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Knowledge and Practices of Meat Hygiene among Meat Handlers and Microbial Profile of Meat in the Jos Abattoir, Plateau State

Miner CA[1], Agbo HA[1], Dakhin AP[1], Udoh P[2]
[1] Department of Community Medicine, Faculty of Clinical Sciences, College of Health Sciences, University of Jos.
[2]Department of Community Medicine, Jos University Teaching Hospital.
Correspondence: Miner, Chundung A, chundungminer@yahoo.com, Phone: +2347037000880

Abstract

Background: *Meat handling and sanitation practices can have resultant effects on the quality of meat sold to the public. The study aimed to determine the knowledge and practices of meat hygiene amongst meat handlers. It also sought to determine the microbial profile of meat sold in the Jos abattoir of Plateau State.*

Methodology: *It was a cross sectional study conducted among 128 butchers and meat handlers in the Jos abattoir selected by total population sampling technique. Data on knowledge and practice was collected using a semi-structured interviewer-administered questionnaire. Sampled meat products were analysed for bacterial load using Serial Dilution technique and bacterial pathogens identified by standard procedures. Epi Info statistical software was used for data analysis at a 95% confidence limit.*

Results: *The mean age of respondents was 32.8 ± 10.4 years and all were males. A fair knowledge of meat hygiene was found among 55.5% of respondents while 8.6% were adjudged to have good meat hygiene practices. The mean bacterial load for sampled meat for sale was 2.5 x 10^3* ± 3.4 *cfu/ml. Main bacterial isolates identified were Escherichia coli, Pseudomonas spp and Enterobacter spp.*

Conclusion: *In this study knowledge of meat hygiene was mostly fair among respondents with a low level of meat hygiene practices and a high level of meat bacterial contamination. The study recommended training for meat handlers for hygiene maintenance, increased inspection of meat sold to the public and provision of standard facilities to ensure the maintenance of a good level of meat hygiene.*

Key words: *meat hygiene, butchers, meat handlers, abattoir, microbial profile*

Introduction

Food borne diseases occur commonly in developing countries particularly in Africa because of the prevailing poor food handling and sanitation practices, obsolete food safety laws, weak regulatory systems, inadequate investment in safer equipment and poor education of food handlers.[1] The World Health Organization (WHO) estimates that worldwide foodborne diseases are the cause of 600 million cases of ill-health and 420,000 deaths annually. Of these deaths, 30% are accounted for by children under 5 years of age. Globally, eating unsafe food is also estimated to

result in 33 million years of healthy lives lost (YLL) yearly, and this number is believed to be an underestimation.[2] More than 30 pathogens have been identified to be responsible including *Norovirus*, *Salmonella*, *Campylobacter* and *E. coli* among others.[2] Estimates from the United States (US) Center for Disease Control (CDC) revealed that 48 million cases of ill-health, 128,000 hospitalizations, and 3,000 deaths in the US annually are from foodborne diseases.[3] Africa has been shown to have the highest burden of food borne diseases per population.[4] However, it is believed that food borne diseases are underestimated or underreported in developing countries as in Nigeria, where it is reported that 90,000 cases occur annually.[5]

Of the foods intended for humans, those of animal origin such as beef, pork, chicken and fish tend to be most hazardous and have been implicated in significant disease occurrence and mortality.[6] An example cited was the report of beef being responsible for 7% of 1.7 million cases of foodborne disease that occurred in England and Wales between 1996 and 2000.[6] A meta-analysis of foodborne pathogens in selected African countries including Nigeria showed varying prevalences of bacterial contamination on raw meat.[7]

An abattoir is "a premise approved and registered by the controlling authority for hygienic slaughtering and inspection of animals, processing, effective preservation and storage of meat products for human consumption".[8] In abattoir operations, certain standards have to be met to provide basic environmental and operating conditions that are necessary for production of safe livestock products for food. Poor hygiene practices in abattoirs lead to the production, handling, sales and consumption of animal food products that constitute serious public health problems not limited to the butchers alone, but also to consumers and people in the immediate surroundings.[9,10]

Abattoir workers with poor hygiene practices along with a poor state of the abattoirs or meat processing plants and ineffective meat inspection service lead to increased risk of consuming unwholesome meat with a significant impact on the health and quality of life.[11,12] The workers at the abattoir are at risk of occupational zoonosis such as anthrax, brucellosis and salmonellosis. Improper disposal of animal waste could cause pollution of water and air leading to unsanitary conditions of the environment and spread of diseases from breeding of flies at site of disposal.

This study sought to determine the knowledge and practices of meat hygiene amongst meat handlers (including butchers) in the government-run Jos abattoir of Plateau State. It also looked at the microbial meat profile of meat slaughtered and sold in the abattoir.

Methods

The study was a cross-sectional study conducted in the State owned abattoir of Plateau State Nigeria that is located in Giring ward of Jos South Local Government Area (LGA). It was established in 1975 for the purpose of inspection, slaughtering, processing and marketing of meat and meat products.[13] Animals commonly slaughtered at this facility include sheep, goats, cows and pigs. The study population included adult meat handlers that operate within the abattoir. A meat handler was taken to be any individual that engages in receiving and/or storing, transporting and/or selling (wholesale and/or retail) of meat and/or poultry. It also included persons who may slaughter animals, dress their flesh, sell

their meat or any combination of the three tasks.

The minimum sample size was calculated using the formula for cross-sectional studies and the proportion of 25.5% of those with good knowledge from a previous study with further adjustment for populations of less than 10,000 and a non-response of 10%.[14,15] A total population sampling technique was used as a preliminary census conducted had shown that the study population was almost equivalent to the estimated sample size.

Data was collected using an interviewer administered questionnaire with sections on socio-demographic information, knowledge of meat hygiene, meat hygiene practices and factors affecting the practice of meat hygiene. Aspects of knowledge and practice that were assessed included hand washing, use of personal protective equipment, cleaning of the work environment, personal hygiene and work habits. Information on regulatory laws guiding the abattoir, training programmes and availability of water and sanitation facilities was also obtained.

Fresh meat samples were also collected from 6 different slaughter and sale sites (10 samples from each site), placed in sterile bottles and immediately transported in insulated ice-lined containers to the laboratory for analysis. This was done at the laboratory of Microbiology Department of the University of Jos using established standard methods.[15] A gram of each sample was placed in 10 ml of sterile water and serial dilutions of 10^{-1}, 10^{-2} were performed for bacterial isolation. Nutrient and MacConkey agar plates were inoculated with 200 ul of each dilution and incubated at 37 $^{\circ}$C for 24 hours. Counts from the nutrient agar plates were noted as total viable counts while counts from MacConkey agar were noted as total coliform count. Bacterial isolates were identified based on morphological characteristics, Gram staining, biochemical tests such as urease test, citrate utilization, motility test, oxidase test and triple sugar iron agar.[15]

All data was collected, processed and analyzed using Epi-Info statistical software version 3.5.4.[16] Knowledge and practice were scored and graded. For both knowledge and practice, they were graded based on percentages of the total attainable score; 80% and above for good, 50 – 79% for fair and less than 50% for poor. For knowledge, there was a total attainable score of 23 which were graded as good (18 – 23), fair (11 – 17) and poor (<11). For practice, there was a total attainable score of 24 graded as good (19 - 24), fair (12 - 18) and poor (<12). A p-value of ≤ 0.05 was considered statistically significant. Ethical clearance was obtained from the Jos University Teaching Hospital Human Research and Ethics Committee. Informed consent was obtained from each participant and permission was obtained from the management of the abattoir before commencement of the study.

Results

A total of 128 respondents were interviewed giving a response rate of 100%. The mean age of respondents was 32.8 ± 10.4 years, those aged 21 – 40 years formed 69.5% of the respondents. All were males. Half of them had completed secondary education. Fifty-eight (58%) were married and 75% were from tribes indigenous to Plateau State. Ninety-nine percent (99%) were Christians and 90% had never had any form of training as shown in Table 1.

A summary of the responses to the knowledge assessment questions is shown in Table 2. Fifty-one (40.2%) of them were aware of what meat hygiene was, but only

31 (24.2%) could adequately explain what it meant. One hundred and twenty (93.7%) of them stated that it was important for meat to be handled safely and all agreed that they have a role in ensuring that meat is kept hygienic. Respondents agreed that hand washing before meat handling; 124 (96.8%) and after using the toilet; 125 (97.7%), proper cleaning and handling of instruments and utensils; 121 (94.5%), daily washing of the work area; 127 (99.2%) and livestock inspection; 127 (99.2%) would reduce the risk of meat contamination. Respondents agreed that meat should not be handled by persons with skin infections; 89 (69.5%), diarrhoea; 71 (55.5%) or cough; 87 (68%). Seventy nine (62%) stated that the use of gloves reduces the risk of meat contamination, 68 (53%) agreed that it is safe to handle meat and money together, while 56 (44%) felt eating and drinking in the work place exposes you to infection. A hundred and seventeen (91.4%) stated that regular medical checks will help reduce disease transmission, 127 (99%) stated that livestock should be inspected before slaughter and that facilities should be inspected regularly; 125 (98%). It was agreed by 101(78.9%) that meat should be refrigerated after slaughter to prevent microbial growth on the meat. Knowledge of meat hygiene when graded found 50 (39.1%) were good, 71 (55.5%) were fair and 7 (5.5%) were poor with a mean knowledge score of 16.4 ± 3.1. Knowledge was found to be statistically significantly associated with level of education (x^2 = 31.49, df = 6, $p < 0.001$) as seen in Table 3.

Good practices that were prevalent amongst them included daily cleaning of work surfaces; 115 (89.8%), daily washing of instruments; 115 (89.8%), washing of hands before meat handling; 127 (99.2%), avoiding work when ill; 109 (85.2%), keeping their fingernails short; 115 (89.8%) and refrigerating of leftover meat; 128 (100%). The meat on the day of interview was said to have been inspected by 126 (98.4%) of respondents and 127 (99.2%) were selling meat of animals slaughtered on that day though 110 (85.9%) said that in the 2 weeks prior to the study, meat that did not pass inspection were still slaughtered and sold. Poor practices identified amongst them included infrequent washing of aprons; 91 (71.1%) non-use of gloves; 119 (93.7%) and handling of meat when injured; 86 (67.7%). Most; 119 (92%) would cover their mouths when coughing over meat but 70 (58.8%) would use their palms to cover their mouths. Most animals were slaughtered on the floor, 126 (98.4%) and 124 (96.8%) butchers would also leave the meat exposed when on display on the tables. (Table 4)

The practices of respondents were found to be good in 11 (8.6%) and fair in 117 (91.4%) persons. None was adjudged to be poor. The mean practice score was 16.5 ± 1.7. Practices were found to be significantly associated with level of education ($x^2 = 8.36$, $p = 0.039$) as shown in Table 3. No statistically significant relationship was found between previous training and knowledge, previous training and practice and between knowledge and practice (Table 3). Information regarding the work conditions and environment of the abattoir was obtained from the respondents. All (100%) respondents stated that they were aware that there are laws guiding the operation of the abattoir but 126 (98.4%) agreed that these laws are ineffective. Sources of water included municipal tap; 118 (92.2%), well; 52 (40.6%), stream; 2 (1.6%) and rain water; 2 (1.6%). Hand washing facilities were stated to be available by 67 (52.3%) of respondents and 107 (83.6%) stated that toilet facilities were available. Only 5

(3.9%) said that personal protective equipment were made available to them. Regarding the frequency of hygiene inspection visits to the abattoir, 71 (55.5%) respondents said the visits were done monthly, every 2 months (10; 7.8%), every 3 – 6 months (9; 7%), >6months (22; 1.7%) and never (7%).

Microbial test results of meat samples are shown in tables 5 and 6. All meat samples had high microbial contamination with mean total coliform count of $2.5 \times 10^3 \pm 3.4$ cfu/ml. The microbe found on all meat samples was *E. coli* with *Pseudomonas spp*. found on all except on one site. Other organisms that were isolated were Enterobacterspp, Citrobacter, *Salmonella typhi* and *paratyphi*.

Recommendations made by respondents on how to improve the abattoir included complete renovation of the abattoir; 68 (53.5%), provision of clean water all year round; 23 (18.1%), better electricity supply; 13 (10.2%) and privatization of the abattoir; 5 (3.9%).

Table 1: Socio-demographic profile of respondents

Variable	Frequency (n = 128)	Percent (%)
Age group (years)		
18 – 20	12	9.4
21 – 30	48	37.5
31 – 40	41	32.0
41 – 50	21	16.4
51 – 60	4	3.1
>60	2	1.6
Highest level of education		
None	15	11.7
Primary	45	35.2
Secondary	65	50.8
Tertiary	3	2.3
Marital status		
Married	74	57.8
Single	53	41.4
Widowed	1	0.8
Tribe		
Indigenous Plateau tribes	95	74.2
Non-indigenous tribes	33	25.8
Religion		
Christianity	127	99.2
Islam	1	0.8
Received meat hygiene training		
Yes	13	10.2
No	115	89.8

Table 2: Responses from assessment of knowledge of meat hygiene

Statement	Response (n = 128) Yes Freq (%)	No Freq (%)
Ever h eard of meat hygiene	51 (40.2)	76 (59.8)
Adequate explained what meat hygiene is	31 (24.2)	97 (75.8)
Safe food handling is an important part of my job	120 (93.7)	8 (6.3)
Hand washing before starting work reduces contamination of meat	124 (96.8)	4 (3.1)
Hand washing after using the toilet reduces contamination of meat	125 (97.7)	3 (2.3)
Proper cleaning and handling of instruments reduce the risk of food contamination	121 (94.5)	7 (5.5)
Daily cleaning of work slabs is important	127 (99.2)	1 (0.8)
Using gloves reduces risk of contamination	79 (61.7)	49 (38.3)
Livestock must be inspected by veterinary doctors before slaughtering	127 (99.2)	1 (0.8)
It is important to quickly refrigerate slaughtered meat	101 (78.9)	27 (21.1)
You shoul d not handle meat if you have		
Cough	87 (68.0)	41 (32.0)
Diarrhea	71 (55.5)	57 (44.5)
Skin infection	89 (69.5)	39 (30.5)
Eating and drinking in the work place exposes you to infection	56 (43.8)	72 (56.3)
It is okay to slaughter dead l ivestock	5 (3.9)	123 (96.1)
Handling meat and money is okay	68 (53.0)	60 (46.9)
The best action to take when you get a cut at work is		
Cover cut and continue work	42 (32.8)	-
Seek first aid before resuming	73 (57.0)	-
Wash cut and continue work	13 (10.2)	-
Regular medical check -ups prevent spread of foodborne diseases by workers	117(91.4)	11(8.6)

Table 3: Relationship of respondents' knowledge and practice grade with socio-demographic characteristics

	Knowledge Grade			p-value	Practice Grade		P-value
Age group	**Poor**	**Fair**	**Good**		**Fair**	**Good**	
-	57(44.5)	39(30.5)	5(3.9)	0.843	92(71.9)	9(7.0)	0.804
>40	14(10.9)	11(8.6)	2(1.6)		25(19.5)	2(1.6)	
Highest level of education							
None	5(3.9)	8(6.2)	2(1.6)		15(11.7)	0(0.0)	
Primary	1(0.8)	30(23.4)	14(10.9)	<0.001	44(34.3)	1(0.8)	0.039
Secondary	1(0.8)	32(25)	32(25)		56(43.8)	9(7.0)	
Tertiary	0(0.0)	1(0.8)	2(1.6)		2(1.6)	1(0.8)	
Tribe							
Indigenous	7(5.4)	50(39.1)	36(28.1)	0.350	86(67.2)	9(7.0)	0.548
Non-indigenous	0 (0.0)	19(14.8)	14(10.9)		31(24.2)	2(1.6)	
Received training							
No	7(5.4)	63(49.2)	45(35.1)	0.641	106(82.2)	9(7.0)	
Yes	0(0.0)	8(6.3)	5(4.0)		11(8.6)	2(1.6)	0.196
Knowledge grade							
Poor	-	-	-		7(5.5)	0(0.0)	
Fair	-	-	-		67(52.3)	4(3.1)	0.191
Good	-	-	-		43(33.6)	7(5.5)	

Table 4: Meat hygiene practices of respondents

Variable	Frequency	Percent (%)
Water sources (multiple response)		
Municipal supply	118	92.2
Well	52	40.6
Rain	2	1.6
Hand washing before handling meat	127	99.2
Hand washing after use of the toilet	127	99.2
Frequency of washing instruments		
Daily	115	89.8
Twice daily	1	0.8
Twice weekly	1	0.8
Others (after each use, not at all, when needed)	11	8.6
Keeps nails short	115	89.8
Avoid work when ill	109	85.2
Handling of meat when injured	86	67.7
Storage of leftover meat by refrigeration	128	100.0
Wearing of gloves when handling meat	8	6.3
Frequency of washing aprons/overalls		
Daily	37	29.1
Once a week	30	23.6
Twice weekly	13	10.2
Thrice weekly	21	16.5
Only when adjudged dirty	18	14.2
No fixed time	8	6.3
Covering of nose and mouth when coughing	116	90.6
Item used to cover when coughing		
Palms	70	58.8
Piece of cloth	49	41.2
Meat of present day inspected	126	98.4
Location of slaughter of meat for present day		
Floor/ground	112	89.6
Slaughter slab	13	10.4
Meat covered while on table	4	3.1
What is done with unused parts		
Sold	99	77.3
Burnt	15	11.7
Dumped	12	9.4
Flushed	2	1.6
What was done with animals rejected for slaughter in the last 2 weeks		
Slaughtered	110	85.9
Treated	18	14.1

Table 5: Microbial quality of fresh beef based on different slaughter sites (mean ± standard deviation)

Slaughter sites	No. sampled	Total viable count (cfu/ml)	Total coliform count (cfu/ml)
Site 1	10	$2.1 \times 10^3 \pm 1.5 \times 10^3$	$3.3 \times 10^2 \pm 1.2 \times 10^2$
Site 2	10	$3.0 \times 10^3 \pm 1.1 \times 10^2$	$1.2 \times 10^3 \pm 7.1 \times 10^2$
Site 3	10	$1.2 \times 10^3 \pm 5.2 \times 10$	$1.3 \times 10^2 \pm 10.0$
Site 4	10	$3.0 \times 10^3 \pm 3.2 \times 10^2$	$1.6 \times 10^3 \pm 5.3 \times 10^2$
Site 5	10	$4.6 \times 10^3 \pm 1.9 \times 10^3$	$5.8 \times 10^2 \pm 5.5 \times 10^2$
Site 6	10	$4.0 \times 10^3 \pm 8.4 \times 10^2$	$1.6 \times 10^3 \pm 1.2 \times 10^3$

Table 6: Distribution of bacterial isolates in relation to slaughter sites

Slaughter sites	No. sampled	*E.coli*	*Pseudomonas spp*	*Enterobacter spp*	*S.typhi*	*S.paratyphi A.*	*Citrobacter spp.*
Site 1	10	3 (30.0)	0 (0.0)	6 (60.0)	0 (0.0)	0 (0.0)	0 (0.0)
Site 2	10	6 (60.0)	4 (40.0)	0 (0.0)	0 (0.0)	2 (2.0)	0 (0.0)
Site 3	10	3 (30.0)	6 (60.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Site 4	10	4 (40.0)	2 (20.0)	0 (0.0)	4 (40.0)	0 (0.0)	0 (0.0)
Site 5	10	6 (60.0)	4 (40.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Site 6	10	4 (40.0)	2 (20.0)	0 (0 .0)	0 (0.0)	2 (20.0)	1 (10.0)
Total	60	26(43.3)	18 (30.0)	6 (10.0)	4 (6.7)	4 (6.7)	1 (1.7)

Discussion

All the respondents in the study were male. This is not surprising as it is typically regarded as a job for males especially in this environment. The young age and low educational status is a finding consistent with other studies conducted among meat handlers in abattoirs in this country.[17,18] It is a job that requires physical strength and no formal training hence can easily be taken up as a profession by those who are young and are not able to further their education.

Meat is a highly nutritious food item providing protein, fat and minerals to humans. In its raw form, it is a good substrate for the multiplication and growth of microorganisms. Butchers serve as a link for consumers to meat that is slaughtered and prepared for sale. They are a key point in maintaining the hygiene of meat sold to consumers. In this study less than 30% were aware of what the term meat hygiene meant. Notwithstanding, more than half had a fair knowledge of what is required for meat hygiene. Their knowledge regarding cleaning instruments, work slabs and hand washing were high but other aspects of hygiene such as use of PPE, cough etiquette, illness and injury management during work were lower. This finding was quite similar to that in a study conducted in Andhra Pradesh.[19] It has been found in other studies that the knowledge of hygiene among butchers is usually poor to fair.[18,20,21] Knowledge was found to be statistically significantly related to level of education. This finding was also demonstrated in a study where they found increasing levels of knowledge with increasing level of education among meat handlers.[22] Lack of training among meat handlers has been reported in Ethiopia and Nigeria[18,23,24]and has been noted to influence both knowledge and practice among butchers and meat

handlers. In contrast, most of the respondents in this study had no training but that was not found to be associated with either knowledge or practice no association could be established.

The practices found among most of the study population was found to be fair. It was also found to have a statistically significant relationship with level of education. This is consistent with findings in other studies conducted in Nigeria and other African countries.[17,21,25] However quite a number of their practices had implications for the meat they were handling. Less than 30% would wash their aprons/overalls daily, most would not use gloves, most would use their palm to cover their mouths when coughing and most would still handle meat while having injuries. All these give room for contamination and cross contamination of meat and endangers not only consumers but the meat handlers themselves. The animals were inspected infrequently, found to be slaughtered on the floor, with mixed sources of water in use and exposure of meat during sale. A worrisome practice is the sale of meat that had been condemned, a practice that would endanger the lives of consumers from zoonotic infections. This supports the finding of poor inspection practices and enforcement of rules and regulations as documented in a study conducted in Benue State, Nigeria that found poor assessment of livestock and inspection issues in several abattoirs.[26] The reported conditions of the abattoir showed less than adequate accessibility to hand washing and toilet facilities, lack of PPE and ineffective laws guiding its operations. A case report on the Jos abattoir also made observations on these conditions and poor practices that were prevalent there.[13] These same practices are prevalent in other abattoirs around the country.[27,28,29] A limitation of this study was not being able to verify all the practices as some were not being conducted at that time and respondents could have provided inaccurate responses to the questions asked.

The results of the microbial analysis on meat samples showed high levels of microbial contamination. These findings are comparable with several studies where poor hygienic practices were also documented.[23,30,31] In contrast, microbial loads assessed in European abattoirs where hygiene standards are much higher showed undetectable levels of contamination.[32] Though direct links between hygiene and microbial loads were not established in this study, it is evident that when compared with the finding in the European abattoirs, improved hygiene practices would lead to lower contaminant levels. It is also documented that contamination levels up to 10^5cfu/100 ml indicate that the meat was slaughtered under unsatisfactory hygienic conditions and the levels in this study are extremely higher than that threshold. The most prevalent microbe isolated were the coliforms E. coli and Pseudomonas. Coliforms are indicative of faecal contamination and repeatedly are identified when meat is being assessed for contamination by microorganisms.[23,31,33,34] The findings in this study of fair levels of knowledge and practice of meat hygiene less than ideal conditions in the abattoir and the high level of microbial growth found on the meat samples are a matter of concern. Being a government owned facility, the responsibility falls on them to fully train meat handlers operating on the premises and provide facilities that protect the hygiene of the meat slaughtered and sold in the abattoir. There should also be an increased level of supervision by the relevant authorities. This will serve to reduce exposure of consumers to infectious diseases potentially present on the meat.

Conflict of interest

The authors declare that there is no conflict of interest in the production of this manuscript.

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