Full Length Research Paper

Estimation of bacterial contamination of indigenous bovine carcasses in Khartoum (Sudan)

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The study was conducted to evaluate the bacteriological contamination in indigenous cattle in slaughterhouse, Khartoum State, during April 2008 - June 2008. A total of 384 swab samples were collected from 32 carcasses for identification of the isolates and bacterial total viable counts (TVCs). The mean total viable count of bacteria after skinning, evisceration and washing operations at shoulder site were, 3.03 ± 0.15, 2.73 ± 0.02 and 2.79 ± 0.10 $\log_{10}$ CFU/cm^2, in the neck site were 3.65 ± 0.02, 3.42 ± 0.02 and 3.72 ± 0.02 $\log_{10}$ CFU/cm^2 and in brisket site were 3.1 ± 0.14, 3.71 ± 0.04 and 3.65 ± 0.02, respectively with statistically significant difference (P < 0.05). In addition, in the rump site, the TVCs in these operations were 3.24 ± 0.02, 2.88 ± 0.02, and 3.18 ± 0.03 $\log_{10}$ CFU/cm^2 in three points of operation with statistically significant difference (P < 0.05). Also, there were statistically significant difference (P < 0.05) in TVCs between knives and worker hands during the three operations. Twelve species of bacteria were isolated and the highest average prevalence was *Staphylococcus arueus* 10.54%, *Klebsella* spp. 10.12% and *Escherichia coli* 8.86%.

Key words: Bovine carcass, bacterial contamination, slaughterhouse.

INTRODUCTION

Meat is considered an important source of proteins, essential amino acids, B complex vitamins and minerals. Due to this rich composition, it offers a highly favorable environment for the growth of pathogenic bacteria. The microbiological contamination of carcasses occurs mainly during processing and manipulation, such as skinning, evisceration, storage and distribution at slaughterhouses and retail establishments (Gill, 1998; Abdalla et al., 2009). Fecal matter was a major source of contamination and could reached carcasses through direct deposition, as well as by indirect contact through contaminated and clean carcasses, equipment, workers, installations and air (Borch and Arinder, 2002). Cattle slaughter operations, such as bleeding, dressing and evisceration, expose sterile muscle to microbiological contaminants that were present on the skin, the digestive tract and in the environment (Gill and Jones, 1999; Bacon et al., 2000). Although, most microbial contaminants of car-

casses represent commensal bacteria, some micro-organisms such as *Salmonella* spp., *Escherichia coli* O157::H7, and *Listeria monocytogenes* pose a threat to consumer health (Gustavsson and Borch, 1993; Samelis et al., 2001). Assessment of the hygienic risk in a beef slaughtering process should involve enumeration of organism indicative of fecal contamination, such as *E. coli*, at specific points in the process. The contamination and/or cross-contamination of carcasses, during slaughtering operations were demonstrated and the results indicated presence of bacteria of potential public health significance (Biss and Hathaway, 1995; Doyle, 1991). There were significant increases in total bacterial counts at skinning points than that at washing operations; also, dirty workers hands, clothes and equipments of the slaughterhouse acted as intermediate sources of contamination of meat (Gill, 1998; Gilmour et al., 2004; AbdelSadig, 2006; Abdalla et al., 2009).

Ali (2007), recorded high contamination level on flank site and lower contamination level on rump sites during skinning.

Cattle and their environment were represented as an important source of pathogenic *E. coli* and contamination

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Table 1. Total viable counts ($\log_{10}$ cfu cm-2) at different sites on carcasses at different operational points.

Sites	operational points			Significance
	Post skinning	Post evisceration	Post washing	
brisket	3.31 ± 0.14	3.71 ± 0.04	3.65 ± 0.02	*
shoulder	3.03 ± 0.15	2.73 ± 0.02	2.79 ± 0.10	*
neck	3.65 ± 0.02	3.42 ± 0.02	3.72 ± 0.02	*
rump	3.24 ± 0.02	2.88 ± 0.02	3.18 ± 0.03	*
Knives	3.40 ± 0.02	3..25 ± 0.03	-	NS
Hands of the workers	3.74 ± 0.02	3.42 ± 0.02	3.71 ± 0.02	*

Not detected'; *, Significant at level ($P < 0.05$); NS, Not Significant.

of meat and meat products which are then transmitted to human (Elder et al., 2000; Hancock et al., 1998; Rice et al., 1996).

This work was carried to identify the main points of contamination of bovine carcasses during slaughtering operations and to evaluate microbial contamination in bovine raw meat.

MATERIALS AND METHODS

The study was conducted for a period of three months, from April to June 2008, at Sabloga Slaughterhouse in Khartoum city, (Sudan). The carcasses were selected randomly. A total of 384 samples were taken from four separate sites: the brisket, shoulder, neck and rump on eight replicated times (32 carcasses), after skinning, evisceration and washing was done, respectively. Carcass sites were sampled by the swab technique; an area of 100 cm^2 was marked with a sterile frame (10 cm × 10 cm) for each site on the carcass. Also, 60 samples were taken from each worker hands and the knives were used for different slaughtering operations. The identification of isolates was carried out according to Barrow and Feltham (1993) and Holt et al., (1994). The total viable counts of isolated bacteria were done according to Miles and Misera (1938).

The data were analyzed using SPSS software (Statistical Package for the Social Sciences, version 11.5, SSPS Inc. and Chicago, IL, USA). All bacterial counts were converted to $\log_{10}$ CFU cm^{-2} for analysis and ANOVA was performed. Statistical significance was set at a P value of < 0.05.

RESULTS

The mean total viable count at brisket site was 3.31 ± 0.14, 3.71± 0.04 and 3.65 ± 0.02 log CF U/cm^2 at the three points of operation with statistically significant difference ($P < 0.05$). In shoulder site, TVCs were 3.03 ± 0.15, 2.73± 0.02 and 2.79 ± 0.10 $\log_{10}$ CF U/cm^2, with statistically significant difference ($P < 0.05$). TVCs in neck site after operational points revealed 3.65 ± 0.02, 3.42 ± 0.02 and 3.72 ± 0.02 $\log_{10}$ CF U/cm^2, respectively, with TVC in the three points of operation were 3.24 ± 0.02 statistically significant difference ($P < 0.05$). In rump site, 2.88 ± 0.02 and 3.18 ± 0.03 $\log_{10}$CF U/cm^2 with statistically significant difference. TVC in knives after skinning

and evisceration were 3.40 ± 0.02 and 3.25 ± 0.03 $\log_{10}$ CF U/cm^2, without statistically significant difference ($P > 0.05$). Also, the TVC of the hands of the workers at post skinning, post evisceration and post washing were 3.74 ± 0.02, 3.42 ± 0.02 and 3.71 ± 0.02 $\log_{10}$ CFU/cm^2, respectively with significant differences ($P < 0.05$) between them (Table 1).

The study revealed twelve types of bacteria with their frequency and percentage of contamination of the carcasses as shown in Table 2. The highest relative frequency of isolates was *Staphylococcus aureus*, 14.76 *Pseudomonas* 14.76, followed by *Bacillus* spp 10.54, *Klebsella* spp 10.12 and *E. coli* 8.86.

DISCUSSION

It was shown in this study that the predominant bacteria isolated were *S. auerus, Pseudomonas* spp, *Bacillus* spp, *Klebsiella* spp and *E. coli* (Table 2). These micro-organisms can be opportunistic pathogens of humans and were isolated from human clinical specimens of an outbreak of food poisoning (Carter and Cole, 1990; Gracey and Collins, 1994; Holt et al., 1994). *Pseudomonas* spp represented the highest average prevalence (14.76%) in this study which is similar to the results of Gustavsson and Brach (1993). From this data, the total bacterial counts results were depended on swabbing method, but Dorsa (1996), Ransom et al. (2002), Gill and Jones (2000) showed that gauze swabbing and excision methods were the same bacterial enumerations on 100 cm^2 area. Also Ware et al. (1999) obtain the same results by using these sampling methods in TAC, TCC and ECC before chilling.

The present work revealed statistically significant difference ($P < 0.05$) during slaughtering operations, this in accord with the results of Gill (1998) who reported bacterial contamination of meat during butchering and skinning.

The high level of bacterial viable counts after post washing of bovine carcasses in this study is in agreement with the study of Ali (2007) who recorded that the highest

Table 2. Bacteria isolated from cattle carcasses in the slaughterhouse.

Type of organisms	Number of isolates isolated from sampled carcasses	Relative frequency of isolates (%)
Staphylococcus aureus	35	14.76
Pseudomonas spp.	35	14.76
Bacillus spp.	25	10.54
Klebsella spp.	24	10.12
Escherichia coli	21	8.86
Micrococcus spp.	20	8.43
Pasteurella	18	7.59
Proteus spp.	17	7.17
Staphylococcus spp.	13	5.48
Salmonella spp.	10	4.21
Staphylococcus epidermidis	10	4.21
Streptococcus spp.	9	3.79
Total	237	100.00

contamination was at the point of washing, on different sites of examination of bovine carcasses.

Another study by Jeffery (2003) revealed that the workers hands and the equipment were the sources of meat contamination and these results are in accord with the present results.

The elimination of contamination sources by practicing good sanitary measures will reduce the occurrence of microorganisms. Appropriate methods should be applied during slaughtering operations, using adequate water and disinfection. Such control measures should include an extensive education programs for proper hygiene and improvement of managements.

In conclusion, this study revealed that the level of contamination on bovine carcasses was much higher. But Sudan is a tropical country, with ambient temperatures conducive for the growth of microorganisms, which can rapidly render meat unsafe for human consumption. The levels of microbial contamination in Sudanese abattoirs may reflect the hygiene status of meat production in the developing world.

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