Applied Tropical Agriculture
Volume 21, No. 3, 223-228, 2016.

Microbial Evaluation of Different Cleaning Techniques on Meat Contact Surfaces in an Abattoir in Akure, Nigeria

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ABSTRACT

The microbial status of meat contact surfaces used in sales of meat in an abattoir in Akure town was evaluated based on three cleaning techniques: ordinary water, ordinary water and detergent and hot water and detergent. Four meat tables were randomly selected and 1cm^2 swab was taken from the four edges before sales (B), during sales (D) and after sales (A) of meat using a sterile swab stick. Twenty-four swab samples was collected and evaluated using conventional methods for isolation, identification and antibiotic susceptibility of microorganisms. The results showed that the mean microbial loads from the different cleaning techniques are significantly different from one another with the bacterial load ranging from 149.25±14.26 to 0.94±0.05 x10^4 CFU/cm^2. Nine organisms were identified, of which Pseudomonas aureginosa, Serratia marcesces, Samonella spp were 90%, 80% and 70% resistant to different antibiotics tested for respectively. In conclusion, hot water with detergent was the most effective of the three cleaning techniques employed. Hence, a high level of hygiene should be given to meat contact surfaces and the sales of meat be carried out in a screened environment to avoid re-contamination of meat contact surfaces and meat via persistent and resistant microorganisms in the environment.

Key words: Meat contact surfaces, microbial load, cleaning technique, abattoir

INTRODUCTION

Meat is an important source of protein, essential amino acids, B complex vitamins and minerals. It is an essential constituent of the human diet, with rich composition and sufficient nutrients that makes it highly perishable thus providing a favorable environment for the proliferation of pathogenic bacteria (Huda *et al.,* 2010), posing a high threat of food borne diseases (Nel *et al.,* 2004; Yousuf *et al*., 2008; Marpandi and Al-Salamah, 2010) and public health hazard(Iroha *et al*., 2011) Several factors contribute to the contamination of meat processed in the abattoir especially during operations such as skinning, evisceration, storage and distribution at slaughterhouses and retail establishments (Doxon *et al*., 1991; Abdalla *et al*., 2009). These operations expose the animal muscle mass to microbes that are present on the skin, digestive tract, environment and the meat contact surfaces (Bacon *et al*., 2000).

The contact surface for the sales of meat is of importance because it serves as the habitat of the meat, where they are placed prior to cutting and sales. These contact surfaces could be in form of wooden or concrete tables, while sources of contamination could emanate from the meat itself, the surrounding air, inadequate cleaning of the tables before sales, during sales and after sales of meat. Thus, an extrinsic mode of meat contamination constitutes a major problem in our abattoirs as potential sources of microbial contamination and recontamination of meat carcasses, thereby significantly reducing the shelf life of the meat (Elmossalami, 2003; Yen, 2003).

Most abattoirs in developing countries are not 100% hygienic (Gill and Jones, 2005), they are also characterized with crude methods of handling, processing and marketing of meat coupled with poor sanitation and hygiene that undermine meat quality. This results into considerable loss of product as well as the risk of food-borne diseases (Garcia, 2007). In addition, it has being observed that most of the butchers, sales men, operators and patrons of abattoirs have poor knowledge of sanitary practices that increases consumer vulnerability to microbial infections (Elmossalami, 2003).

Given these concerns and potential for food borne illness, this study was conducted to determine the microbial status of meat contact surfaces (tables) used for sales of meat in an abattoir in Akure metropolis and the effects of the different cleaning techniques instituted on their microbial load.

MATERIALS AND METHODS

Sample collection

The Oyarubule abattoir in Akure, (located North $07^{0}16.934^{1}$, East $005^{0}11.228^{1}$) was used for this study, four meat contact surfaces (tables) used in sales of beef were randomly selected. The swab contact method described by Evancho *et al.* (2001) was used to obtain swab samples from the edges of the tables ($1cm^2$) before sales (B), during sales (D) and after sales of meat (A), while three methods of washing was evaluated: ordinary water (Ow), ordinary water with detergent (OwD) and lastly, hot water with detergent (HwD). Twenty-four swab samples each were collected at the different sampling period for each cleaning technique studied. The samples were taken to the laboratory in refrigerated coolers for analysis and estimation of total viable count.

Preparation and inoculation of samples

Each of the swab sample was dissolved in 1ml of sterile peptone water after which 0.1ml was inoculated into aseptically prepared nutrient agar plates. Inoculated plates was incubated at $37^{o}C$ for 24 hr, after which visible colonies were counted using a colony counter, while distinct colonies were sub-cultured and identified using biochemical test (viz: catalase, coagulase, oxidase, sugar reduction, Grams reaction), and morphological characteristics described by Olutiola *et al.,* (2000).

Antibiotics susceptibility test

The microorganisms isolated were tested against a wide range of antibiotics using the disk diffusion method of Clinical and Laboratory Standard Institute (CLSI, 2005).The antibiotic multi-disc contained Ampiclox (30µg), Septrin (30µg), Ciprofloxacillin (10µg), Zinnacet (20µg), Erythromycin (10µg), Gentamycin (10µg), Amoxacillin (30µg), Streptomycin (10µg), Rocephin (25µg) and Pefloxacin (10µg). The zone of clearance observed was measured to the nearest whole millimeter and interpreted based on the CLSI guidelines.

Statistical analysis

Data collected was analysed using general linear model procedure and ANOVA with SPSS software 17^{th} edition (2007).

RESULTS AND DISCUSSION

The total bacterial counts observed on the meat contact surface ranged from 149.25±14.26 to 0.94±0.05 $x10^4$ CFU/cm^2. However, the microbial load of the meat contact surfaces was higher with the use of ordinary water and detergent compared to ordinary water only at the different sampling periods (B and D) except after sales (A; 6.00± 2.67 $x10^4$ CFU/cm^2) Table 1. This result suggests inadequate cleaning and unhygienic handling of meat contact surfaces, which in turn could lead to contamination and re-contamination of meat after slaughtering and during sales, as reported also by Lasta *et al*. (1992).

Table 1: Outcome of the effect of different cleaning techniques on the mean microbial load of sampled meat contact surfaces

Sampling period	Ow	OwD	HwD
BS	97.13±13.77	149.25±14.26	30.50±10.80
DS	17.38±9.94	110.63±12.99	23.13±9.64
AS	49.13±10.96	6.00±2.67	0.94±0.50

Keys; B- Before sales, D- During sales, A-After sales, Std-Standard deviations, Ow – Ordinary water, OwD – Ordinary water with Detergent, HwD- Hot water and Detergent

The higher microbial counts observed with the use of ordinary water and detergent compared to ordinary water only could be due to the detergent serving as another source of contamination or enabled further proliferation of the microorganisms. However, there was a significant difference between the three cleaning techniques used (Table 2). The mean microbial load (18.19 x 10^4 CFU/cm^2) observed when hot water was used was higher compared to results obtained by Sethulekshmi and Nanu (2009) from meat cutting table. Generally, the mean microbial load observed on the meat contact surfaces despite the cleaning technique used was lower than values reported by Omoruyi *et al*. (2011).

Table 2: Mean microbial load on meat contact surfaces with different cleaning technique

Cleaning technique	**Mean $x10^4$ (CFU/cm^2)**
Ordinary water	88.63 ^{c}
Ordinary water and detergent	54.54 ^{b}
Hot water and detergent	18.19 ^{a}

Table 3 revealed the interactions between the organisms isolated at the different sampling period and the different cleaning techniques. Nine organisms were isolated in all and the organisms isolated from the meat contact surfaces in our study were similar to those isolated by Sethulekshmi and Nanu (2009) and Omoruyi *et al*. (2011),

Table 3: Microorganisms isolated from meat contact surfaces

Sampling period	**Isolated Organisms with different cleaning technique**		
	Ordinary water	**Ordinary water and Detergent**	**Hot water and Detergent**
Before sales	*Salmonella spp*	*Salmonella spp*	*Salmonella spp*
	Streptococcus faecalis	*Streptococcus faecalis*	*Bacillus spp.*
	Bacillus spp	*E. coli*	*Staphylococcus aureus*
	Micrococcus spp	*Enterobacter aerogenes*	*Pseudomonas aureginosa*
	Staphylococcus aureus	*Micrococcus spp*	*E. coli*
	Pseudomonas aureginosa	*Staphylococcus aureus*	
	Serratia marcesces	*Pseudomonas aureginosa*	
During sales	*Salmonella spp*	*Micrococcus spp*	*Bacillus spp*
	Bacillus spp	*Staphylococcus aureus*	*Staphylococcus aureus*
	Staphylococcus aureus	*Salmonella spp*	*Salmonella spp*
	Pseudomonas aureginosa	*Bacillus spp*	*Micrococcus spp*
	Micrococcus spp	*Serratia marcesces*	*E .coli*
	Serratia marcesces		
After sales	*Salmonella spp*	*Micrococcus spp*	*Bacillus spp*
	Bacillus spp	*Staphylococcus aureus*	*Staphylococcus aureus*
	Staphylococcus aureus	*Pseudomonas aureginosa*	
	Pseudomonas aureginosa	*Enterobacter aerogenes*	

Table 4: Antibiotics susceptibility analysis of isolates (in millimeter)

Organisms	PEF	CN	APX	Z	AM	R	CPX	S	SXT	E	% Resistance
1	0	0	0	0	0	0	1	0	0	0	90%
2	8	0	2	0	6	0	6	0	0	0	60%
3	4	5	3	1	4	0	6	2	2	4	10%
4	2	0	0	0	0	0	6	0	0	0	80%
5	0	6	0	4	5	0	7	0	5	7	40%
6	4	2	2	5	2	4	6	2	0	4	10%
7	6	0	0	0	8	0	6	0	0	0	70%
8	7	5	2	0	2	3	0	6	2	8	20%
9	4	0	6	2	2	0	5	2	3	4	20%

KEY: PEF- Pefloxacin=10µg, CN- Gentamycin=10µg, APX-Ampiclox=30µg, Z-Zinnacet=20µg, AM-Amoxacillin=30µg, R-Rocephin=25µg, CPX- Ciprofloxacin=10µg, S-Streptomycin=30µg, SXT- Septrin = 30µg, E-Erythromycin=10µg.
(1)*Pseudomonas auregenosa* (2) *Streptococcus faecalis* (3) *Bacillus spp* (4) *Serratia marcesces* (5) *Staphylococus aureus (*6) E. coli (7) *Salmonella spp (8) Micrococcus spp (9) Enterobacter aerogenes*

which have also been reported to be found in foods, environments and other places by Enabulele and Uriah (2009).

The persistence of organisms like *Samonella spp, Bacillus spp, Staphylococcus aureus* and *Pseudomonas auregenosa* throughout the sampling period (B,D,A) when ordinary water was used indicated that ordinary water will not be effective for cleaning, as all the organisms involved are pathogenic and poses a risk of food borne disease. This also reveals the extent of human handling and the level of deterioration of the meat (Clarence *et al*. (2009), which can further result in contamination of the meat contact surfaces. Slaughtering is a suitable progressive process for the contamination of carcass by partially pathogenic bacteria (Forsythe and Hayes, 1998). Hence, all surfaces in contact with meat should be under check and kept clean to minimize the risk of bacterial contamination (Butterorth-Heineinann, 2000).

In addition, for ordinary water and detergent, the persistence of *Staphylococcus aureus, Micrococcus spp*, throughout the sampling time, alongside contamination with *Serratia marcesces* and *Bacillus spp* during sales, could be due to environmental contamination with these organisms. Their presence also typifies a high probability of contamination of the meat contact surfaces by feaces (Siragusa *et al*., 1995; Siragusa *et al*., 2000; Lawan *et al*., 2011). However, due to their absence after washing, it is advisable that meat is sold in a screened environment shielded from contamination by human handling, flies and air. Also, training and supervision of abattoir workers is needful, in order to ensure compliance to hand washing, appropriate cleaning and sanitation that will help reduce cross contamination (Kusumaningrum *et al*., 2003).

Results of the antibiotics susceptibility test revealed that the organisms isolated from the abattoir tables showed varied resistance and sensitivity to the various antibiotics tested (table 4). Most importantly are *P. aureginosa*, which showed 90% resistance and was only susceptible to Ciprofloxacin (CPX), *Serratia marcesces* with 80% resistance and sensitive to Pefloxacin and Ciprofloxacin and *Samonella spp* with 70% resistance and sensitive to Pefloxacin, Ampiclox and Ciprofloxacin. These organisms are of public health importance, especially due to their resistance to commonly used antibiotics by humans; hence their presence on meat contact surface further confirms the poor state of meat processing in developing countries as revealed by (Abdalla *et al*., 2009).

CONCLUSION

The meat contact surfaces had a high mean microbial load before sales and can be further contaminated with other micro-organisms during sales, however the use of cleaning techniques after washing will help lower the mean microbial load, hence, hot water with detergent can be used for cleaning being the most effective of the three techniques employed in this study. The microorganisms isolated (*Pseudomonas auregenosa, Streptococcus faecalis, Salmonella spp, Bacillus spp, Staphylococcus aureus, Enterobacter aerogenes Micrococcus spp, E.coli and Serratia marcesces*) in this study are of public health importance, the resistance of *P. aureginosa, Serratia marcesces* and *Samonella spp* to most of the antibiotics tested for calls for great concern. It is however important that hygienic practices be upheld in the abattoir and sales of meat be done in a screened environment.

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