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# Microbiological Quality of Goat Carcasses at Different Stages of Slaughter in Dallam Island Abattoir

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**A B S T R A C T**

A study was carried out to evaluate the microbial quality of goat carcasses at Dallma island slaughterhouse in Alzafraa District, UAE, during June 2017. A total of 284 swab samples were collected from 40 carcasses for identification of the isolates and bacterial total viable counts (TVCs). Cotton swab samples were also collected from knives and hands of workers used in the slaughter process. The study found that predominant bacterial isolates at Dallma were *E.coli* and *Staphylococcus aureus* and these were revealed very low values before and after treatment of operational points also at worker's hands and their knives were low, but *Salmonella* spp. was not detected. The mean total viable count (TVCs) post skinning, post evisceration and post washing at neck site was 2.26 ± 0.81, 2.48± 0.81 and 2.74± 0.66 log CFU/cm$^2$ before the treatment, whereas after treatment was 1.60 ± 0.60, 1.65 ± 0.58 and 1.33 ± 0.58 log CFU/cm$^2$ with statistically significant difference (P<0.05). In brisket site, TVCs before treatment of the carcasses were 2.24 ± 0.64, 2.62± 0.57 and 3.01±0.52 $\log_{10}$ CFU/cm$^2$ but after the treatment of the samples were 1.67 ± 0.94, 1.87 ± 0.74 and 1.68 ±0.81 CFU/cm$^2$, with statistically significant difference *(*P<0.05).TVCs of the samples from the rump site samples before treatment at operational points, revealed mean 2.54± 0.49, 2.56±0.84 and 2.37±0.63 $\log_{10}$ CFU/cm$^2$ and after treatment were, 1.73 ± 0.81, 1.87 ±0.74 and 1.55±0.62 $\log_{10}$ CFU/cm$^2$ respectively (P<0.05). In shoulder site, TVC in the three points of operation before treatment were 1.37±0.62, 2.75±0.84 and 2.73±0.66 $\log_{10}$CFU/cm$^2$, whereas after treatment 1.40 ± 0.73, 1.73 ±0.45 and 1.61 ±0.69 $\log_{10}$CFU/cm$^2$ with statistically significant. TVC in knives after skinning and evisceration before treatment samples were 3.23±0.66 and 3.00±0.48 log CFU/cm$^2$ while after treatment were 1.18 ± 0.28 and 1.30±0.47 logCFU/cm$^2$. Also the TVC, of the hands of the workers post skinning, post evisceration and post washing were 3.15±0.37, 3.43±0.34 and 3.15±0.30 $\log_{10}$ CFU/cm before treatment samples, but in treated samples were 2.54 ± 0.41, 1.64 ±0.44 and 2.68 ±0.79 $\log_{10}$ CFU/cm$^2$ respectively. The decontamination processes are important to eliminate the sources of contamination and that by application of food safety methods such as HACCP and an appropriate training for personnel.

## Introduction

Gulf States are a major small ruminant's importer of meat. It represents the world's largest import market for live sheep and goats to meet the strong consumer demand, as sheep and goat meat forms an important component of the Arab diet (Cernicchiaro, 2013). Goat meat, and especially kid meat, is increasingly being consumed for its characteristic taste,

desired chemical composition and nutritional properties. Like all other types of meat, goat meat can also be a source of pathogenic bacteria. Bacteria can reach the surface of the carcasses during slaughtering of healthy goats and carcass processing. The operations of skinning and evisceration are highly risky for carcass contamination by microorganisms (Ivanovic *et al.,* 2011; Ivanovic *et al.,* 2014). Meat, a rich source of the protein and fat, low in carbohydrate content and with sufficient water activity, supports the growth of both spoilage and pathogenic bacteria. Growth of yeasts and molds is essentially slow on fresh meat as compared with bacteria; therefore, they are not major component of spoilage flora (Doyle, 2007). The food and Agricultural organization (FAO) of the United Nations and the World Health Organization (WHO) stated that illness due to contaminated food is perhaps the most widespread health problem and an important cause of reduced economic productivity (Käferstein, 2003). Raw meat may harbor many important pathogenic microbes i.e. *Salmonella spp*., *Campylobacter jejuni/coli*, *Yersinia enterocolitica*, *E. coli*, *S. aureus* and, to some extent, *Listeria* spp., making the meat as risk for human health, without the proper handling and control of these pathogens, food borne ill-nesses may occur (Nørrung *et al.*, 2009). Meat, an excellent source of protein in human diet is highly susceptible to microbial contaminations, which can cause its spoilage and food borne infections in human, resulting in economic and health losses (Komba *et al.,* 2012). Although muscles of healthy animals do not contain microorganisms, meat tissues get contamination during the various stages of slaughter and transportation (Ercolini *et al.,* 2006). A great diversity of microbes inhabit fresh meat generally, but different types may become dominant depending on pH, composition, textures, storage temperature, and transportation means raw meat (Ercolini *et al.,* 2006; Li *et al.,* 2006; Adu- Gyamfi *et al.,* 2012). Microbial contamination of animal carcasses during slaughtering is an unavoidable problem in the conversion of live animals to meat for consumption (Dickson and Anderson, 1991). The contamination of meat by microbial pathogens can occur at any stage of the meat chain (Duffy *et al.*, 2006; Rhoades *et al*, 2009). Furthermore, the prevention or mastery of meat contaminations can be carried out at a stage of the chain different from the stages at which the contamination has occurred (Chen *et al.,* 2012). Carcass dressing and evisceration processes constitute critical points in the microbial contamination of muscle for which corrective measures need to be implemented (Bacon *et al.,* 2000; Abdalla *et al.,* 2009a; Abdalla *et al.,* 2009b). Cattle slaughter operations, such as bleeding, dressing, and evisceration, may expose sterile muscle to microbiological contaminants that are present on the skin, the digestive tract, and in the environment (Gill and Jones, 1999; Bacon *et at.,* 2000; Abdalla *et al.,* 2009a; Abdalla *et at.,* 2009b). It has been demonstrated that the workers and their slaughter instruments could spread contamination into the internal organs of beef cattle. Dickson and Anderson (1992) isolated *Salmonella* spp. and *Escherichia coli* from the hands of workers. The presence of bacteria of potential public health significance was explained by Dolye (2007) and Biss and Hathaway (1995) during slaughtering operations. There were significance increases in total bacterial counts at skinning points than that at washing operations and also dirty worker's' hands, clothes and equipments of the slaughterhouse acted as intermediate sources of contamination of meat (Gill,1998; Gilmour *et aI.,* 2004; Abdelsadig, 2006; Abdalla *et al.,* 2009a; Abdalla *et al.,* 2009b). Ali (2007) recorded high contamination level on rump sites during skinning. Cattle and their environment were represented important sources of pathogenic *E. coli* (Hancock *et al.,* 1998; Elder *et al.,* 2000).The aim of this study

was to determine the microbiological contamination of goat carcasses processed on a slaughter line in a slaughterhouse, by determining the TVC, number and the presence of *Enterobacteriaceae* and then categorizing the bacterial levels.

## Materials and Methods

### Sample collection

A total number of 284 swabs from 40 goat carcasses were collected from the neck, rump, shoulder and brisket during operational points; skinning, evisceration and washing at Dallma island slaughterhouse in Alzafraa District, UAE. Muscle carcass sites were sampled by swab technique (Bell, 1997).

An area of 100 $cm^2$ marked with a sterile frame of 10 cm × 10 cm on each site of the carcass was rubbed for 30 seconds and swabs were transferred to a screw-capped test tube containing 10 ml of sterile maintenance medium (0.85% NaCl and 0.1% peptone). Also 60 samples from worker hands and 60 samples from their knives. These samples were taken at different operation points of slaughtering process. The tubes were transported to microbiology laboratory at 4$^oC$ for further analysis within 4 hours.

### Aerobic plate count (APC)

Aerobic plate count was carried out on total plate count agar as described by Bell (1997). The medium was autoclaved and maintained at 46ºC. Samples were serially diluted and an aliquot of 1 ml of each of serial dilution was transferred to the petri dishes (4 inch diameter) and molten agar (15-20 ml) was poured on it. Plates were gently swirled to uniformly mix the sample and incubated at 37ºC for 48 hours. After incubation APC was determined from appropriate plates.

### Enumeration of *Escherichia coli*

*Escherichia coli* were enumerated on Eosin methylene blue agar (Oxoid, 2006) by plating an appropriate dilution on plates followed by aerobic incubation at 37°C for 24hrs. After incubation *E. coli* were counted as colonies with distinct metallic sheen (Bhandare *et al.*, 2007).

### Isolation and identification of *Staphylococcus aureus*

The bacteriological culture was performed following the standard microbiological technique (Quinn *et al.*, 2002). Swab samples were streaked on blood agar media using cotton applicator and the plates were incubated aerobically at 37°C and examined after 24–48 h of incubation. The colonies were identified based on morphological characteristics, hemolytic pattern and Gram's staining reaction. The representative colonies which were positive for Gram's staining and typical grapes like structure under microscope were further sub-cultured on nutrient agar plates (Oxoid, 2006) and incubated at 37 °C for 24 hours. Pure colonies were preserved and maintained on nutrient slants for further characterization of the isolates. Eventually, identification of the agent was done based on biochemical tests and these were catalase, coagulase, mannitol salt agar and purple agar base tests. Samples were considered positive for *Staph. aureus* when the isolates were catalase and coagulase positive and showed fermentation of mannitol and maltose (Strong yellow discoloration of both media).

### *Salmonella* detection

Samples were subjected to *Salmonella* detection according to ISO 6975 (ISO, 2002), with some modifications. Under sterile conditions, each sample set was treated with 160 mL of BPS (Oxoid, 2006) and

homogenised at 4 °C and 260 rpm (Stomacher 400 circulator, Seward, Worthing, England). Then, 40 mL of the obtained homogenates were centrifuged at 1000× *g* for 15 min, the supernatant was discarded, and the obtained pellet was re-suspended in 10 mL of buffered peptone water at 1% (w/v); this was followed by incubation at 37 °C for 18 h. Then, the obtained cultures were transferred to Muller-Kauffmann tetrathionate/ novobiocin broth and Rappaport-Vassiliadis medium with soya, which were incubated at 37 °C - for 42 °C 24 hours, respectively. The obtained cultures were streaked onto plates containing xylose lysine deoxycholate agar and mannitol lysine crystal violet brilliant green agar and incubated at 37 °C for 24 hours. *Salmonella* suspect colonies were transferred to triple sugar iron agar and lysine iron agar slants and incubated at 37 °C for 24 hours (Oxoid, 2006).

## Statistical analysis

All bacterial counts were converted to $\log_{10}$ (cfu/cm$^{-2}$) for analysis. ANOVA was performed. Statistical significance was set at P- value of ≤0.5.

## Results and Discussion

The mean total viable count (TVCs) post skinning, post evisceration and post washing at neck site was 2.26 ± 0.81, 2.48± 0.81 and 2.74± 0.66 log CFU/cm$^2$ before the treatment, whereas after treatment was 1.60 ± 0.60, 1.65 ± 0.58 and 1.33 ± 0.58 log CFU/cm$^2$ with statistically significant difference (P<0.05). In brisket site, TVCs before treatment of the carcasses were 2.24 ± 0.64, 2.62± 0.57 and 3.01±0.52 $\log_{10}$ CFU/cm$^2$ but after the treatment of the samples were 1.67 ± 0.94, 1.87 ± 0.74 and 1.68 ±0.81 CFU/cm$^2$, with statistically significant difference *(*P<0.05). TVCs of the samples from the rump site samples before treatment at operational points, revealed mean 2.54± 0.49, 2.56±0.84 and 2.37±0.63 $\log_{10}$ CFU/cm$^2$ and after treatment were, 1.73 ± 0.81, 1.87 ±0.74 and 1.55±0.62 $\log_{10}$ CFU/cm$^2$ respectively (P<0.05). In shoulder site, TVC in the three points of operation before treatment were 1.37±0.62, 2.75±0.84 and 2.73±0.66 $\log_{10}$ CFU/cm$^2$, whereas after treatment 1.40 ± 0.73, 1.73 ±0.45 and 1.61 ±0.69 $\log_{10}$CFU/cm$^2$ with statistically significant difference (Table 1).

TVC in knives after skinning and evisceration before treatment samples were 3.23±0.66 and 3.00±0.48 $\log_{10}$ CFU/cm$^2$ while after treatment were 1.18 ± 0.28 and 1.30±0.47 $\log_{10}$ CFU/cm$^2$ (Table 2). Also the TVC, of the hands of the workers post skinning, post evisceration and post washing were 3.15±0.37, 3.43±0.34 and 3.15±0.30 $\log_{10}$ CFU/cm before treatment samples, but in treated samples were 2.54 ± 0.41, 1.64 ±0.44 and 2.68 ±0.79 $\log_{10}$ CFU/cm$^2$ respectively (Table 2).

Isolation and identification of bacteria at different operational points under investigation showed that *Salmonella* spp. was not detected, but *E. coli* was detected in very (low < 3 CFU/swab) and *Staphylococcus aureus* (<10 CFU/swab) revealed very low values before and after treatment of operational points also at worker's hands and their knives were low.

The acceptable international standards for swab values which are <2.8 log CFU/cm$^2$ for TVC, and the unacceptable values are >4.3 log CFU/cm$^2$, respectively were set and agreed to be a criterion for assessing and evaluating the microbial contamination of carcasses and a useful mean to know the hygienic and safety states of meat. According to the Decision 2001/471/EC of the EU Commission, the acceptable value of TVC was set at 2.8 log10 cfu/cm$^2$ (EU, 2001). The present results recorded that the bacterial counts (Table 1) were high in the four sites (neck, shoulder, brisket and rump) before treatment at

skinning, evisceration and washing. These findings in agreement with the findings of Gill and Barker (1998) and Abdalla *et al.,* (2009a) who reported that meat contaminated by bacteria during skinning operation. The contamination of meat at different parts showed significant statistical difference in the microbial count (Mboto *et al.,* 2012). The reduction of TVC after treatment in this study may be attributed to proper wearing and cleaning of the body before and after skinning resulting in the decreased level of contaminating bacteria (Aftab *et al.,* 2012).

Also evisceration process has an important role in contamination of the muscles, because the feces are riched with coliform bacteria (Collobert *et al.,* 2002; El-Hadef *et al.,* 2005; Bhandare *et al.,* 2007). Washing of the body reduced the level of organisms with complete wearing of protective clothes as shown in our study, whereas in another study of Ali (2007) and Abdalla *et al.,* (2009b) recorded that post washing might increase the level.

In this study the bacterial count from workers' hands after treatment showed significant reduction (Table 2) compared with control and the washing of knives by warm water (82 °C) decreased the level of viable bacteria. These results are similar to the results of Abdalla *et al.,* (2010). The presence of bacteria in meat in the slaughterhouse indicated that unhygienic handling of meat. The decontamination processes are important to eliminate the sources of contamination and that by practicing an appropriate training for personnel, application of good hygienic methods.

The contamination of *E. coli* occurs in meat through soiling of the carcass and plant environment with faecal materials during slaughter process. This contamination is mainly evident where slaughter procedures are not hygienic. The results in the current agree with Jeffery *et al.,* (2013) in bovine carcasses in Sudan whereby *E. coli* represented the highest average prevalence. Sudan and Malawi are tropical countries, with ambient temperatures conducive for the growth of microorganisms resulting in rendering meat unsafe for human consumption. They can be found in the air, dust, water and human faeces, and can be present on clothing and utensils handled by human.

*Staphylococci* are a normal part of the microflora of the nose throat and skin and only *S. aureus* is considered to be pathogenic (Clarence *et al.,* 2009) and the nasal passage is the most significant site. For instance Abdalla *et al.,* (2009) found $3.74 \pm 0.02$ log10 CFU/cm$^2$ on hands of workers in Sudan before skinning in sheep which is lower than $3.01 \pm 0.52$ $\log_{10}$ CFU/cm$^2$ at brisket before treatment at washing point. In their study, they also found lower TVC of $3.40 \pm 0.02$ $\log_{10}$ CFU/cm$^2$ on knives against $6.38 \pm 0.38$ $\log_{10}$ CFU/cm$^2$ in this study. Another study by Jeffery *et al.,* (2013) revealed that the workers' hands and the equipment were the sources of meat contamination and these results are in accordance with the present results.

However, the TVC for knives before treatment is much lower than what was reported by Adetunji and Odetokun (2011) who found 14.01 $\log_{10}$ CFU/cm$^2$ in tropical goat abattoir in Nigeria. In this study the findings obtained suggest that the hygienic procedures conducted during slaughtering process were enough to avoid the contamination by *Salmonella* spp. in the processing environment.

**Table.1** Mean±Sd of Total viable counts (Iog10cfu $cm^2$) on sites of the carcasses in goats(n=284) in Dellma Island slaughterhouse, at Abudaibi, UAE

| Site | Operational points | | | | | | Sig. |
|---|---|---|---|---|---|---|---|
| | Before treatment | | | After treatment | | | |
| | Skinning | Evisceration | Washing | Skinning | Evisceration | Washing | |
| **Neck** | 2.26±0.81 | 2.48±0.81 | 2.74±0.66 | 1.63±0.60 | 1.65±0.58 | 1.33±0.58 | * |
| **Brisket** | 2.24±0.64 | 2.62±0.57 | 3.01±0.52 | 1.67±0.94 | 1.87±0.74 | 1.68±0.81 | * |
| **Rump** | 2.54±0.49 | 2.56±0.84 | 2.37±0.63 | 1.73±0.81 | 1.87±0.74 | 1.55±0.62 | * |
| **Shoulder** | 1.37±0.62 | 2.75±0.84 | 2.73±0.66 | 1.40±0.73 | 1.73±0.45 | 1.61±0.69 | * |

*= (Sig.) significant at level (P<0.05)

**Table.2** Mean±Sd of Total viable counts of bacteria (Log10cfu/ $cm^2$) at hands of the workers and knives before treatment and after treatment on different sites of the goats (n=284) carcasses in Dellma Island slaughterhouse at Abudaibi, UAE

| Site | Operational points | | | | | |
|---|---|---|---|---|---|---|
| | Before | | | After | | |
| | Skinning | Evisceration | Washing | Skinning | Evisceration | Washing |
| **Hands** | 3.15±0.37* | 3.43±0.34* | 3.15±0.37 * | 2.54±0.41* | 1.64±0.44* | 2.68±0.79* |
| **Knives** | 3.23±0.66* | 3.00±0.48* | ND | 1.18±0.28* | 1.30±0.47* | ND |

*= significant at level (P<0.05), ND= not detected

The low occurrence of *Salmonella* spp. in bovine carcasses during slaughtering has already been observed in similar studies conducted in other countries (Li *et al.*, 2004; Rhoades *et al.*, 2009). Also, the contamination of bovine carcasses after the end of the slaughtering process (after the end washing) could be a relevant source of the initial contamination of *Salmonella* spp. in the beef processing environment of slaughterhouses (Ruby *et al.*, 2007). In conclusion, this study showed that the level of contamination on goat carcasses was higher than the acceptable value set by the EU. However, to attain the international requirements and acceptable value set by the EU (2001) Commission, involving good sanitary measures during slaughtering processes that will lead to the reduction of the amount of the microorganisms and other hazards should be stressed on. Hazard Analysis Critical Control Point (HACCP) should be applied properly during slaughtering operations. To make all these, extensive education and training programs on hygiene for workers should immediately be started.

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