



Prevalence and Antibiotic Susceptibility of *Salmonella* species Isolated from Beef and its Related Samples in Techiman Municipality of Ghana

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ABSTRACT

Salmonella species are important foodborne pathogens that have been implicated in a number of foodborne outbreaks. A total of 240 beef and its related samples obtained from the Techiman Municipality of Ghana were screened using the conventional method in the Food and Drug Administration-Bacteriological Analytical Manual (FDA-BAM)-USA. The overall prevalence of *Salmonella* species was 57.08%. The prevalence of *Salmonella* species ranged from 33.30% to 75.00% in the meat and its related samples (table, knife and apron), and 6.30% to 93.80% at the various meat sale points (locations where meat is sold). Prevalence of *Salmonella* species was significantly higher in meat (75.00%), table (60.00%) and knife (60.00%), than apron (33.33%). The most contaminated meat sale point was Kenten and Main markets (93.75%) and the least contaminated sale point was Sansema junction (6.25%). All the *Salmonella* species were susceptible to ciprofloxacin but resistant to vancomycin. Intermediate resistances occur for all the antibiotics except ciprofloxacin and vancomycin. The *Salmonella* species also exhibited 23 antibiotic resistant patterns with the pattern EVa (erythromycin and vancomycin) being the commonest (exhibited by nine different isolates). Multiple antibiotic index (MAR index) ranged from 0.11 to 0.67. This study revealed that beef and its related samples in Techiman markets are contaminated with *Salmonella*.

Introduction

Salmonella species particularly non-typhoidal *Salmonella* species is recognized worldwide as an important foodborne pathogen. Scallan et al. (2011) estimated that non-typhoidal *Salmonella* species is the second largest cause of foodborne illnesses (11%) after norovirus (58%), the leading cause of hospitalizations (35%) and death (28%) in the United States of America. In the European Union, 91,034 human cases of salmonellosis were reported in 2012 (European Food Safety Authority, 2014). Hospitalizations and case fatality were 45.1% and 0.14%, respectively of confirmed salmonellosis cases (European Food Safety Authority, 2014). Saba et al. (2013) stated that data on salmonellosis is scarce especially in most developing and underdeveloped countries. In countries where data on salmonellosis are available, it is still believed that the magnitude of the incidence is underestimated, as many cases of salmonellosis are not reported (Forshell and Wierup, 2006). Symptoms of salmonellosis in healthy individuals include fever, diarrhoea, nausea, abdominal pain and vomiting (Centers for Disease Control and Prevention, 2013; Miller and Pegues, 2005). In immune-compromised individuals, elderly and children septicaemia, reactive arthritis as well as neurological and neuromuscular illnesses can occur (European Food Safety Authority, 2014; Forshell and Wierup, 2006).

Of all the non-typhoidal *Salmonella* species, *Salmonella* Enteritidis and *Salmonella* Typhimurium are the most frequently reported serovars associated with human foodborne salmonellosis (Department for Environment, Food and Rural Affairs, 2013; European Food Safety Authority, 2014). The common reservoir of non-typhoidal *Salmonella* species is the gastrointestinal tract of a wide variety of farm animals including poultry, pigs, sheep, goat and cattle (Adzitey et al., 2012a; Department for Environment, Food and Rural Affairs, 2013; European Food Safety Authority, 2014; Frederick and Nurul, 2011). *Salmonella* species in the gastrointestinal tract of farm animals can end up in meats, meat products and other foodstuffs through cross contamination. Contamination of beef, chevon, mutton, poultry meat, burgers, sausages and many more by *Salmonella* species has been reported (Adzitey et al., 2010; Adzitey et al., 2011; Adzitey et al., 2014; Bonardi et al., 2013; Department for Environment, Food and Rural Affairs, 2013; European Food Safety Authority, 2014; Kagambèga et al., 2013; Lai et al., 2014; Umeh and Enwuru, 2014). Resistance of foodborne pathogens including non-typhoidal *Salmonella* species is an increasing public health problem (Adzitey et al., 2012b; European Food Safety Authority, 2004). European Food Safety Authority (2004) reported that the risk to public

health from the selection of resistant organisms depends on the particular bacterium, the behaviour and prevalence of the bacteria, the antimicrobial in question, the type of resistance, and stage of animal production.

In Ghana, there are fewer reports on the prevalence and antibiotic resistance of *Salmonella species* in animals and humans. The few studies on *Salmonella species* have also concentrated much on humans rather than foodborne isolates (Awua-Boateng, 2007; Puopelle, 2014; Saba et al., 2013). However, food including meat and their related samples are important sources of *Salmonella species* and their association with foodborne infections in Ghana should not be ignored. In a survey by Danikuu (2004) in the Kumasi Municipality of Ghana, 15(6%) *Salmonella species* were isolated from various animal species. Adzitey et al. (2011) also isolated *Salmonella species* from meat samples in the Tamale Municipality of Ghana. Data on the prevalence and antibiotic resistance of *Salmonella species* in Techiman Municipality is unavailable. Therefore, we report for the first time on the prevalence and antibiotic resistance of *Salmonella species* in beef and its related samples in Techiman Municipality of Ghana.

Materials and Methods

Location of Study

The study was conducted in Techiman Municipality in the Brong Ahafo Region of Ghana. Techiman is located in the Southern part of Ghana and is one of the leading market towns in the south of Ghana (Anonymous, 2014). Techiman Municipality has a population of 104, 212 people and can be located on longitude 07°34'38"North and latitude 01°55'45"West (Anonymous, 2014).

Collection of samples

Two hundred and forty beef and its related samples were collected from various meat sale or processing point(s) in the Techiman Municipality between May 2013 to June 2014. The samples were taken at random from fourteen meat retail shops and one abattoir (the main abattoir in Techiman). Swab samples were collected from beef (n=60), tables (n=60), knives (n=60) and aprons (n=60). The samples were transported under 4°C in an ice chest and analyzed immediately on reaching the laboratory.

Isolation and Identification of *Salmonella Species*

Isolation and identification of *Salmonella species* was carried out using a modified method according to the Food and Drug Administration-Bacteriological Analytical Manual (FDA-BAM)-USA (Wallace and Hammack, 2007). Swabs were moistened with sterile distilled water just before swabbing. An area of 10cm² of beef, table, knife and apron samples was swabbed. Swabs were pre-enriched in 10ml Buffered Peptone Water (BPW) and incubated at 37°C for 24 hours. After which 0.1ml of pre-enriched aliquots were transferred into 10ml Rappaport and Vassiliadis (RV) and Selenite Cystine (SC) broths. Samples in RV broths were incubated at 42°C for 24 hours while samples in SC broths were incubated at 37°C for 24 hours (enrichment). After enrichment 0.1ml of the aliquots were streaked on Xylose Lysine Deoxycholate

(XLD) and Brilliant Green (BG) agars, and incubated at 37°C for 24-48 hours. Presumptive *Salmonella* colonies were picked, purified, Gram stained and subjected to the following biochemical tests; growth characteristics on triple sugar iron, lysine iron and Simon citrate agars, and urease production. *Salmonella* isolates were confirmed by Latex Agglutination Kit for *Salmonella* (Oxoid Limited, Basingstoke, UK). All media used were also purchased from Oxoid Limited, Basingstoke, UK.

Antimicrobial Susceptibility of *Salmonella Species*

The disk diffusion method of Bauer-Kirby (1966) was used to determine the antibiotic sensitivity of 45 *Salmonella* isolates against the following antibiotics; amoxicillin/clavulanic acid (Amc) 30µg; chloramphenicol (C) 30 µg; gentamicin (Cn) 10 µg; ceftriaxone (Cro) 30 µg; ciprofloxacin (Cip) 5 µg; erythromycin (E) 15 µg; suphamethoxazole/trimethoprim (Sxt) 22 µg; tetracycline (Te) 30 µg and vancomycin (Va) 30 µg. The disks were purchased from Oxoid Limited, Basingstoke, UK. Pure cultures of *Salmonella* were grown overnight in Tryptic Soy Broth (TSB) (Oxoid Limited, Basingstoke, UK) at 37°C and the concentration adjusted using sterile TSB until a 0.5 McFarland turbidity was attained. One hundred µl of the culture was then swabbed onto Mueller Hinton agar (Oxoid Limited, Basingstoke, UK) using a sterile cotton swab. Three antimicrobial disks were placed on the surface of the agar plate at a distance to avoid overlapping of inhibition zones. The plates were incubated at 37°C for 16 to 18 hours and the results were interpreted as sensitive, intermediate, or resistance according to Clinical and Laboratory Standards Institute guidelines (Clinical and Laboratory Standards Institute, 2006). *Escherichia coli* was used as control in the antimicrobial susceptibility test (Adzitey et al., 2012b).

The multiple antibiotic resistance (MAR) index was calculated and interpreted according to Krumperman (1983) using the formula: a/b, where 'a' represents the number of antibiotics to which a particular isolate was resistant and 'b' the total number of antibiotics tested.

Statistical Analysis

The data obtained was analysed using generalized linear model of Statistical Package for the Social Sciences (SPSS) Version 17.

Results and Discussion

Distribution of *Salmonella Species* in Beef and its Related Samples

The distribution of *Salmonella species* in beef and its related samples collected from Techiman is shown in Table 1. From Table 1, *Salmonella species* were isolated from beef (45/60), table (36/60), knife (36/60) and apron (20/60) samples. The prevalence of *Salmonella species* in apron was significantly lower (P<0.05) than that of beef, table and knife. Furthermore, beef (75.00%) samples were the most contaminated source, followed by table (60.00%) and knife (60.00%) samples. It is known that the high nutritive value of meat makes it an ideal medium for the growth of bacteria (Prescott et al., 2002). Apron (33.30%) samples were the least contaminated source.

The primary source of *Salmonella* contamination in this study can be from beef samples. Table surfaces can be contaminated by beef samples placed on them. Knives can be contaminated by beef and table surfaces during cutting. Aprons may have been contaminated by *Salmonella species* from beef, tables and/or knives. Particles of beef can splash onto aprons during cutting to contaminate them. Also processors might touch table or knife surfaces with their hands and unconsciously use them to rub on their aprons. This study indicates that beef and its related samples in Techiman Municipality of Ghana are contaminated with *Salmonella species* and consumers are at risk of contracting salmonellosis from consuming beef and/or contact with beef related samples in the Techiman Municipality.

The distribution of *Salmonella species* in different meat sale points in Techiman Municipality is presented in Table 2. Almost all the samples (15/16) examined at Kenten and Main markets were contaminated by *Salmonella species*. Most samples collected from slaughter house (14/16), Anyinabrem market (14/16), Site market (13/16), Hansua market (13/16), Brigade market (13/16), Nana Abena market (11/16) and Dwomor market (10/16) were also contaminated by *Salmonella species*. Isolation of *Salmonella species* < 7/16 was observed at Takofiannor, Ahenfie, Abanim, and Zongo markets, as well as Zongo-Tamale station and Sansema junction. There were significant differences ($P < 0.05$) in the prevalence of *Salmonella species* among the different meat sale points. Positive *Salmonella* samples from Kenten, Main, Anyinabrem, Site, Hansua, Brigade, Nana Abena and Dwomor markets, and Slaughter house did not differ significantly ($P > 0.05$) from each other but differed significantly ($P < 0.05$) from Ahenfie market, Abanim market, Zongo-Tamale station, Zongo market and Sansema junction. Kenten and Main markets were the most contaminated location (93.75%) while Sansema junction was the least contaminated location (6.25%). The findings of this study indicate that all meat sale points in the Techiman Municipality are contaminated by *Salmonella species* and the prevalence may vary and/or may be similar from location to location.

The differences in the prevalence observed in beef, table, knife and apron samples, and the various meat sale points suggest the level of hygienic practices observed in the handling and processing of meat in Techiman. The standard of hygienic practices in samples and locations with higher prevalence is lower than those samples and locations with lower prevalence. Adzitey et al. (2011) identify *Salmonella species* in beef sold in selected meat shops at the Tamale Metropolis of Ghana. They attributed the contamination of meat samples to a number of unhygienic practices practiced in the Tamale Metropolis. These practices include using unsterilized knives and equipment, working on dirty tables, selling meat in the open, wearing of dirty cloths and aprons, and busily conversing while selling meat. Contrarily to this study Addo et al. (2007) did not identify *Salmonella species* in food samples examined in ten selected hotels in Accra, the capital of Ghana. Danikuu (2004) isolated *Salmonella*

species 6% (15/250) from animals (fowls, pigs and sheep) in the Kumasi Metropolis of Ghana but cattle and goat samples were negative for *Salmonella species*. Adzitey et al. (2014) also did not identify *Salmonella species* in beef, apron and table samples examined at the Yendi Municipality of Ghana. Nonetheless they identified *Staphylococcus spp.*, *Streptococcus spp.*, *Bacillus spp.*, *Pseudomonas spp.*, *Escherichia coli* and *Proteus spp.* in the beef, apron and table samples (Adzitey et al., 2014).

The prevalence of *Salmonella species* in cattle or beef samples have been reported in other countries. In Nigeria, Umeh and Enwuru (2014) reported an overall prevalence of *Salmonella species* in livestock faeces to be 21.80% while that of cattle was 10.00%. *Salmonella species* were present (52%) in cattle faeces collected from a central abattoir at Ouagadougou, Burkina Faso (Kagambèga et al., 2013). In a study involving cattle in Texas, USA, 19.00% of feedlot cattle carcasses and 54.00% of adult cattle carcasses were positive for *Salmonella species* (Beach et al., 2002). Zhao et al. (2001) examined 210 ground beef samples in retail meats in Washington, DC, USA and found 4 (2%) to be positive for *Salmonella species*. Measures to reduce the spread of *Salmonella species* in cattle, beef and it related samples in Techiman and Ghana as a whole will include the practice of biosecurity, feed and water treatment, thermal treatment of carcasses, and the observance of good manufacturing practice (GMP) and hazard analysis critical control point (HACCP).

Antimicrobial Susceptibility

The antimicrobial susceptibility of 45 *Salmonella species* were determined against 9 antimicrobial agents, and the results are presented in Table 3. The overall resistance, intermediate and susceptibility was 35.50% (144/405), 7.90% (32/405) and 56.54% (229/405), respectively. All *Salmonella species* (100%) examined were resistant to vancomycin but susceptible to ciprofloxacin. A large percentage of the *Salmonella species* were also resistant to erythromycin (75.56%) and susceptible to gentamicin (86.67%), ceftriaxone (73.33%), sulphamethoxazole/trimethoprim (68.89%), chloramphenicol (62.22%), tetracycline (57.78%) and amoxicillin/clavulanic acid (57.78%). Intermediate resistances were observed for all the antibiotics except vancomycin and ciprofloxacin. Intermediate resistance refers to those *Salmonella species* that were not clearly resistant or susceptible. It has been suggested in clinical diagnoses that patients with intermediate results can be given a higher dosage of antibiotics (Lorian, 2005). Organisms that exhibit intermediate resistance also have the tendency to easily become resistant (Adzitey et al., 2012c). The use of antibiotics in the treatment of diseases and as growth promoters in farm animals, use of antibiotics for treating humans and other factors have been linked to the development of resistant microorganisms including *Salmonella species* (European Food Safety Authority, 2004; Krumperman, 1983). Resistant *Salmonella species* can contaminate carcasses, processing equipment, and other foods which pose a risk for public and animal health.

Table 1 Distribution of *Salmonella species* in beef, table, knife and apron samples

Location in Techiman	Number of samples tested	Number of positive samples	% Prevalence
Meat	60	45	75.00
Table	60	36	60.00
Knife	60	36	60.00
Apron	60	20	33.30
Overall	240	137	57.08

Table 2 Distribution of *Salmonella species* in different meat sale points in Techiman

Location in Techiman	Number of samples tested	Number of positive samples	% Prevalence
Kenten market	16	15	93.75
Main market	16	15	93.75
Slaughter house	16	14	87.50
Anyinabrem market	16	14	87.50
Site market	16	13	81.25
Hansua market	16	13	81.25
Brigade market	16	13	81.25
Nana Abena market	16	11	68.75
Dwomor market	16	10	62.50
Takofiannor market	16	6	37.50
Ahenfie market	16	4	25.00
Abanim market	16	3	18.75
Zongo-Tamale station	16	3	18.75
Zongo market	16	2	12.50
Sansema junction	16	1	6.25
Overall	240	137	57.08

Table 3 Percentage antibiotic resistance of *Salmonella species* isolated from meats and it related samples

Antimicrobial	<i>Salmonella species</i>			
	*n/45	R (%)	I (%)	S (%)
Amoxicillin/clavulanic acid (Amc) 30µg	13.00	28.89	13.33	57.78
Chloramphenicol (C) 30 µg	11.00	24.44	13.33	62.22
Ciprofloxacin (Cip) 5 µg	0.00	0.00	0.00	100.00
Ceftriaxone (Cro) 30 µg	8.00	17.78	8.89	73.33
Gentamicin (Cn) 10 µg	3.00	6.67	6.67	86.67
Erythromycin (E) 15 µg	34.00	75.56	22.22	2.22
Suphamethoxazole/trimethoprim (Sxt) 22 µg	12.00	26.67	4.44	68.89
Tetracycline (Te) 30 µg	18.00	40.00	2.22	57.78
Vancomycin (Va) 30 µg	45.00	100.00	0.00	0.00

*n, number of resistant *Salmonella species*; S, susceptible; I, Intermediate; R, resistant

Table 4 shows the antibiotic resistance profile and Multiple Antibiotic Resistance (MAR) index of individual *Salmonella species* from different sources. The *Salmonella species* exhibited 23 antibiotic resistant patterns with MAR index ranging from 0.11 to 0.67. The majority of the *Salmonella species* (14 isolates) were resistant to three antibiotics (MAR index of 0.33), followed by resistant to two antibiotics (12 isolates; MAR index of 0.22), resistant to four (6 isolates; MAR index of 0.44) and five antibiotics (6 isolates; MAR index of 0.56), resistant to one antibiotic (4 isolates; MAR index of 0.11) and resistant to six antibiotics (3 isolates; MAR index of 0.67). The resistant pattern EVa was the commonest and was exhibited by 9 different *Salmonella* isolates. The 3 *Salmonella* isolates that were resistant to 6 different antibiotics exhibited the resistant patterns AmcCESxtTeVa (2 isolates) and CCnESxtTeVa (1

isolate). Of the 6 *Salmonella* isolates that were resistant to five different antibiotics, 2 each exhibited the pattern AmcCETeVa and CESxtTeVa and 1 each exhibited the pattern CCroESxtVa and CnESxtTeVa.

Saba et al. (2013) analysed four *Salmonella species* isolated from humans in the Tamale Metropolis and found that they were all susceptible to amoxicillin-clavulanate, ciprofloxacin, gentamicin, tetracycline and chloramphenicol. In this study we found 100.00% susceptibility to ciprofloxacin but high resistance to gentamicin. We also found some resistances to amoxicillin-clavulanate, chloramphenicol and tetracycline. Puopelle (2014) isolated *Salmonella species* from humans in Akwatia, Eastern Region of Ghana and reported a resistant of 76.30% to trimethoprim/sulfamethoxazole. All the *Salmonella species* 100.00% were susceptible to ciprofloxacin and

norfloxacin (Puopelle, 2014). Our findings on the susceptibility to trimethoprim/sulfamethoxazole and ciprofloxacin were similar to that of Puopelle (2014) but differ in terms of norfloxacin. Danikuu (2014) reported that multidrug resistance was a common feature in *Salmonella* species isolated from livestock in the Kumasi

Metropolis. All the isolates were resistant to tetracycline but susceptible to ciprofloxacin (Danikuu, 2014). The results obtained for ciprofloxacin was in agreement with this current work but not the result for tetracycline. We found some resistance (40%), intermediate resistance (2.22%) and susceptibility to tetracycline (57.78%).

Table 4 Antibiotic resistance profile and multiple antibiotic resistance index of individual *Salmonella* species from different sources

Serial Number	Salmonella code	Source	Antibiotic resistant profile ^a	Number of antibiotics	MAR index
1	NAT3	Table	AmcCESxtTeVa	6	0.67
2	TMT4	Table	AmcCESxtTeVa	6	0.67
3	DMM4	Meat	AmcCETeVa	5	0.56
4	DMK2	Knife	AmcCETeVa	5	0.56
5	STT2	Table	AmcCnETeVa	4	0.44
6	ZK3*	Knife	AmcCroVa	3	0.33
7	SKK4	Knife	AmcCSxtVa	4	0.44
8	NAM4	Meat	AmcETeVa	4	0.44
9	ABM1	Meat	AmcETeVa	4	0.44
10	NAK3	Knife	AmcEVa	3	0.33
11	STM3	Meat	AmcEVa	3	0.33
12	AYK4	Knife	AmcEVa	3	0.33
13	ABM3	Meat	AmcTeVa	3	0.33
14	SHM1	Meat	CCnESxtTeVa	6	0.67
15	HST3	Table	CCroESxtVa	5	0.56
16	TMM2	Meat	CESxtTeVa	5	0.56
17	STK2	Knife	CESxtTeVa	5	0.56
18	TMK3	Knife	CETeVa	4	0.44
19	HSM2	Meat	CETeVa	3	0.33
20	SHT1	Table	CnESxtTeVa	5	0.56
21	TSMI	Meat	CroEVa	3	0.33
22	TSM2	Meat	CroEVa	3	0.33
23	ZK3	Knife	CroEVa	3	0.33
24	SM4	Meat	CroSxtVa	3	0.33
25	TSTI	Table	CroVa	2	0.22
26	NAK1	Knife	CroVa	2	0.22
27	BGK4	Knife	ESxtTeVa	4	0.44
28	BGM2	Meat	ESxtVa	3	0.33
29	BGT2	Table	ESxtVa	3	0.33
30	STK3	Knife	ETeVa	3	0.33
31	BGT3	Table	ETeVa	3	0.33
32	ZM4	Meat	EVa	2	0.22
33	ZM4*	Meat	EVa	2	0.22
34	TSTI*	Table	EVa	2	0.22
35	NAT4	Table	EVa	2	0.22
36	ABM4	Meat	EVa	2	0.22
37	BGT3	Table	EVa	2	0.22
38	AYTI	Table	EVa	2	0.22
39	AYM1	Meat	EVa	2	0.22
40	BGT2	Table	EVa	2	0.22
41	HSK1	Knife	TeV	2	0.22
42	AFM4	Meat	Va	1	0.11
43	DMT2	Table	Va	1	0.11
44	SHM4	Meat	Va	1	0.11
45	BGK1	Knife	Va	1	0.11

^aAmoxicillin/clavulanic acid (Amc) 30 µg; Chloramphenicol (C) 30 µg; Ciprofloxacin (Cip) 5 µg; Ceftriaxone (Cro) 30 µg; Gentamicin (Cn) 10 µg; Erythromycin (E) 15 µg; Suphamethoxazole/Trimethoprim (Sxt) 22 µg; Tetracycline (Te) 30 µg; Vancomycin (Va) 30 µg.

In other countries such as Nigeria, Umeh and Enwuru (2014) reported that *Salmonella species* isolated from some farm animals showed resistance profile ranging from 1-9 antimicrobials. Resistance to tetracycline and gentamycin was 81.00% and 14.00%, respectively (Umeh and Enwuru, 2014). In Burkina Faso, Kagambèga et al. (2013) reported that 52 (14%) of 383 *Salmonella* isolates were resistant to one or more antimicrobials tested, and 23 of these were from cattle, 23 from poultry and 6 from hedgehog faeces. Sixty four percent (64%) showed decreased sensitivity (intermediate resistance) to one or more antimicrobial (Kagambèga et al., 2013). In Italy, Bonardi et al. (2013) reported that all *Salmonella species* isolated from pigs at slaughter were susceptible to ciprofloxacin and gentamicin, and 56% were resistant to tetracycline. In food producing animals in China, the resistant rate for ciprofloxacin was 41.5% and more than 99% of the *Salmonella* isolates collected were resistant to at least one antibiotic (Lai et al., 2014). Lai et al. (2014) also reported that *Salmonella* resistance rates for 15 antibiotics in 2012 were significantly higher than those in 2009. Resistance to tetracycline seems to be common in *Salmonella* strains from food animals in the European Union in 2002 (European Food Safety Authority, 2004).

The antibiotic resistances reported in this study were either similar or differ from studies by other authors in Ghana and other countries. Differences in resistant rate have been attributed to differences in samples examined, sampling procedure, breakpoints used and the level of usage of antibiotics in animal farming and human therapeutic purposes (European Food Safety Authority, 2004; Forshell and Wierup, 2006). Bring to after attributed Antibiotics are not normally used to treat people with *Salmonella* infection because the infection is self-limiting in 5-7 days (Centers for Disease Control and Prevention, 2013). However, in situations where antibiotics are required a variety of antibiotics such as sulfonamides (trimethoprim/sulfamethoxazole), penicillins (amoxicillin), cephalosporins (ceftriaxone) and flouoroquinolones (ciprofloxacin) have been suggested (Centers for Disease Control and Prevention, 2013; Miller and Pegues, 2005). In this study all the *Salmonella species* were susceptible to ciprofloxacin. Studies conducted in Ghana by Danikuu (2014), Puopelle (2014) and Saba et al. (2013) also indicated that all *Salmonella species* isolated were susceptible to ciprofloxacin. Therefore ciprofloxacin (flouoroquinolones) can be the first antibiotic of choice for treating Salmonellosis in Ghana and especially when the infection is caused by the consumption of beef in the Techiman Municipality. In the absence of ciprofloxacin, gentamicin may be used before ceftriaxone, suphamethoxazole/trimethoprim and amoxicillin/clavulanic acid.

In conclusion, the overall prevalence of *Salmonella species* was 57.08%. The prevalence in meat and it related samples ranged from 33.30% to 75.00% while the prevalence among the various meat sale points ranged from 6.25% to 93.75%. There is the need for meat handlers, processors and sellers in Techiman and Ghana

as a whole to observe hygienic practices in the handling, processing and selling of meats and meat products. *Salmonella species* isolated from beef and it related samples exhibited varying resistances to antibiotics. Averagely, 56.54% were susceptible, 7.90% were intermediate and 35.50% were resistant. Total susceptibility and resistance occurred for ciprofloxacin and norfloxacin respectively. Multiple antibiotic index ranged from 0.11 to 0.67 (that is resistant to 1 to 6 different antibiotics). Majority of the *Salmonella species* were resistant to three antibiotics but the resistant pattern, EVa was the commonest. There is the need to control the use of antibiotics in animal farming and treatment of humans in Ghana to curb the incidence of increasing multidrug resistant *Salmonella species*. The findings of this study can serve as baseline information on the prevalence and antibiotic resistance of *Salmonella species* from meat samples in Ghana to monitor trends in the future.

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