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Prevalence of *Escherichia coli* and *Salmonella* spp. in Beef Samples Sold at Tamale Metropolis, Ghana

Frederick Adzitey
Department of Animal Science, University for Development Studies, P.O. Box TL 1882, Tamale, Ghana, West Africa

ABSTRACT

This work reports for the first on the prevalence of *Escherichia coli* and *Salmonella* spp. in beef sold in the Tamale Metropolis. The conventional method was used to isolate *Escherichia coli* and *Salmonella* spp. from beef samples sold at the Tamale Metropolis. Seventy beef samples were obtained from seven different locations where meat is popularly sold in the Tamale Metropolis and analyzed microbiologically for *Escherichia coli* and *Salmonella* spp. by following procedures in the Bacteriological Analytical Manuel of the FDA-USA. The average prevalence of *Escherichia coli* was 56% and was highest in Location G (100%), followed by Location C (80%), Locations D and F (60%), Location B (50%) and Location E (40%). *Escherichia coli* was not isolated from Location A. The overall prevalence of *Salmonella* spp. in the beef samples was 31%. The location with the highest prevalence of *Salmonella* spp. was Location F (90%), followed by Location D (50%), Location E (30%) and Location C (20%). Locations A, B and G exhibited a prevalence of 10%. Locations with better hygienic standards exhibited low prevalence of *Escherichia coli* and *Salmonella* spp. The study indicated that beef samples sold in the Tamale Metropolis were contaminated by *Escherichia coli* and *Salmonella* spp. Thus, consumers are exposed to *Escherichia coli* and *Salmonella* spp. infections from consuming beef samples in Tamale.

Key words: Beef, conventional method, *Escherichia coli*, foodborne infections, *Salmonella* spp.

INTRODUCTION

Escherichia coli and *Salmonella* spp. are gram negative facultative anaerobe bacteria and are widely distributed in the gastrointestinal tract of farm animals (WHO, 2005; Adams and Moss, 2008; Feng and Weagant, 2009; Frederick, 2011; Frederick and Huda, 2011; Adzitey *et al*., 2012a). They are also members of the family Enterobacteriaceae and ferment glucose and/or lactose (Frederick, 2011; Frederick and Huda, 2011). Li *et al*. (2004) reported that in studies of meat species, *Escherichia coli* O157: H7 and *Salmonella* spp. are among the important pathogens in terms of human health and diseases. *Escherichia coli* and *Salmonella* spp. have been isolated from sick and healthy people and from a variety of meat and meats products (Li *et al*., 2004; Adzitey *et al*., 2010, 2011, 2012a, b, 2014; Zhao *et al*., 2001; Salihu *et al*., 2012; Adimasu *et al*., 2014; Carnot *et al*., 2014; Geck *et al*., 2014; Gunasekaran *et al*., 2014; Olowokere *et al*., 2014). In the USA, Mead *et al*. (1999) reported that nontyphoidal *Salmonella serovars* caused about 1.4 million cases of human illnesses while, pathogenic *Escherichia coli*, caused 270,000 cases of human illness. Scallan *et al*. (2011) also reported that nontyphoidal *Salmonella* spp. was the second largest cause of foodborne illnesses (11%), the leading cause of hospitalizations (35%) and death (28%) in the

USA. In the United Kingdom 8,798 confirmed cases of nontyphoidal *Salmonella* infection were reported while 1,277 cases of *Escherichia coli* infection were reported (DEFRA. 2010). The afore-mentioned data emphasizes on the significance of *Escherichia coli* and *Salmonella* spp. in human foodborne illnesses.

The three Northern regions of Ghana account for the production of most of the cattle in Ghana (Adzitey, 2013) and consequently beef production in Ghana, although some cattle are imported into Ghana from neighbouring countries. Thus, the importance of cattle in the Northern region of Ghana cannot be over emphasized. The importance varies from the provision of food (meat in the form of beef), to employment, income, family prestige, draught power and many more. Beef is a ready source of animal protein to most Ghanaians. The muscle of healthy living cattle is essentially sterile (Warriss, 2000). Contamination of muscles, carcasses or meat including beef occurs from poor or faulty processing of animals during pre and post slaughter handling (Adzitey and Huda, 2012; Adzitey, 2011; Adzitey and Nurul, 2011). Unhygienic methods of slaughtering and processing cattle are very common in Tamale (Adzitey *et al*., 2010, 2011). These methods expose beef to pathogenic foodborne pathogens.

There is very limited research on the prevalence of *Escherichia coli* and *Salmonella* spp. in beef sold in the Tamale Metropolis. Therefore, this study was carried out to determine the occurrence of *Escherichia coli* and *Salmonella* spp. in beef sold in the Tamale Metropolis.

MATERIALS AND METHODS

Location of study: The study was conducted in Tamale Metropolis. Tamale is the capital town of the Northern Region of Ghana. It is located within the Guinea Savannah belt. Tamale is the third most populous settlement in Ghana, in terms of population, with a population of 537.986 people. Tamale metropolis can be located on longitude 09°24'27" North and latitude 00°51'12" West. The Tamale Metropolis occupies approximately 750 km^2, which is 13% of the total area of the Northern Region.

Sample collection: The surfaces of 70 beef carcasses from seven different locations in Tamale Metropolis, where meat is popularly sold were swabbed using sterile cotton swabs. A surface area of about 10 cm^2 was swabbed for each sample and ten beef swab samples were collected from each location. The swabs were stored in an ice chest containing ice blocks and transported to the laboratory where analysis was carried out immediately upon arrival for the presence of *Escherichia coli* and *Salmonella* spp. Sampling was done from May 2014 to September 2014. General observation on the conditions under which meat is sold in the Tamale Metropolis was also made during data collection.

Bacteriological analysis: Analysis for *Escherichia coli* and *Salmonella* spp. were done using a modified method according to the Food and Drug Administration-Bacteriological Analytical Manual (FDA-BAM) (Wallace and Hammack, 2007; Feng and Weagant, 2009). Briefly a swab was pre-enriched in 10 mL buffered peptone water and incubated at 37°C for 24±2 h. For *Escherichia coli*, a loopful of the aliquots (ca. 10 µL) from the buffered peptone water was streaked onto Levine's Eosin-Methylene Blue (LEMB) agar and incubated at 37°C for 24±2 h. Presumptive *Escherichia coli* colonies appear as dark centered and flat, with or without metallic sheen. One to three colonies showing such characteristic nature were picked from each plate and purified on nutrient agar. They were identified and/or confirmed using Gram staining, *Escherichia coli* latex agglutination test and

biochemical tests. For *Salmonella* spp., 0.1 and 1 mL of pre-enriched aliquots (buffered peptone water) were transferred into 10 mL rappaport and vassiliadis broth and 10 mL selenite cystine broth, respectively for enrichment. Enrichment samples in rappaport and vassiliadis broth were incubated at 42°C for 24 h while, those of the selenite cystine broth were incubated at 37°C for 24 h. Enriched aliquots (ca. 10 μL) were then streaked onto xylose lysine deoxycholate and brilliant green bile agar and incubated at 37°C for 24-48 h. Presumptive *Salmonella* spp. were purified on MacConkey and nutrient agar and were identified and/or confirmed using Gram staining, *Salmonella* latex agglutination test and biochemical tests. All incubations were done under aerobic condition and all media used were purchased from Oxoid, UK.

RESULTS

The results for the prevalence of *Escherichia coli* and *Salmonella* spp. in beef samples examined in the Tamale Metropolis is presented in Table 1. The overall prevalence of *Escherichia coli* and *Salmonella* spp. was 56% (39/70) and 31% (22/70), respectively. The highest prevalence occurred in Location G 100% (10/10) for *Escherichia coli* and Location F 90% (9/10) for *Salmonella* spp. Higher percentage of beef samples obtained from Locations C (80%), D (60%) and F (60%) were contaminated by *Escherichia coli*. Fifty percent of beef samples obtained from Location G were contaminated by *Salmonella* spp. *Escherichia coli* was not isolated from Location A. The least occurrence of *Salmonella* spp. were Locations A, B and G which recorded 10% (1/10) for each of the locations.

DISCUSSION

The study provides useful information to consumers and all stake holders about the presence of *Escherichia coli* and *Salmonella* spp. in beef samples sold in the Tamale Metropolis and the risk of contracting *Escherichia coli* and *Salmonella* spp. infections from the consumption of beef in the Metropolis. Of the 70 beef samples tested, 39 (56%) were positive for *Escherichia coli*. The prevalence of *Escherichia coli* was highest in Location G 100% (10/10). The prevalence of *Escherichia coli* in the other locations were Location C 80% (8/10), Locations D and F 60% (6/10), Location B 50% (5/10) and Location E 40% (4/10). *Escherichia coli* was not isolated from Location A 0% (0/10). This result suggests that beef samples in the Tamale Metropolis are contaminated with *Escherichia coli*. Unhygienic conditions and practices such as butchers (meat sellers or processors) wearing dirty clothes and/or aprons, dirty surfaces of chopping tables, using the same knife in cutting beef carcasses without sterilization, mixing different meat types on the same chopping table, busily conversing while cutting and selling meat, houseflies hovering around meat

Table 1: Prevalence of *Escherichia coli* and *Salmonella* spp. in beef samples in tamale metropolis

	Escherichia coli		*Salmonella* spp.	
Location (n = 10)	No. of positive	%	No. of positive	%
A	0	0	1	10
B	5	50	1	10
C	8	80	2	20
D	6	60	5	50
E	4	40	3	30
F	6	60	9	90
G	10	100	1	10
Overall (n = 70)	39	56	22	31

and selling meat in untidy environments were observed. It was noticed that locations with high prevalence of *Escherichia coli* and *Salmonella* spp. compromised with most of the afore-mentioned unhygienic and conditions and practices. It is widely recognized that the presence of *Escherichia coli* in any food or water sample is an indication that, that food or water sample has been contaminated by faeces (WHO, 2005; Feng and Weagant, 2009; Nataro and Kaper, 1998; Burgess *et al*., 2005). The absence of *Escherichia coli* in Location A could be due to the relatively better hygienic conditions under which butchers in that location sold their meat. Some of the butchers in Location A had their tables covered with nets, wear neater clothings/aprons and sold meat under a much tidy environment. Even though no *Escherichia coli* was isolated in this location, it is possible this pathogen can be isolated at a different time if their hygienic standard falls or is lowered. The presence of *Escherichia coli* in the beef samples examined is worrying because certain strains of *Escherichia coli* such as strain *Escherichia coli* O157: H7 can cause food poisoning. Besides that, *Escherichia coli* can cause urinary infection, fever, vomiting, diarrhea, severe abdominal pain, hemorrhagic colitis, haemolytic-uremic syndrome and even death (Teophilo *et al*., 2002; Smith *et al*., 2003).

With regards to *Salmonella* spp., averagely 31% (22/70) of the beef samples were positive. The highest was found in Location F 90% (9/10). The prevalence of *Salmonella* spp. in other locations were Location D 50% (5/10), Location E 30% (3/10) and Location C 20% (2/10). Location A, B and G recorded a prevalence of 10% (1/10). Similarly to the results obtained for *Escherichia coli* in this study, beef samples in Tamale metropolis are contaminated by *Salmonella* spp.. The occurrence of *Salmonella* spp. in the various locations suggest the conditions under which beef is handled in the Tamale metropolis. Locations with high prevalence of *Salmonella* spp. have lower hygienic standards compared to locations with low prevalence. The isolation of *Salmonella* spp. in the beef samples examined is also of public health concern. This is due to the fact that *Salmonella* spp. cause Salmonellosis. Typical symptoms of illness associated with Salmonellosis include nausea, vomiting and diarrhea; additional complications associated with infection include septicemia, or reactive arthritis (Adams and Moss, 2008; Feng and Weagant, 2009). The pathogen *Salmonella* is also known to be a causative agent of gastroenteritis (Mead *et al*., 1999). Among all foodborne pathogens, *Salmonella* spp. is recognized to play a significant role in foodborne illnesses, hospitalizations and death of humans (Scallan *et al*., 2011).

In general, the beef samples were contaminated more by *Escherichia coli* (56%) than *Salmonella* spp. (31%). With the exception of Location A and Location F where beef samples had higher prevalence in *Salmonella* spp. than *Escherichia coli*, the rests of the Locations were dominated by *Escherichia coli*. In addition all the locations had beef samples being contaminated by both *Escherichia coli* and *Salmonella* spp. save Location A. Zhao *et al*. (2001) studied the prevalence of *Escherichia coli* in a variety of meat samples. They reported a prevalence of 39, 19 and 16% for chicken, beef and pork samples, respectively. In this study, a higher prevalence of 56% was observed in the beef sample. Li *et al*. (2004) reported the prevalence of *Escherichia coli* in Bison carcasses post-evisceration, post-washing and chilling to be 73.28, 56.89 and 11.3%, respectively. For *Salmonella* spp. it was 2.59% post-evisceration, 3.45% post-washing and 2.93% chilling (Li *et al*., 2004). Prevalence of *Escherichia coli* post-washing is similar to findings of this study. The prevalence of *Salmonella* spp. was higher in this present work than that of Li *et al*. (2004).

CONCLUSION

Beef samples in the Tamale metropolis were found to be contaminated by *Escherichia coli* and *Salmonella* spp. More beef samples were contaminated by *Escherichia coli* than *Salmonella* spp.

The occurrence of both *Escherichia coli* and *Salmonella* spp. differ in different locations, which is mainly due to the level of hygienic standards observed by the meat processors/sellers. Meat consumers and the public are exposed to food poisoning by consuming beef that is cooked improperly. Therefore, it is recommended that meat consumers in Tamale should cook (70°C for 15 min) their meat well before consuming it. Further research should investigate the antibiotic resistance and pathogenicity of *Escherichia coli* and *Salmonella* spp. in beef.

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