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Effects of cleaning agents in reducing microbial load on meat display tables at the Bodija municipal abattoir, Ibadan, Nigeria

A. E. J. Awosanya, O. K. Bolatito and V. O. Adetunji

Department of Veterinary Public Health and Preventive Medicine, University of Ibadan, Nigeria

Abstract

Meat display tables have been implicated as one of the sources of meat contamination and a critical control point in food processing. Cleaning and disinfection operations are of great importance within the food processing industries for food safety reasons. The effectiveness of four cleaning agents as treatments for the reduction of microbial contamination of meat display tables used by meat sellers at the Bodija municipal abattoir in Ibadan, Oyo state, Nigeria was assessed within April and October, 2009. The treatments include the use of: 1. Pipe-borne water (27^oC); 2. Hot water at 85^oC; 3. Pipe-borne water and detergent; 4. Combination of pipe-borne water, detergent and sodium hypochlorite. Swab samples were taken from a 1cm^2 area on each wooden table surfaces before and after application of each treatment. They were processed and grown on nutrient agar and MacConkey agar to determine the effects of each treatment on total aerobic and coliform counts in the laboratory. The results revealed that all the four treatments had statistically significant difference ($P<0.05$) in reducing microbial contamination with treatment 4– combination of pipe-borne water, detergent and sodium hypochlorite having the highest percent reduction in total aerobic and coliform counts (63% and 75% respectively). It is recommended that treatments 3 and 4 should be incorporated into the routine activities of meat sellers before the commencement of daily sales and after, because of their greater effect in reducing coliform than treatments 1 and 2, in order to minimize contamination of meat arising from meat display tables.

Keywords: Cleaning Agents, Meat Display Tables, Microbial Contamination

Introduction

Meat is an important element in the diet of most people and its safety depends upon the application of effective control measures at all stages of the production chain. Despite the extensive scientific progress and technological developments achieved in meat industry in recent years, microbial meat borne illness remains a global concern (Hinton, 2000; Glavin, 2003). During the processing, preparation and packaging of meat products, meat products may encounter microorganisms which may make meat or its products unsuitable for consumption, this condition is called microbial contamination of meat. The microorganisms may come from the meat itself (when dirty animals or diseased animals are slaughtered), the food contact surfaces (display tables, processing floor, dirty cloths or hands of meat handlers) and/or the surrounding environment (Haque, et al., 2008). In Nigeria an undoubtedly source of extraneous contamination of meat is the meat display tables used by meat sellers (Fasanmi et al., 2010).

The maintenances of bacterial content of meat either superficial or deep at a low level is of perhaps greatest importance to packaging industry so that a safe and marketable product for public consumption and export can be ensured, for every process hinges upon inhibition of bacteria growth (Gracey, 1981).

Many countries such as U.S.A have implemented intervention-based HACCP (Hazard analysis and critical control point) where a specific cleaning procedure is applied to the product during processing to reduce the microbial load present on meat. Using Cleaning interventions can considerably lead to improvement in the shelf life of the fresh or further processed meat products and ensure its safety for the consumer. Such interventions includes knife trimming, hot water washing, use of detergents, use of mild disinfectants and antiseptics such as sodium hypochlorite, organic acid washing and steam vacuuming (Hinton, 2000).

New safety technologies are continually being developed to help processors to meet the increasingly stringent microbiological criteria that are being applied through the red meat supply chain. Efficient cleaning and disinfection of meat processing equipment is often neglected because of the extra work involved and that the positive effects are not immediately noticeable. The cleaning processes at the Ibadan municipal abattoir are not thorough. Water without the addition of detergents is in use. However, this neglect has led to unhygienic production of meat and meat products and its attendant losses. In order to provide useful information on production and marketing of safe and wholesome meat, this study aimed at assessing the effectiveness of some cleaning agents as treatments for reducing microbial contamination of wooden meat display tables used by meat sellers. The effects of the cleaning agents on total aerobic counts (TAC) and total coliform counts (TCC) were assessed.

Materials and Methods

Bodija Municipal Abattoir is located on latitude N 07^o 25' 984'' and longitude E 003^o 54' 887'' (Geographical positioning system, etrex, Garmin, Taiwan). The abattoir is the main abattoir in Ibadan and it has retail outlets for sales of meat, which are displayed on wooden tables, to the public. On the average, a total of about 300 cattle and 350 sheep and goats are slaughtered per day.

Out of a total of 25 meat tables, five tables were selected at random and used for this study. Two swab samples were taken from a 1cm^2 area on each table surface before and after each treatment. Treatment 1 was washing with pipe-borne water (27^{o}C), Treatment 2 was washing with hot water at 85^{o}C, and Treatment 3 was washing with detergent (OMO®, Unilever, Lagos, Nigeria) and pipe- borne water (27^{o}C), while Treatment 4 was washing with pipe borne water (27^{o}C), detergent and sodium hypochlorite (Reckitt Benckiser™). One treatment was per day and hard brush was used in scrubbing the tables longitudinally for 5minutes. The swab samples were then ice packed and transported to the Food and Meat Hygiene laboratory of the Department of Veterinary Public Health and Preventive Medicine, University of Ibadan for microbial analysis on each day.

The mixture of pipe-borne water and detergent powder (OMO®, Unilever, Lagos, Nigeria) was prepared by measuring 60g of the detergent into 20 litres of potable well water and thoroughly mixed to form a homogenous mixture according to the manufacturer's specification.

This was prepared by adding 60g of detergent powder to 20 litres of pipe-borne water and subsequently adding 250 ml of 3.85% M/v of sodium hypochlorite (JIK®). The mixture was thoroughly mixed according to manufacturer's specification.

On each sampling day, to ease counts, each swab was vortexed in 9mls of sterile 0.1 % peptone water (Fishers scientific, UK). The dilution continued until a ten fold dilution was attained. 0.1ml of each tenth fold dilution was surface plated on Nutrient agar (Fluka 7014, Germany) for total aerobic plate count and MacConkey agar (Fishers scientific, UK) for coliform counts. The plates were incubated aerobically at 37^{o}C for 24hrs. At the end of incubation a digital colony counter (Lapiz. 0671M.JG.058, Mumbai, India) was used in counting discrete colonies. Counts were expressed in colony forming unit per cm^2 area (CFU/cm^2) and later converted to the $\log_{10}$ CFU/cm^2 values (Speck, 1986).

Statistical Analysis

The microbiological data were expressed in CFU/cm^2 and Log_{10} CFU/cm^2. The means, standard deviations and percentage reduction were determined using Graph pad Prism. Student't' Test for paired samples was used to determine the levels of statistical significance at 95% confidence interval. Microsoft Excel 2003 was used for the Student't' test computation.

Results

Treatment 1 which was washing with pipe-borne water (27 ^{o}C) caused the lowest reduction by 22% and 20% in the TAC and TCC respectively. Treatment 2 which is washing with hot water at 85^{o}C resulted in 38% and 29% reduction in the TAC and TCC respectively. Treatment 3 which is washing with pipe-borne water and detergent produced 55% and 59% reduction in the TAC and TCC respectively. Treatment 4 which is washing with pipe-borne water, detergent and sodium hypochlorite caused the highest reduction in TAC and TCC by 63% and 75% respectively (table 1).

Table 1: Mean total aerobic count and coliform count before and after each treatment

Treatments	Total aerobic count(CFU/ cm^2)			Coliform count(CFU/ cm^2)		
	Before washing Mean±SD	After washing Mean±SD	Reduction percentage (%)	Before washing Mean±SD	After washing Mean±SD	Reduction percentage (%)
Treatment 1	290.00 ± 6.75	226.40 ± 23.04*	22	78.80 ± 41.40	62.80 ± 41.87*	20
Treatment 2	207.20 ± 61.99	128.60 ± 30.67*	38	62.80 ± 13.70	44.40 ± 8.20*	29
Treatment 3	177.80 ± 20.08	79.40 ± 5.13*	55	71.00 ± 9.96	28.80 ± 7.53*	59
Treatment 4	189.40 ± 68.56	70.40 ± 25.20*	63	93.00 ± 12.31	23.00 ± 5.15*	75

*statistically significant at P<0.05; SD = standard deviation

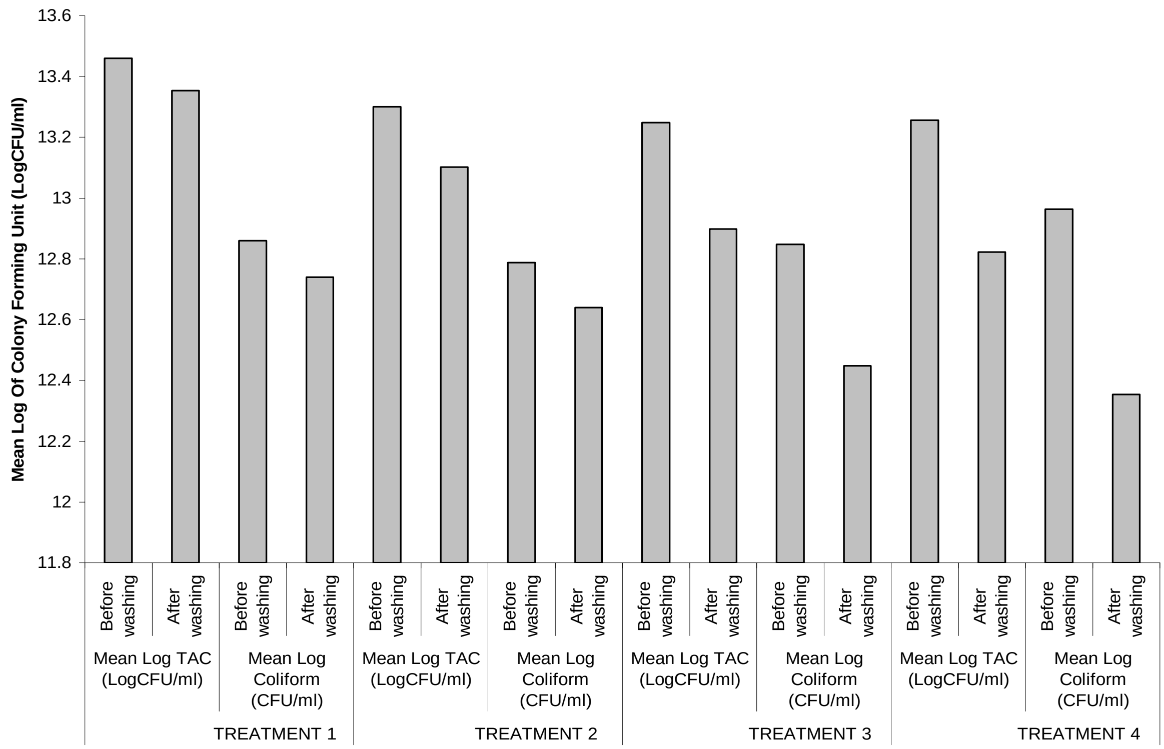

Fig. 1: Mean log of colony forming units before and after treatments

Treatment 1: Washing with pipe-borne water (27 ^{o}C)
Treatment 2: Washing with hot water at temperature of 85^{o}C
Treatment 3: Washing with pipe-borne water and detergent
Treatment 4: Washing with pipe-borne water, detergent and sodium hypochlorite
TAC: Total Aerobic Counts

There was statistical significant difference at P<0.05 between the means of the TAC and TCC before and after application of all the treatments. Treatment 1 decreased TAC and TCC by 0.11 and 0.12 log CFU/cm^2 respectively; Treatment 2 decreased TAC and TCC by 0.20 and 0.15 log CFU/cm^2 respectively. Treatment 3 caused 0.35 and 0.40 log CFU/cm^2 reduction in the TAC and TCC respectively; while treatment 4 caused 0.44 and 0.61 log CFU/cm^2 reduction in the TAC and TCC respectively (figure 1).

Discussion

There was lowest reduction in TAC (22%) and TCC (20%) after administration of treatment 1– washing with pipe-borne water. The minimal reduction in TAC and TCC observed after application of treatment 1 agreed with the reports of Weise and Levetzow (1976), Gracey (1981) and Schitt (1992) who pointed out that water lacks germicidal and antimicrobial properties and its high surface tension facilitates a poor contact between wood surface and the water. It appeared also that washing with pipe-borne water has more effect in reducing total aerobic microbes than coliforms. Though the differences in total aerobic and coliform counts before and after application of treatment 1 were statistically significant (P<0.05), the reduction of 0.11 and 0.12 log CFU/cm^2 unit in the TAC and TCC was not satisfactory in comparison to others and is far less than a unit reduction in log of microbes (SCVPH, 2001). However, several washing with cold water had been shown to reduce surface contamination of meat and poultry carcasses by 90–99% (SCVPH, 1998). Presence of knife scratches on the table surfaces may also contribute to the little effect of washing with pipe-borne water on microbial load reduction.

Treatment 2– washing with hot water at 85^{o}C caused a greater reduction in the TAC (38%) and TCC (29%) than treatment 1. This observation showed that more microbes were destroyed with increase in temperature; however the effect was less on TCC compared with TAC. The differences in both TAC and TCC before and after application of treatment 2, though statistically significant, were not satisfactory in relation to treatments 3 and 4. The log reduction of 0.20 and 0.15 log CFU/cm^2 in TAC and TCC respectively was significantly less than a unit and thus not satisfactory (SCVPH, 2001). The reason could be due to the fact that heat treatment such as washing with water at 85^{o}C causes coagulation of organic matters especially fat and protein (remnant from meat) on the tables and this forms a protective coating around the microbes, thus shielding them from the germicidal effect of hot water (Weise and Levetzow, 1976; Schitt, 1992; SCVPH, 2001). However, according to the report of SCVPH in 1998 on benefits and limitations of antimicrobial treatments for poultry carcasses, hot water (74–95^{o}C) was shown to reduce *Escherichia coli* and Salmonellas by 99–99.9% on beef and poultry carcasses.

There was a higher reduction in TAC (55%) and TCC (59%) after application of treatment 3– washing with pipe-borne water and detergent than was observed for treatment 2. The reduction effect of treatment 3 on TCC was more than on the TAC. This observation could be explained in the light of detergent having greater germicidal properties than cold water or hot water as well as the surface active effects of detergent on water as reported by Skaarup (2003). The addition of detergent to water lowers the surface tension of the water and thus facilitating a good contact between wood surface and water and in the process detergent exerts its germicidal effect (Skaarup, 2003). Similarly, a statistical significant difference (P<0.05) was observed between the mean values for TAC and TCC before and after application of treatment 3. However, the reduction effect was not satisfactory because the log reduction of 0.35 and 0.40 log CFU/cm^2 in the TAC and TCC respectively was significantly less than a unit (SCVPH, 2001).

Treatment 4– washing with pipe-borne water, detergent and sodium hypochlorite had the highest reduction rate in TAC (63%) and TCC (75%) of all the treatment schedules. More so, the reduction effect of treatment 4 was more on the TCC than TAC. The highest reduction in TAC and TCC recorded after application of treatment 4 may be due to the combined germicidal effects of sodium hypochlorite and the detergent, as well as the surface active property of detergent which facilitates good contact between the wood surface and the sodium hypochlorite used, thus allowing the germicidal effect of both the detergent and sodium hypochlorite to take effect (Gracey, 1981; Skaarup, 2003). A statistical significant difference (P<0.05) existed between the mean values for TAC and TCC before and after treatment 4. The log reduction of 0.44 and 0.61 log CFU/cm^2 in the TAC and TCC was fairly satisfactory (SCVPH, 2001)

Though, all the treatment schedules showed statistical significant differences (P<0.05) in the means values of the TAC and TCC before and after application of each treatment, only treatments 3 and 4 caused more than 50% reduction in both TAC and TCC.

The finding of this study is relevant to the meat industry staff in Nigeria and in countries where meat are displayed on wooden tables. Meat sellers should be made aware of the need for proper cleaning and disinfection of their display tables as an integral part of the production process in ensuring availability of safe and wholesome meat to the public. It is recommended that effective cleaning and disinfection with water and detergent and preferably water, detergent and sodium hypochlorite of wooden meat display tables used by meat sellers should be incorporated into their daily activities before commencement of daily sales and after end of sales.

The effects of varied concentrations of the cleaning agents on microbial load and on characterized strains of prevalent pathogenic bacteria are areas for further studies.

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