboratory was about 30 min. All samples were cultured within 7 h of being taken.

The samples were examined for determining the count of aerobic mesophilic bacteria (aerobic plate count [APC]) and Enterobacteriaceae (EC), using standardized conventional methodologies (i.e., International Organization for Standardization [ISO] method 18593:2004, ISO method 4833:2003, ISO method 21528-2:2004, and for method of calculation, method ISO 7218:2007, amendment 1). Sample cotton swabs were placed in sterile bags with 100 ml of sterile peptone broth (peptone-tryptone water; Biolife, Milan, Italy) and thoroughly massaged in order to recover bacteria from the swabs. Serial dilutions were performed by mixing 1 ml of the initial dilution with a ninefold volume of sterile peptone broth, and by repeating this operation for each new dilution. For APC enumeration, 1 ml of each dilution was mixed with 15 ml of molten plate count agar (PC agar standard method, Biolife) in sterile petri dishes. For Enterobacteriaceae isolation, the same procedure was repeated, but instead used 10 ml of molten violet red bile glucose agar (Bioline) in lieu of plate count agar. Once the agar was solidified, an additional 15 ml of medium was poured onto the surface of the inoculated plate to prevent spreading growth. After complete solidification, relevant plates were incubated at 30 ± 1°C for 72 ± 3 h for isolating mesophilic aerobic flora and at 37 ± 1°C for 24 ± 3 h for Enterobacteriaceae isolation.

For APC enumeration, only plates with number of colonies from 10 to 300, and all kind of colonies were considered. For enumeration of Enterobacteriaceae, only plates from 10 to 150 of characteristic colonies (oxidase-negative and glucose-positive colonies) were considered. Results were converted to CFU per square centimeter.

Data were recorded on a spreadsheet, including information on the slaughtered animal and an indication of the climatic conditions at the time of slaughter.

**RESULTS**

All the cultures from hide and meat surface samples showed abnormally high APC, in the order of 10²⁰ CFU/cm² or higher. This could be related to the lack of adequate conditions during the preparation of these cultures and the lack of controls for the media used, which could have been contaminated. APC were not considered further and were excluded from the study.

Results of EC are presented in Table 1.

**DISCUSSION**

This preliminary investigation provides first insights into the process hygiene of the traditional Sahrawi method of slaughtering camels and on the microbiological status of the resulting camel meat. Enterobacteriaceae were below the detection limit in 70% of the samples taken from the animals (hide swabs, 7 of 10, <1 CFU/cm²); meat surface swabs immediately after the skinning, 8 of 10, <1 CFU/cm²; and meat surface swabs after evisceration and dissection of carcass, 6 of 10, <1 CFU/cm²). In the samples where Enterobacteriaceae were identified (30% of the samples), counts varied between 1.8 × 10⁴ and 6.6 × 10⁵ CFU/cm².

Studies carried out in Saharan countries have been published on the microbiological quality of camel or cattle meat (6–9). These studies have been carried out under different conditions (i.e., controlled abattoir conditions.

<table>
<thead>
<tr>
<th>Carcass no.</th>
<th>Swab A</th>
<th>Swab B</th>
<th>Swab C</th>
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<tbody>
<tr>
<td>1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
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<td>1.8 × 10³</td>
<td>6.6 × 10⁴</td>
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<td>3</td>
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<td>10</td>
<td>&lt;1</td>
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*a* Taken from the hide after killing.  
*b* Taken from the carcass meat surface after skinning.  
*c* Taken from the meat surface from the area immediately lateral-proximal to that of swab B after evisceration and carcass cutting.
classic ventrodorsal dehiding) and with different study designs (e.g., different areas sampled). Thus, they cannot serve as reference for direct comparison with the results obtained in the present study. However, they can be considered as suitable references of process hygiene performance under those particular situations.

There is variability between the results of those published studies. These differences could be attributed to differences between species (i.e., cattle versus camel) and/or between abattoirs (i.e., hygiene practices). There is no information readily available in order to identify what factors could contribute to those differences.

Considering the limitations when comparing our results with those of the other studies, fewer Enterobacteriaceae were found on the camel hide in our study. A possible explanation for this could relate to area from which the samples were taken. Samples in our study were taken in the area dorsal to the tip of the shoulder, while in other studies samples were taken from ventral areas, which are potentially more contaminated. Sampling sites chosen were those close to the first opening cuts done for dehiding (i.e., shoulder region). However, it has to be noted that other areas of the carcass could be exposed to largest source of fecal contamination from the hide, like the ventral and perineal region or the limbs. However, those areas could not be sampled, as the hide is not incised in that region, as the carcass lies in the prone position, over the stretched hide. Therefore, by choosing the areas examined in the current study, EC could have potentially been underestimated.

In carcasses where the hide (swab A) had EC below the detection limit, the samples taken from the carcass meat just after skinning (swab B) showed EC below the detection limit as well. On the other hand, EC below the detection limit in samples taken after cutting (swab C) were less frequently associated with EC below the detection limit in swab A (i.e., 40%) or in swab B (i.e., 40%). Overall, in 4 of the 10 trials, all samples resulted in EC below the detection limit. However, it was not possible to estimate any statistical significance in these correlations because of the small number of carcasses sampled.

It could be hypothesized that the dressing technique used in this study (i.e., dorsoventral route) could positively have an effect on the low transfer of Enterobacteriaceae from the hide to the carcass meat. Initial opening cuts on the hide are done on the dorsal area of the carcass, where fecal contamination and levels of Enterobacteriaceae could be lower than in the ventral-umbilical area. This could result in a limited initial transfer of Enterobacteriaceae from the hide to the carcass, followed by the continuous rolling down of the hide and thus, lack of direct contact between the ventral-umbilical area of the hide (i.e., more prone to fecal contamination) and the dressed parts of carcass.

Further studies should be carried out in order to validate these preliminary results of the process hygiene assessment of the camel slaughter methodology presented in this study. These studies should include measurements of APC. In order to identify optimal strategies for monitoring the microbiological process hygiene performance, the sampling of different anatomical areas should also be explored.

Furthermore, the comparison of the microbiological hygiene performance of animals slaughtered in commercial abattoirs between carcasses dehided under traditional procedures (i.e., ventral dehiding) and dehided following the Sahrawi traditional method (i.e., dorsal dehiding) should be investigated. This could serve to validate the hypothesis of the potential positive impact of the dorsal dehiding method in carcass meat hygiene.

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REFERENCES