



Microbial Quality of Beef in the Yendi Municipality of Ghana

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ABSTRACT

The microbial quality of beef, table and apron in five meat retail shops in the Yendi Municipality of Ghana was investigated in order to ascertain their safety. The shops were selected from Central market A (external), Central market A (internal), Central market B, Central mosque and Taxi rank. A total of 45 samples were collected, 9 from each meat shop (retailer). The samples were stored under 4°C for transportation to the laboratory. Microbiological analysis was carried out immediately upon arrival in the laboratory under aseptic conditions. Beef, table and apron samples from Central market B had the highest mean total bacterial count of 5.8×10^7 cfu/cm², followed by Taxi rank (9.5×10^6 cfu/cm²), Central mosque (1.5×10^6 cfu/cm²), Central market A (external) (1.0×10^6 cfu/cm²) and Central market A (internal) (8.1×10^5 cfu/cm²). Mean bacterial count of beef, table and apron were 5.0×10^6 cfu/cm², 3.7×10^7 cfu/cm² and 3.1×10^5 cfu/cm², respectively. Table surface bacterial count from Central market B was significantly higher ($p < 0.05$) than bacterial counts from the other samples. Bacterial species identified on the beef, apron and table samples were *Staphylococcus* spp., *Escherichia coli*, *Streptococcus* spp., *Pseudomonas* spp., *Proteus* spp., and *Bacillus* spp. Among the five meat shops/retailers sampled, Central market B was the most contaminated shop. Table surfaces were also the most contaminated source compared to beef and apron. *Staphylococcus* spp. and *Escherichia coli* were the most common identified bacteria. There is the need for improvement in the standard of selling meat in the Yendi Municipality.

Keywords: Apron, beef, microbial quality, table, retail shops

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INTRODUCTION

Animal production is an integral part of Ghana's agricultural economy and a major source of livelihood for many rural households in the Yendi Municipality. Ruminants such as cattle, goats and sheep and non-ruminants such as poultry and pigs are reared in Yendi (Adzitey, 2013). Animal protein is essential in human diets because the amino acid composition of animal protein

matches closely to that of humans (Warriss, 2010). Even though meat is very important to humans it can also be detrimental when contaminated with pathogenic microorganisms. The food that we eat is also rarely if ever sterile, they carry microbial associations whose composition depends upon which organism gain access and how they grow, survive and interact in food over time (Adams and Moss, 2008). The microorganism present will originate from the natural microflora of the raw material and those organisms introduced in the cause of harvesting\slaughter, processing, storage and distribution (Adams and Moss, 2008).

Some foodborne pathogenic microorganisms that contaminate meat are *Staphylococcus spp.*, *Aspergillus spp.*, *Salmonella spp.*, *Campylobacter spp.*, *Listeria monocytogenes*, *Enterococcus spp.*, *Streptococcus spp.*, and *Escherichia coli* (Jay et al., 2005; Adams and Moss, 2008; Adzitey et al., 2010; Adzitey et al., 2011; Adzitey et al., 2012a; Adzitey et al., 2012b; Adzitey et al., 2013). Foodborne pathogens cause human illnesses and some deaths in developed and developing countries including Ghana. A good meat ready for consumption should not contain foodborne pathogens or their toxins that will be injurious to human health. It is therefore important to conduct research to determine the microbial quality of beef, to create awareness of the microbial safety of meat. The objective of this study was to determine the microbial quality of beef in the Yendi Municipality of Ghana.

MATERIALS AND METHODS

Location, duration and data collection

Samples were collected from five retail shops in the Yendi Municipality. The Municipal is located in the eastern corridor of the Northern Region of the Republic of Ghana between latitude 9°-35°N, 0°-30°W, and 0°-15°E (Population and Housing Census, 2010). This study took place between January, 2013 and July, 2013. A total of 45 samples were collected from five different meat retail shops in the Yendi Municipality using random sampling. Nine (9) samples were taken from each shop. The retail shops were Yendi market shop A internal, Yendi market Shop A external, Yendi market Shop B, Central mosque shop and Taxi rank shop. Table 1 shows the breakdown of the meat shops, type and number of samples examined. Swabs were taken from the table, apron and the meat. The swabs were transported to the University for Development Studies (U.D.S) Microbiology Laboratory under 4°C and microbiological analysis carried out immediately upon arrival.

Table 1: Meat shop, type and number of samples examined at the Yendi Municipality

Meat shop	Type of sample and number examined		
	Beef	Table	Apron
Central market A (internal)	3	3	3
Central market A (external)	3	3	3
Central market B	3	3	3
Central mosque	3	3	3
Taxi rank	3	3	3
Total	15	15	15

Microbiological analysis and identification of bacteria genera

Swabs were placed in 10 ml sterile peptone water and thoroughly shaken to obtain the neat (10^1). One (1) ml of the neat was transferred into 9 ml sterile peptone water until 10^6 was obtained. Thus serial dilutions were made from 10^1 to 10^6 and were spread plated onto blood and nutrient agar plates. Plates were incubated at 37°C for 24 hours under aerobic condition and the colony forming units were counted to obtain the microbial load. Colony forming unit was calculated using the formula:

$$N = \frac{\Sigma C}{[(1 \times n_1) + (0.1 \times n_2)] \times (d)}$$

N = Number of colonies per cm^2

ΣC = Sum of all colonies on all plates counted

n_1 = Number of plates in first dilution counted

n_2 = Number of plates in second dilution counted

d = Dilution from which the first counts were obtained

Some colonies with different shape, colour and appearance were picked at random from plate count agar and identified using Gram staining. The morphology and colour of the colonies under the microscope was compared to that of Anonymous (2013) to aid in the identification of the various genera. Other tests like catalase test, oxidase test and growth on McConkey (lactose and sorbitol) agars and blood agar were used to confirm some of the isolates.

Statistical analysis

Data obtained was analyzed using Statistical Package for the Social Sciences (SPSS) version 17.0 at 95% confidence level.

RESULTS AND DISCUSSION

The result obtained from sampling five meat retail shops is presented in Table 2. From Table 1, the total bacteria count for beef, table and apron ranged from 1.3×10^4 cfu/ cm^2 to 1.7×10^8 cfu/ cm^2 . The total mean microbial load was 5.8×10^7 cfu/ cm^2 , 9.5×10^6 cfu/ cm^2 , 1.5×10^6 cfu/ cm^2 , 1.0×10^6 cfu/ cm^2 , and 8.1×10^5 cfu/ cm^2 for Central market B, Taxi rank, Central mosque, Central market A (external), and Central market A (internal), respectively. Thus Central market B retail shop had the highest total mean count of 5.8×10^7 cfu/ cm^2 followed by the Taxi rank retail shop with a total mean count of 9.5×10^6 cfu/ cm^2 and the least was the Central market A (internal) with a total mean count of 8.1×10^5 cfu/ cm^2 . In general, there were no significant differences ($p > 0.05$) among all the type of samples examined except table surfaces from Central market B which was significantly higher ($p < 0.05$) than the rest of the samples. The high bacteria count in the Central market B was above 10^6 and meat samples with microbial load above 10^6 is said to be unsatisfactory (Wilson *et al.*, 1981). The high level of contamination in this shop can be attributed to the fact that retailers in this area sell under shade, (exposed to the external environment) and practice unhygienic practices.

Table 2: Total aerobic bacteria count

Meat shop	No. of samples examined	Sample examined (cfu/cm ²)		
		Beef	Table	Apron
Central market A (internal)	9	1.9×10 ^{5a}	2.2×10 ^{6a}	2.5×10 ^{4a}
Central market A (external)	9	1.6×10 ^{5a}	2.9×10 ^{6a}	2.5×10 ^{4a}
Central market B	9	4.1×10 ^{4a}	1.7×10 ^{8b}	1.3×10 ^{4a}
Central mosque	9	2.4×10 ^{6a}	8.5×10 ^{5a}	1.3×10 ^{6a}
Taxi rank	9	2.2×10 ^{7a}	6.0×10 ^{6a}	2.1×10 ^{5a}
Total mean	45	5.0×10 ⁶	3.7×10 ⁷	3.1×10 ⁵

Means (cfu/cm²) in the same row and column with different superscripts are significantly different ($p \leq 0.05$).

Observation made shows that the meat here is placed on tables which are not well cleaned after a day's work and in the open with houseflies hovering around the beef. The butchers themselves pay little concern to their personal hygiene and serve the meats with dirty hands and clothing. Prescott *et al.* (2002) reported that, the muscle tissues of healthy animals are free of microorganisms. However the muscle tissues are easily contaminated with both pathogenic and non-pathogenic microorganisms at the time of slaughter under poor processing conditions. In addition the high nutritive value of meat makes it an ideal medium for bacterial growth.

On comparing the microbial contamination at various retail shops it was observed that those retailers who sell in a closed environment (Central market a internal and Central market A external) had less microbial count than the rests. For instance, Central market A internal had the least average microbial count, and this meat shop was located within a block building housing numerous butchers with their meat displayed on tables. The building is well aerated with covered windows. This seems to reduce the number of flies within the building. The meats sold here are obtained from the abattoir. The main sources of contamination may be the unsterilized tables, apron and the handling of the meat with unsterilized instruments such as knives.

Other researchers have also investigated bacterial counts or types on beef and it related samples. Arthur *et al.* (2004) investigated the prevalence of *E. coli* and the number of aerobic bacteria and enterobacteriaceae at various steps in commercial beef processing plants and reported that 76% of animal hides coming into the plants were contaminated with *E. coli* O15, but no carcasses leaving the cooler were contaminated with *E. coli* O157. They also reported aerobic plate and enterobacteriaceae counts average of 7.8 and 6.2 log cfu/100cm², respectively, on hides, and 1.4 and 0.4 log cfu/100cm², respectively, on chilled carcasses. Swabs from 48 beef carcasses were all positive for aerobic bacteria with 99.8% of the samples, having total counts of ≤ 100000 cfu/cm² (Bohaychuk *et al.*, 2011). Coliform bacteria were isolated from 22.4% beef carcasses (Bohaychuk *et al.*, 2011). Goja *et al.* (2013) analyzed 40 samples of fresh meat (beef) randomly selected from Khartoum, Omdurman and Bahri in Khartoum State, Sudan and found that total viable count ranged from 4.78×10^4 to 3.39×10^5 cfu/g and *Staphylococcus* count ranged from 3.23×10^3 to 8.7×10^3 cfu/g. Out of 340 (250 raw meat samples and 90 surface swabs from meat processing equipment samples), 84% were found to be contaminated with bacterial species, including *Klebsiella*, *Enterobacter*, *Staphylococcus aureus* and *Bacillus subtilis* (Ali *et al.*, 2010).

Microbial load on beef, table and apron

The genera of bacteria identified from beef, table and apron is shown in Table 3. From Table 3 beef sold in the Municipality was contaminated with various genera of bacteria with *Staphylococcus spp.* and *Escherichia coli* being the most commonly identified bacteria probably due to the poor slaughtering, handling, and environmental conditions. The mean viable count

found on the beef showed that apart from the beef sold in the Central market B retail shop with a mean total bacteria count of 5.8×10^7 cfu/cm², all the beef from the retail shops were not spoiled since counts were 10^6 cfu/cm² or less. Nevertheless the isolation of pathogenic organisms like *Escherichia coli* which is important food-borne pathogen is of public health concern. Consumers are therefore at risk of consuming beef from the various meat shops around Yendi Municipality and adequate cooking will be needed to kill these pathogens.

Table 3: The genera of bacteria identified from beef, table and apron

Meat shop	Beef	Table	Apron
Central market A (internal)	<i>Staphylococcus spp.</i> , <i>Streptococcus spp.</i> , <i>Escherichia coli.</i> , <i>Bacillus spp.</i>	<i>Staphylococcus spp.</i> , <i>Proteus spp.</i> , <i>Pseudomonas spp.</i> , <i>Escherichia coli.</i>	<i>Staphylococcus spp.</i> , <i>Streptococcus spp.</i> , <i>Escherichia coli.</i> , <i>Mucor spp.</i>
Central market A (external)	<i>Staphylococcus spp.</i> , <i>Streptococcus spp.</i> , <i>Mucor spp.</i>	<i>Staphylococcus spp.</i> , <i>Pseudomonas spp.</i> , <i>Proteus spp.</i> , <i>Escherichia coli.</i>	<i>Staphylococcus spp.</i> , <i>Mucor spp.</i> , <i>Pseudomonas spp.</i> , <i>Escherichia coli.</i>
Central market B	<i>Staphylococcus spp.</i> , <i>Pseudomonas spp.</i> , <i>Bacillus spp.</i> , <i>Proteus spp.</i>	<i>Staphylococcus spp.</i> , <i>Pseudomonas spp.</i> , <i>Escherichia coli.</i>	<i>Staphylococcus spp.</i> , <i>Streptococcus spp.</i> , <i>Escherichia coli.</i>
Central mosque	<i>Staphylococcus spp.</i> , <i>Pseudomonas spp.</i> , <i>Proteus spp.</i> , <i>Escherichia coli.</i>	<i>Staphylococcus spp.</i> , <i>Proteus spp.</i> , <i>Bacillus spp.</i>	<i>Staphylococcus spp.</i> , <i>Pseudomonas spp.</i> , <i>Bacillus spp.</i> , <i>Escherichia coli.</i>
Taxi rank	<i>Staphylococcus spp.</i> , <i>Bacillus spp.</i> , <i>Pseudomonas spp.</i> , <i>Proteus spp.</i> , <i>Escherichia coli.</i>	<i>Staphylococcus spp.</i> , <i>Proteus spp.</i> , <i>Pseudomonas spp.</i> , <i>Bacillus spp.</i> , <i>Escherichia coli.</i>	<i>Staphylococcus spp.</i> , <i>Streptococcus spp.</i> , <i>Bacillus spp.</i>

The meat cutting table was highly contaminated with a total mean bacteria count of 3.7×10^7 cfu/cm² and Central market B had the highest count of 1.7×10^8 cfu/cm². Most retailers in the municipality cover the table with a piece of cardboard instead of washing after the days' work and the continuous addition of pieces of meat provide a source of nutrient for the growth of bacteria. Also, the temperature ranges between 21°C to 36°C which is conducive for bacteria growth. Reynolds *et al.* (2005) stated that about 80% of infectious diseases are spread through hand contact with hands and other objects. Some of the genera of bacteria that were identified on the table were *Staphylococcus spp.*, *Escherichia coli*, *Bacillus spp.* and *Proteus spp.* These Bacteria are easily transferred to the meat due to close contact and continuous turning of meat during cutting (FAO, 1991).

Apron contains total mean count of 3.1×10^5 cfu/cm² and Central mosque had the highest value of 1.3×10^6 cfu/cm². It was observed that most of the retailers only put on their apron when they want to sell bones whilst others use the aprons to clean the cutting edge when about to sell meat. Also the apron is left on the table containing the meat. This gives a clear idea why most of the genera of bacteria on the table are also found on the apron. Rombouts and Nouts (1994) reported that, the clothing or hands of the personnel and the physical facilities are all sources implication of foodborne illnesses.

It was found that *Staphylococcus spp.* runs through all the retail shops. This can be due to contamination from the skin of the animal/humans or other unhygienic place in the abattoir during the process of slaughtering. This is in agreement with report by Postgate (2000) that *Staphylococcus spp.* can be part of the normal flora on the skin of humans and animals which can be transmitted from person to product through unhygienic practices. A similar work done by Adzitey et al. (2011) in the Tamale Metropolis revealed that, animals are slaughtered in abattoirs and sometimes in backyards without observing strict hygienic practices. It is also a common practice to see people carrying carcasses just after dressing on their bare shoulders (Adzitey et al., 2011). Sulley (2006) reported that, the vehicles and trucks for transporting carcasses are inadequate, and compelling others to use motor-bikes and bicycles as a means of transport. The same researcher reported that, the few transports are not properly cleaned and thus contained high microbial loads. Ansah et al. (2009) found various levels and numbers of total bacteria count, *Streptococcus spp.*, *Staphylococcus spp.*, *Bacillus spp.*, *Escherichia coli*, *Micrococcus spp.*, *Diplococci spp.* and *Corynebacteria spp.* on eggs sold in the Tamale Metropolis.

The general of bacteria identified in this study include many species which are non-pathogenic, and form part of the commensal human microbiome of the mouth, skin, intestine, and upper respiratory tract. However, some species of these genera can be pathogenic or cause food spoilage. For instance, *Escherichia coli* can cause gastroenteritis, urinary tract infections, neonatal meningitis, hemolytic-uremic syndrome, peritonitis, mastitis, septicemia and pneumonia (Guentzel., 1996; Jay, 2000; Adams and Moss, 2008; Adzitey, 2011). *Bacillus spp.* includes species that cause anthrax, food spoilage and food poisoning similar to that caused by *Staphylococcus* (Guentzel., 1996; Jay, 2000; Adams and Moss, 2008). *Staphylococcus aureus* and *Pseudomonas aeruginosa* are currently the most common pathogens in nosocomial pneumonia, followed by *Enterobacter* and *Klebsiella* (Guentzel., 1996; Adams and Moss, 2008). *Pseudomonas spp.* also causes food spoilage (Jay, 2000). *Streptococcus spp.* can cause septic sore throat, scarlet fever, septicemia infections, meningitis, endocarditis, erysipelas and necrotizing fasciitis (FDA, 2013). *Proteus spp.* includes pathogens responsible for wound and many human urinary tract infections (Guentzel, 1996). Some *Mucor spp.* can cause mucormycosis which is characterized by thrombosis and tissue necrosis (Badior et al., 2013).

CONCLUSION

Beef sold at the Central market B was the most contaminated and contains various genera of bacteria that can be injurious to human health (*Escherichia coli*, *Staphylococcus spp.*, *Bacillus spp.*). Nevertheless beef sold in the other retail shops were found to be near unacceptable limits and contain some genera of bacteria that are of public health concern. Table sources were the most contaminated, followed by beef and apron. General observation also revealed that beef were under unhygienic conditions. It is recommended that retailers/butchers should be educated on the need to practice personal hygiene.

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