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The Growth and Survival of *P. aeruginosa* (ATCC 29733) and *E. coli* O157:H7 Inoculated onto Ground Raw Dromedary and Beef Meat Stored at 10°C

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Abstract: This study investigated the growth and survival of *Escherichia coli* O157:H7 and *P. aeruginosa* (ATCC 29733) both on whole pieces of dromedary and beef meat. Growth curves of local microflora, including total aerobic counts, *Enterobacteriaceae* and Lactic acid bacteria were also generated. *E. coli* O157:H7 and *P. aeruginosa* (ATCC 29733) strains were inoculated onto separated whole pieces of dromedary and beef meat an initial level of approximately 2.3 $\log_{10}$ cfu g^{-1} and 2.7 $\log_{10}$ cfu g^{-1}, respectively. The inoculated meat was stored at 10°C for 11 days. Significant growth ($p<0.05$) of *E. coli* O157:H7 and *P. aeruginosa* (ATCC 29733) was observed on both dromedary and beef samples. At the end of the storage microbial counts (*Enterobacteriaceae*, *E. coli* O157:H7 and *P. aeruginosa* ATCC 29733) on beef sample were significantly higher ($p<0.05$) than counts observed on pieces of dromedary meat stored at 10°C. By the day 11, Lactic acid bacteria and total aerobic counts displayed similar growth patterns on both meats, while they showed a slower growth rate in dromedary compared to beef meat. The initial pH values were approximately similar in both meats species. However, it was noted that the pH on beef pieces increased faster and was significantly higher ($p<0.05$) than that on camel pieces after 11 days storage at 10°C. Since the day 8, the beef meat showed a pigment decomposition, dark color and development of off-odours, whereas camel meat still in good appearance until the last day of storage. It was concluded that the difference in the microbial quality during the storage between beef and camel meat might be explained by the low pH value of camel meat and a combination of anaerobic metabolism with somewhat higher or different background flora.

Key words: Dromedary · Beef · Meat · *Escherichia coli* O157:H7 · *P. aeruginosa* ATCC 29733 · Lactic acid bacteria · pH

INTRODUCTION

Gradual increase in world population and change in lifestyles has resulted in demands for quality oriented foods of animal origin. Though, the meat from healthy animal is sterile, it may be contaminated by dirty skin, hooves, hair, intestinal contents, knives, cutting tools, infected personnel, polluted water, air, faulty slaughtering procedure, post slaughter handling and storage [1-3]. Different pathogenic and spoilage types of organisms may be introduced into the meat during slaughtering and processing, which causes rapid spoilage, great loss of valuable protein and also affects human health. Therefore, it is very important to reduce the initial microbial load to increase the shelf-life of meat.

Studies have shown that apparently healthy beef, dairy cattle and sheep harbor *E. coli* O157:H7 [4-6]. To date, the source of bacterial contamination in meat, as in other implicated foods and waters, has been linked to fecal material [4]. Ground beef and other bovine products have been implicated as the primary sources of *E. coli* O157:H7 since many Enterohemorrhagic *E. coli* O157 (EHEC O157) outbreaks have been linked to these foods [7-9].

Currently, no information are available neither on the shelf life of camel meat, nor on the growth of pathogen

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and spoilage bacteria in this foodstuff. To be competitive in marketing fresh meat products, it is important that the sensory and microbial shelf life of this kind of meat be determined. However, there is a lack of published researches characterizing the influence of final pH on microbial loads of dromedary meat.

The aim of this study was to investigate the behavior of *E. coli* O157:H7 and *P. aeruginosa* ATCC 29733 on whole pieces of both dromedary and beef meat stored at 10°C. The growth of local microflora common to raw meat (Lactic acid bacteria and *Enterobacteriaceae* and aerobic mesophilic counts) and pH were also investigated.

MATERIALS AND METHODS

Preparation of Meat: Post-rigor lean beef and dromedary muscles were obtained from traditional butchers in Temara City, 5h after slaughtering. Samples were transported to the laboratory in plastic bags within one hour. Small meat pieces weighting approximately 25 g were prepared using aseptic procedures, sterile utensils and sanitized equipment.

Strains, Culture Conditions and Inoculums Preparation: Strains of *E. coli* O157:H7 and *P. aeruginosa* (ATCC 29733) were obtained from the culture collections of the Laboratory of Medical Bacteriology, National Institute of Health, Rabat, Morocco. Inoculums were prepared from frozen (-80°C) stock cultures of *E. coli* O157:H7 and *P. aeruginosa* (ATCC 29733). The two strains were maintained by brain heart infusion (BHI, Merck, Darmstadt, Germany) broth with glycerol (20%). Frozen cultures of *E. coli* O157:H7 and *P. aeruginosa* ATCC 29733 were thawed and 0.1 ml of each culture suspension was inoculated into separate 40 ml aliquots of BHI at 37°C for 18 h to achieve viable cell populations of 9 $\log_{10}$ CFU ml^{-1}.

Inoculation and Packaging of the Dromedary and Beef Meat: An inoculum of each strain was prepared by diluting 1ml of the suspension with 1000 ml of sterile 0.1% (w/v) peptone (Merck, Darmstadt, Germany) water. Concentrations of the resulting cultures of *E. coli* O157:H7 and *P. aeruginosa* were determined as 6 – 7 $\log_{10}$ CFU ml^{-1} by serial dilutions and viable counts by surface plating respectively on Sorbitol MacConkey agar (SMCA, Merck, Darmstadt, Germany) and cetrimide fucidin cephaloridine medium (CFC, Oxoid). Half of each meat cubes were inoculated with 2 $\log_{10}$ CFU of E. coli/g of beef/camel and the remaining half with 2.77 $\log_{10}$ CFU of *P. aeruginosa*/g of beef/camel, by proceeding as follow: Using sterile forceps, meat were immersed separately for one min into sterile dishes containing the prepared suspensions of *E. coli* O157:H7 and *P. aeruginosa* at room temperature (20°C). Excess culture was allowed to drip from the cubes and they were held for one hour at 4°C to allow the bacteria to adhere to the muscle. Immediately after draining was completed, inoculated pieces of dromedary and beef meat were weighed out in 250±5 g lots and distributed into sterile polystyrene stomacher bags (Steward) and closed hermetically and stored at 10°C. Samples were tested for quantitative determination of *E. coli* O157:H7, *P. aeruginosa*, Lactic acid bacteria and total viable count. The control was used to carry out an investigation for the presence of *E. coli* O157:H7 and *P. aeruginosa* occurring naturally on dromedary and beef meat. This experimental procedure was performed on two separate occasions. The results presented are a mean of two replicates.

Bacterial Enumeration: After preparing and inoculating beef samples at day 1 and following incubation at 11 days, randomly selected bags containing meat were examined for *E. coli* O157:H7 and *P. aeruginosa*, *Enterobacteriaceae*, Lactic acid bacteria, total aerobic counts at day 1 to the Day 11. Portions of 10 g of each meat sample were homogenized with 0.1% peptone solution in the Stomacher for 1 min, in order to have decimal dilutions from 10^{-1} to 10^{-5}. Total aerobic counts were determined using Plate Count Agar (PCA; Difco Laboratories) incubated aerobically at 30°C for 2 days. *E. coli* O157:H7 was determined on Sorbitol MacConkey agar (SMCA, Merck, Darmstadt, Germany) after an incubation of 48 h at 35°C. *Enterobacteriaceae* other than *E. coli* O157:H7 were enumerated on the same medium (SMCA, Merck, Darmstadt, Germany) but only red colonies were counted using the pour plate method and incubated at 37°C for 18-24 h. Lactic acid bacteria were determined using de Man Rogosa Sharpe (MRS) agar (Merck; Darmstadt, Germany). MRS plates were incubated at 30°C for 48 h. *Pseudomonas aeruginosa* were enumerated on cetrimide fucidin cephaloridine medium (CFC, Oxoid), incubated at 30°C for 2 days.

pH Analysis of Stored Meat: The pH was measured in a slurry made of 10 g of meat blended with 100 ml of distilled water for 2 min in a Stomacher according to the procedure described by Koniecko [10], using pH/Temp meter (Model 8000, VMR Scientific product).

Statistic Analyses: The experiment was repeated two times. Populations of bacteria are a mean of the two replicates, the total aerobic counts, the *E. coli* O157:H7, the *Enterobacteriaceae* counts, the *Pseudomonas aeruginosa* counts and the *Lactobacillus* counts were transformed with logarithm to the base 10. Data were analysed using the Statistical Analysis System software program (SAS Institute, cary, NC). Microbiological and pH data were analysed by the general linear models (glm) procedure and Duncan's multiple range tests with examination for significant differences ($p<0.05$).

RESULTS

Growth of *E. Coli* O157:H7 and the Total Aerobic Counts on Dromedary Meat and Beef Meat: In the present study, *E. coli* O157:H7 was not detected in any un-inoculated dromedary or beef meat. Figure 1 and Figure 2 show the populations of *E. coli* O157: H7 and the total aerobic counts on camel and beef meat pieces stored at 10°C, respectively. A slight growth of the organism was observed on both whole pieces of beef and dromedary meat during the first 4 days storage, as the *E. coli* O157:H7 counts increased from 2 to 3.6 $\log_{10}$ CFU g^{-1} on whole pieces of dromedary meat and from 2.3 to 3.77 $\log_{10}$ CFU g^{-1} on beef product, whereas the total aerobic counts remained approximately constant in both inoculated meat in the first 3 days. After 5 days storage at this temperature, significant ($p<0.05$) difference growth of the organism was observed between the both meats, with *E. coli* O157:H7 counts reaching levels of 3.84 $\log_{10}$ CFU g^{-1} on whole pieces of dromedary meat and 4.9 $\log_{10}$ CFU g^{-1} on beef meats. By day 11, *E. coli* O157:H7 numbers reached their highest population on both meat, with a total increase of 1.77 $\log_{10}$ CFU g^{-1} on dromedary pieces and 2.3 $\log_{10}$ CFU g^{-1} on beef meat. On meat stored at 10°C, it was also noted that *E. coli* O157:H7 counts on beef pieces were significantly ($p<0.05$) higher than those observed on camel meat , indicating that the kind of the meat can influence the growth of the pathogen. Initial total aerobic counts were approximately similar on both camel (4.39 $\log_{10}$ CFU g^{-1}) and beef pieces (4.36 $\log_{10}$ CFU g^{-1}). However, the level of total aerobes in beef meat increased faster than the level of total aerobes in dromedary meat stored at the same temperature (10°C; Figure1). But, there was not a significant difference ($p > 0.05$) in the level of total aerobes between the two meats by the end of the storage period.

Growth of Local *Enterobacteriaceae* on Dromedary Meat and Beef Meat: Figure 3 shows the populations of *Enterobacteriaceae* stored at 10°C. Under the similar storage temperature and conditions a different growth pattern was observed for the *Enterobacteriaceae* in both stored samples. The initial level of *Enterobacteriaceae* on beef meat was approximately 2.69 $\log_{10}$ CFU g^{-1} and less than 1.6 $\log_{10}$ CFU g^{-1} on camel meat.

On both meat pieces, only slight growth of the *Enterobacteriaceae* was observed in the first 3 days. A faster growth rate was observed during day 3 to day 11, as the counts increased by 2.47 $\log_{10}$ CFU g^{-1} on the camel meat and by 4 $\log_{10}$ CFU g^{-1}on the beef meat. By day 11, *Enterobacteriaceae* counts at 10°C reached their highest population of 5.77 $\log_{10}$ CFU g^{-1} on camel pieces and 7.95 $\log_{10}$ CFU g^{-1} on beef pieces. A significant difference ($p<0.05$) was noted between the growth rate of *Enterobacteriaceae* on dromedary and beef whole pieces during storage.

Growth of *P. Aeruginosa* (ATCC 29733) and the Total Aerobic Counts on Dromedary Meat and Beef Meat: Figures 4 and 5 show the populations of total aerobic counts and *Pseudomonas aeruginosa* on dromedary and beef whole pieces stored at 10°C, respectively. Under the similar storage temperatures, total aerobic counts displayed similar growth patterns on both dromedary and beef, while the *P. aeruginosa* showed a slower growth rate. On both meat pieces, the population of total counts increased rapidly after the third day to achieve a count of 9.69 $\log_{10}$ CFU g^{-1}on dromedary whole pieces and a count of 9.5 $\log_{10}$ CFU g^{-1}on beef whole pieces. No significant difference was noted between the total aerobic counts of dromedary and beef meat by the end of the experiment.

The number of *Pseudomonas aeruginosa* did not differ much between dromedary and beef pieces during the first few days in aerobic storage. The initial inoculum was about 2.77 $\log_{10}$ CFU g^{-1} on whole pieces of dromedary and about 2.6 $\log_{10}$ CFU g^{-1} on beef pieces. For both red meats, only slight growth of the *P. aeruginosa* was observed in the first 3 days, with increases of approximately 0.066 $\log_{10}$ CFU g^{-1} on dromedary pieces and 0.39 $\log_{10}$ CFU g^{-1} on beef pieces. A faster growth rate was observed during day 3 to day 11 on beef whole pieces, as the counts increased by 0.95 $\log_{10}$ CFU g^{-1}. For dromedary pieces stored at the same conditions by day 11, *P. aeruginosa* counts at 10°C reached their highest population of 3 $\log_{10}$ CFU g^{-1} with increases of approximately by 0.22 $\log_{10}$ CFU g^{-1} from

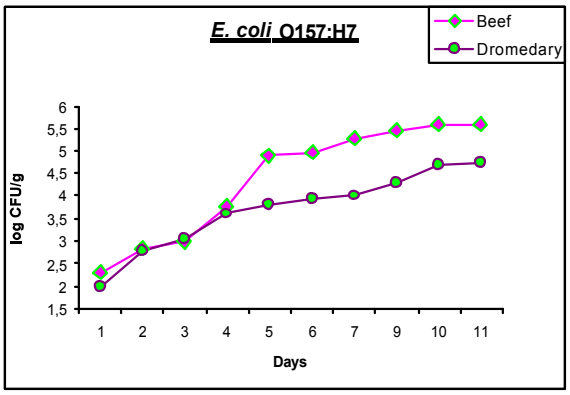

Fig. 1: Changes of *E. coli* O157:H7 counts on whole pieces of dromedary and beef meat after inoculation at low initial level (2.3 log CFU g^{-1}) with *Escherichia coli* O157:H7, during storage at 10°C for 11 days.

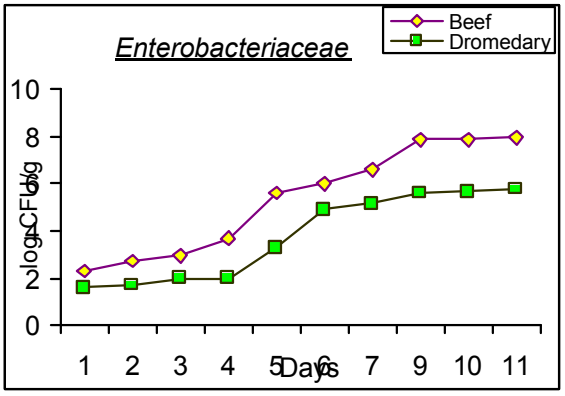

Fig. 3: *Enterobacteriaceae* counts on whole pieces of dromedary and beef meat inoculated with *E. coli* O157: H7, during storage at 10 °C for 11 days.

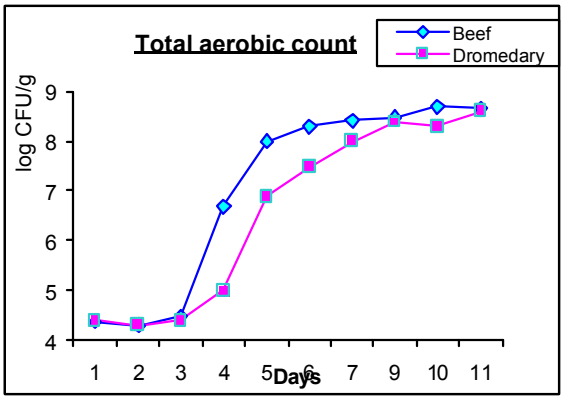

Fig. 2: Changes of total aerobic counts on whole pieces of dromedary and beef meat inoculated with *E. coli* O157: H7, during storage at 10 °C for 11 days

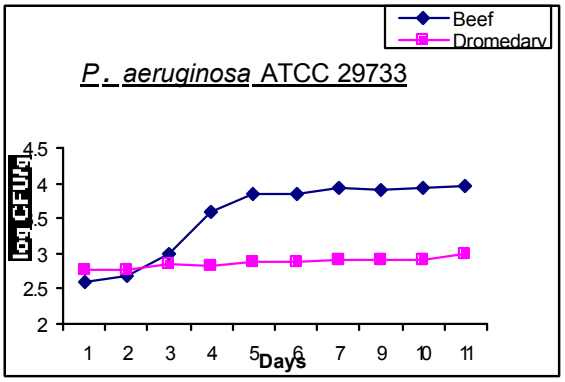

Fig. 4: Changes of *P. aeruginosa* counts on whole pieces of dromedary and beef meat after inoculation at low initial level (2.7 log CFU g^{-}) with *P. aeruginosa* ATCC 29733, during storage at 10°C for 11 days

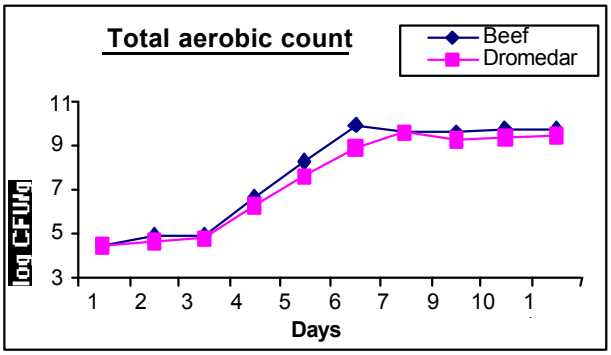

Fig. 5: Changes of total aerobic counts on whole pieces of dromedary and beef meat inoculated with *P. aeruginosa* ATCC 29733, during storage at 10°C for 11 days

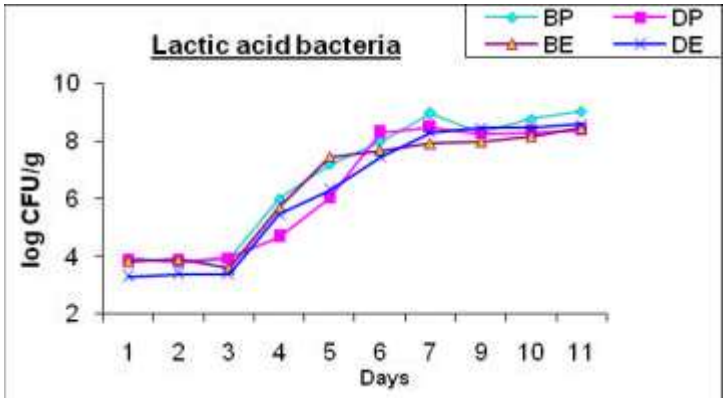

Fig. 6: Changes in numbers of presumptive lactic acid bacteria recovered on MRS agar from dromedary and beef whole pieces stored at 10°C for 11 days, in both *E. coli* O157:H7 and *P. aeruginosa* ATCC 29733 inoculated essays.
BE: Whole beef inoculated with *E. coli* O157:H7; DE: Whole dromedary pieces inoculated with *E. coli* O157:H7; BP: Whole beef pieces inoculated with *P. aeruginosa* ATCC 29733; DP: Whole dromedary pieces inoculated with *P. aeruginosa* ATCC 29733.

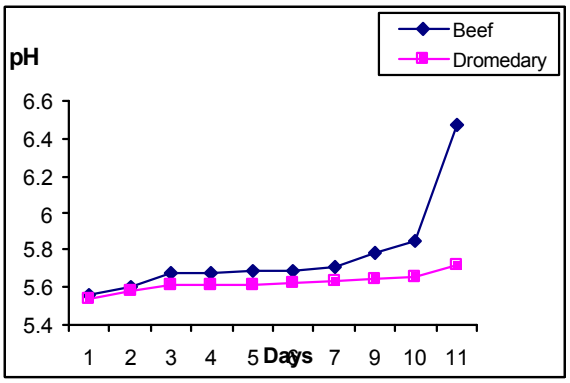

Fig. 7: Changes of pH values on whole pieces of dromedary and beef meat inoculated with *E. coli* O157: H7, during storage at 10 °C for 11 days.

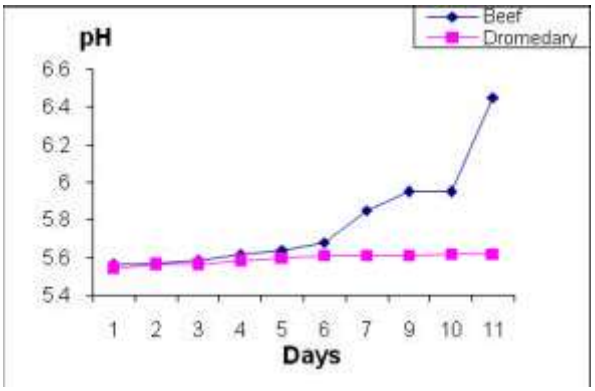

Fig. 8: Changes of pH values on whole pieces of dromedary and beef meat, inoculated with *P. aeruginosa* ATCC 29733, during storage at 10 °C for 11 days.

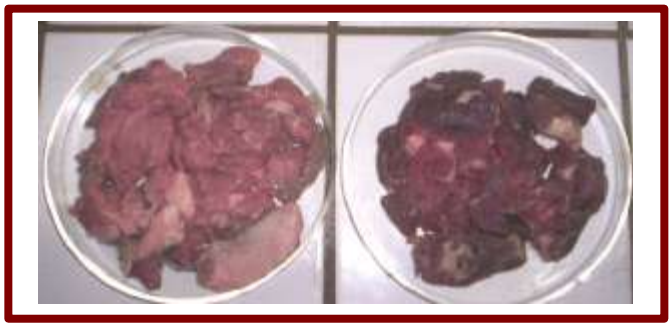

Fig. 9: Photograph representing the difference in appearance dromedary pieces (at left) and the beef pieces (at right) at the 11 day of the storage at 10°C.

the first day to day 11. The growth of these organisms at 10°C was significantly lower ($p<0.05$) on camel meat than on beef meat stored.

Changes of Lactic Acid Bacteria Count on Dromedary and Beef Meat: Figure 6 shows changes in numbers of presumptive lactic acid bacteria recovered on MRS agar from dromedary and beef whole pieces stored at 10°C for 11 days, in both *E. coli* O157:H7 and *P. aeruginosa* ATCC 29733 inoculated essays.

The initial Lactic acid bacteria numbers were approximately the same on dromedary and beef whole pieces. From the day 1 to the day 11 lactic acid bacteria counts increased significantly ($p<0.05$) in the four essays. However, lactic acid bacteria numbers were significantly lower ($p<0.05$) in *E. coli* O157:H7 inoculated dromedary pieces (6.3 $\log_{10}$ CFU g^{-1}) than *E. coli* O157:H7 inoculated beef pieces (7.47 $\log_{10}$ CFU g^{-1}) on the day 5. Thus the numbers Lactic acid bacteria were significantly lower ($p<0.05$) in *P. aeruginosa* inoculated dromedary pieces (4.69 $\log_{10}$ CFU g^{-1}) than the same experiment on beef pieces on day 4.

Changes of pH on Dromedary and Beef Meat: The initial pH values of dromedary meat ranged around 5.54 and around 5.56 for beef meat (Figures 7,8). Within the first 6 days storage, only slight changes were observed, as the pH value increased approximately by 0.07 to 0.12 units for the four inoculated essays. After 7 days, the pH value on meat from the two species increased rapidly. By day 11, the final sampling day, the pH had increased to final values ranged from 5.72-5.62 on dromedary pieces and from 6.45-6.47 on beef pieces. On both inoculated essays (*E. coli* O157:H7 and *P. aeruginosa* ATCC 29733), no significant difference ($p>0.05$) was observed between samples from the same species in the same sampling day except on day 9 and day 10 for beef pieces. However, it was noted that the pH on beef meat increased faster and was significantly higher ($p<0.05$) than that on camel pieces after 11 days storage.

DISCUSSION

Bacterial spoilage of meat is caused by those organisms with the greatest ability to proliferate when exposed to a given set of substrate and storage conditions. Properly processed fresh meat should have a low pH and minimal numbers of contaminating bacteria. Stored dromedary and beef whole pieces, of the same initial bacterial loads, showed differences in rates of spoilage, bacterial growth and pH. This indicates that factors other than the initial bacterial loading are of importance in determining the shelf life of vacuum-packed meat.

In this work growth of both *E. coli* O157:H7 and *P. aeruginosa* ATCC 29733 was highest in the meat with the highest pH (beef whole pieces), suggesting that pH has a significant effect on these organisms. This is in agreement with several workers who have reported that bacteria grew better in meat of high pH than on low pH meat [11, 12]. The same authors reported that the initial pH correlated with the rate of spoilage (the time to obtain a degree of spoilage of 1.5) and the bacterial growth rate (the time to obtain maximum numbers of bacteria).

The difference in the microbial quality during the storage between beef and camel meat might be explained by the low pH value of camel meat in comparison of those of other red meats. The variation obtained in this study on beef and camel, respectively, could probably be explained by differences in factors such as the meat pH and the initial loading of bacterial contamination. Traditionally, pH has been considered as a fundamental parameter in the microbiological quality of the meat [11-13]. However, there is a lack of published researches characterizing the influence of final pH on microbial loads of camel meat. It has been reported by Elidrissi [14] that camel meat presented the lowest pH value comparatively to other red meats and poultry meats. Dromedary meat pH varied between a maximal value of 6.10 and the minimal value of 5.37, with an average value of 5.63. In the same study no significant difference was noted between dromedary and beef pH. The variance analysis on the effect of age and sex on camel meat pH showed that there is no significant difference between the old and young animals and mal and female. Nevertheless young camel meat pH was lightly higher than the adult one. These results are approximately similar to those reported by Elgasim and Elhag [15] who reported the pH value of dromedary meat is around 5.6.

The initial pH value of beef samples in the present work ranged around 5.65, similar to that of beef reported in other studies [16-18]. Within the first 6 days storage, only a slight increase in the pH value was observed, likely as a result of the production of organic acids by bacterial flora [18]. Then the pH increased rapidly, presumably as a result of the production amines during storage [18]. It was interesting to note that after 11 days storage, the pH increased faster on beef meat than on dromedary

whole pieces, with a difference of approximately 0.75 to 0.83 units. Also, Logue et *al.* [16] documented similar observations on beef and pork, with the pH increase occurring faster on pork product and with a pH difference of approximately 1 unit noted between pork and the beef product over the storage study.

In fact previous studies explained the shorter shelf life of pork comparatively to beef. A higher incidence of high pH values for pork than beef has been stated as a plausible explanation for the observed differences in the shelf life [19]. In fact, it is well-known that high-pH meat spoils more rapidly than meat of a normal pH due to selection for bacteria such as *Enterobacteriaceae*, *B. thermosphacta* and *Shewanella putrefaciens* and due to a low concentration of glucose [20-22]. Also, it was noted that the pH of beef muscle was lower than that of lamb and consequently less conducive to growth of spoilage organisms. As a result beef have a longer shelf-life. Besides pH and L-lactate, fat content was identified as an important factor regarding spoilage and bacterial growth. The growth rate of lactic acid bacteria, the dominant bacteria on the vacuum packaged meat, was somewhat higher on meat of a high fat content than on meat of low fat content [11]. The shelf lives of vacuum-packaged pork and beef have been compared and the significance of intrinsic factors has been demonstrated [23]. It was suggested that the rapider depletion of glycogen and glucose in pork compared with beef, was of importance in dictating the shorter shelf life of pork.

A significant positive correlation was found between pH and most microbial counts, including Lactic acid bacteria, *Enterobacteriaceae*, *E. coli* O157:H7, *0P. aeruginosa* ($p<0.05$). This positive correlation could indicate that high pH values favorably influences microbial growth. Blixt and Borch [11] observed in pork and beef vacuum-packed meat that LAB showed a growth pattern related to initial pH. These finding were not coincide with those of Silla and Simonsen [24], who did not observe any correlation between pH and lactobacilli levels in sliced vacuum-packed meat products.

In the current work, counts on MRS constituted the majority of the background microflora in both red meats during storage. Studies on refrigerated vacuum-packed meat products carried out by other authors have demonstrated a similar dominance of this microbial group [11, 25, 26]. According to Gram *et al*. [27] mainly lactic acid bacteria and also *Enterobacteriaceae*, *Brochothrix thermosphacta* and *Shewanella putrefaciens*, which are capable of growing on anaerobic atmospheres, are responsible for spoilage in vacuum-packed meat and meat products. Sour and acid odour observed in these products upon spoilage has been reported to be caused by lactic acid bacteria [25]. Some LAB strains that produce butyric acid, a compound which imparts rancid/buttery flavours and odours [28], are likely to produce earlier meat spoilage than strains that do not produce butyric acid. Similarly, the generation of ethanol, sulphides and non-butyric short-chain organic acids, such as lactate and acetate, while sometimes inhibitory to other organisms, can impart their own spoilage characteristics when present in significant concentrations [29, 30].

Microbial spoilage of food occurs when total aerobic counts and/or *Enterobacteriaceae* counts reach 7 $\log_{10}$ CFU g^{-1} (ICMSF, 1984) and when lactic acid bacteria reach 7 $\log_{10}$ CFU cm^{-2} [26-31]. Korkeala et *al.* [25], also indicated that 7 $\log_{10}$ lactobacilli/g is the limit for perception of off-odours in vacuum-packed beef. In the present study beef pieces containing lactic acid bacteria and *Enterobacteriaceae* at levels higher than 7 $\log_{10}$ CFU g^{-1} (day 8) showed a repulsive off-odours when opening the bag. This observation coincides with findings of Insausti et *al.* [32] who indicated that the higher *Enterobacteriaceae* counts in meat show high correlation with sensory evaluation for unacceptable odour. A dark color and green pigments on the surface of beef pieces were also observed (Figure 9). According to Guignot *et al.* [33] and Holmer *et al*. [12], meat colour is also influenced by pH. However, in the present study none of the dromedary samples with >7 $\log_{10}$ CFU g^{-1} had any off-odours or color changes, even when higher than 8 $\log_{10}$ total aerobic count g^{-1} were detected (Figure 9).

The consequences of growth of *E. coli* O157:H7 on meat are particularly serious. In this study we used a storage temperature of 10°C as a "worst case" of inadequate refrigeration. Several studies predict the growth of pathogens based on several conditions, including temperature, pH and additives, such as salt and sodium nitrite [18, 34]. However, results obtained from experiments conducted in foods showed that growth of *E. coli* O157:H7 can also be influenced by many other factors. The significantly difference between the bacterial growth rate on beef and dromedary pieces may be due to a combination of anaerobic metabolism with somewhat higher or different background flora. Microbial variations between the two meat pieces could have been caused by remnants of lactic acid on the meat. Many studies have demonstrated that background flora can inhibit the

growth of *E. coli* O157:H7 in food. Vold *et al.* [35], reported that the presence of high levels of background microflora inhibited the growth of *E. coli* O157:H7 in beef stored at 12°C. They also indicated that various background microflora have different inhibitory abilities. It has been shown that organic acids may influence the growth of *E. coli* O157:H7 [36]. In addition, the nature of the surface of the meat can play a role in the attachment of the bacteria [37]. The moisture content of the meat may also be important [38].

In conclusion, the kind of meat showed an influence on the growth of *E. coli* O157:H7, *Enterobacteriaceae, P. aeruginosa* ATCC 29733 as these organisms grew faster on beef meat pieces than on camel meat. But, to be able to assign a proper shelf life to packed dromedary, to keep its good microbial quality and to well understand its extending shelf life, other parameter (pH, glycogene, lactate..) should also be considered.

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