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Investigation of the contamination rate of guinea fowl meats and its related samples by *Escherichia coli* using one health approach

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Abstract*— Guinea fowl meat is an essential source of protein and other nutrients for humans. Their contamination by bacteria is a threat to public health and a one health approach of tackling this is warranted. This study investigated the contamination rate of guinea fowl meats and it related samples by *Escherichia coli* using one health approach. It also investigated the antibiotic resistance of the *Escherichia coli* from the guinea fowl sources. A total of 200 samples were randomly collected from guinea fowl wet markets in Ghana and the contamination of guinea fowl sources by *Escherichia coli* was done using the procedures in the Bacteriological Analytical Manual of USA-FDA. The disc diffusion method was used for antibiotic resistance test following confirmation by polymerase chain reaction. The contamination rate of *Escherichia coli* was the highest for processing knife (96.0%) and least for water from main source (28.0%). Faeces, processing floor, processor's hands, meat, water used for washing meat and processing table were all contaminated with *Escherichia coli*. The partial fragment analysis of *uidA* gene by PCR yielded a band of ~147 bp for confirmation of *Escherichia coli*. The *Escherichia coli* isolates exhibited highest resistance to ceftriaxone (60.5%), but susceptibility to azithromycin (94.7%). Intermediate resistance was highest for gentamicin (34.2%). The MAR index ranged from 0.0 (resistant to 0 antibiotic) to 0.8 (resistant to 7 antibiotics) with 24 different resistance profiles. This study confirms that some of the guinea fowl samples collected from wet market were contaminated by *Escherichia coli* that were resistant to some antibiotics. Appropriate handling of guinea fowl meats and it related samples considering one health from processing and sale points are recommended to prevent the spread of foodborne infections.

***Keywords*— Antibiotics; contamination; *Escherichia coli;* guinea fowl; resistance**

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I. INTRODUCTION

Guinea fowls are generally raised for their meat and eggs [1]. Guinea fowl meat which is a type of poultry meat is liked by many people around the globe and serves as a delicacy for some people in certain countries including Ghana [2, 3]. The meat is said to be versatile, delicious, tasty and healthier than many other types of meat [4, 5]. It is rich in protein as well as low in fat and cholesterol. Guinea fowl meat contains about 28% protein which is higher than the 23% reported for chicken meat, and the fat content is three times less than that of beef. Besides the protein, fat and cholesterol contents, it is also a good source of minerals (calcium, iron, magnesium, phosphorus, potassium, sodium and zinc) and vitamins (Vitamins A, B1, B2, B3, B5, B6, B9 and B12) [5].

Escherichia coli are Gram negative, rod-shape, non-spore forming, and members of Enterobacteriaceae family. They are also facultative anaerobes and have the ability to switch between aerobic respiration and fermentation depending on the presence or absence of oxygen [6]. *Escherichia coli* are among the foodborne pathogens of public health concern and some strains have been implicated in a number of foodborne outbreaks which resulted in illnesses, hospitalizations and sometimes deaths [7, 8]. Besides that, *Escherichia coli* are among the major bacteria associated with bacterial infections in poultry including guinea fowl. These bacteria cause severe health problems in poultry with the potential of causing mortality, reduced production or increase expenses in preventing/treating the diseases using antibiotics [9].

Antibiotics are used to treat *Escherichia coli* infections either in animals or humans when necessary. However, their use has been linked with the development of resistances by bacteria [10]. There are some evidences of the use of antibiotics in animal production and the development of resistance to those antibiotics used by farmers [11-14]. Antibiotic resistance is also a global health issue with serious efforts geared towards reducing it menace by relevant and responsible stakeholders [15]. Bacteria including *Escherichia coli* possess antibiotic resistance genes or are capable of modifying their genes under different mechanisms to increase their resistance [16, 17]. Several approaches to combating antibiotic resistances have been suggested [17, 18]. These approaches include phage therapy, antimicrobial peptides, passive immunization, prompt clinical response, use of phytochemicals, new diagnostic testing, liposomal nanoparticles, antivirulent therapy, vacccines, monoclonal antibodies, among others [17-20].

In addition, a one health approach towards viewing the spread of resistant bacteria along the meat processing chain is important. There is paucity of information on the occurrence and antibiotic resistance of *Escherichia coli* associated with guinea fowls. Therefore, this study determined the contamination rate and antibiotic resistance of *Escherichia coli* in guinea fowl wet markets using one health concept.

II. MATERIAL AND METHODS

A. Study area

The study was conducted in Tamale Metropolis, in the northern region of Ghana. The Metropolis shares boundaries with the Sagnarigu District to the west and north, Mion District to the east, East Gonja to the south and Central Gonja to the south-west. It lies between latitude 9º16 and 9º34 North and longitudes 0º 36 and 0º 57 West [21].

B. Sample collection for microbiological analysis

A total of 200 samples comprising of faeces (n=25), processing floor (n=25), processing table (n=25), processing knife (n=25), meat (n=25), water from source (municipal water supply) (n=25), water used for washing meat (n=25), and processor's hands (n=25) were collected from five guinea fowl wet markets solely and popularly known for selling guinea fowl meats in the Tamale Metropolis. Purposive sampling was used to select wet markets and simple random sampling was employed to collect samples at the wet markets. The samples were transported in an ice chest containing ice to the Bruce Hunter Microbiology Laboratory at UDS Nyankpala campus where microbiological analyses were carried out for *Escherichia coli* immediately upon reaching the laboratory.

C. Isolation of Escherichia coli (E. coli)

The isolation of *E. coli* was done according to Feng *et al*. [6], with slight modifications. Samples were pre-enriched in 10 µl Buffered Peptone Water (BPW) and incubated for overnight at 37°C. Samples in BPW were streaked on Levine's Eosin-methylene Blue Agar and incubated at 37 ºC for another 24 h. Presumptive *Escherichia coli* colonies appeared as dark centered and flat, with or without metallic sheen; such isolates were streaked on Trypticase Soy Agar and also incubated at 37 ºC for 24 h. They were then identified and initially confirmed using Gram stain (Gram negative rod shaped), *Escherichia coli* latex agglutination test kit (by coagulation) and growth in Brilliant Green Bile Broth with Durham tube (turbidity with gas production). All incubations were done under aerobic condition and all media used were purchased from Oxoid Limited, Basingstoke, UK.

D. Confirmation of Escherichia coli isolates by polymerase chain reaction (PCR)

Deoxyribonucleic acid (DNA) extraction was performed using freshly grown cultures. The cultures were lysed in 30 µl Dnase/Rnase Free Water at 99 °C for 10 min in peqSTAR 96X Universal thermal cycler (VWR Prelab, UK). The lysates were used as DNA template for the PCR.

Confirmation of *Escherichia coli* isolates by PCR was carried out following the procedures of Bej *et al*. [22] and Upadhyay *et al*. [23], with slight modifications. The PCR reaction (20 µl) consisted of 10 µM each of primers (Table 1), 20 mM Tris-HCl (pH 8.9 at 25 °C), 1.8 mM $MgCl_2$, 22 mM NH_4Cl, 0.2 mM dNTPs, 5% glycerol, 0.06% IGEPAL® CA-630, 0.05% Tween- 20, xylene Cyanol FF, Tartrazine, 0.25U One *Taq*® DNA polymerase (New England Biolabs® Inc) and 2 µl lysate as template. The temperature cycles and expected fragment size is shown in Table 1.

Polymerase chain reaction amplicons were separated using agarose gel electrophoresis (2% agarose containing 2.5µl ethidium bromide). The FastRuler™ Middle Range DNA Ladder was used to determine the size of fragments. The PCR amplicons, 7 µl were mixed with 1µl of 6X Loading Dye. Mixtures were loaded into the wells of the gel and electrophorized at 80 V for 30 mins and visualized under UV light using UV Transilluminator and images captured with microDOC (Cleaver Scientific Company, UK).

E. Antibiotic resistance test for Escherichia coli

The Antibiotic resistance test was performed using the disc diffusion method of Bauer *et al*. [24]. *Escherichia coli* isolates were examined against the following antibiotics: amoxicillin 30 µg (AML), amoxycillin/clavulanic acid 30µg (AUG), azithromycin 15 µg (AZM), ceftriaxone 30 µg (CRO), chloramphenicol 30 µg (C), ciprofloxacin 5 µg (CIP), gentamicin 10 µg (CN), tetracycline 30 µg (TE) and suphamethoxazole/trimethoprim 22µg (SXT), purchased from MAST Group Limited, UK. Cultures of *Escherichia coli* were inoculated in Trypticase Soy Broth (TSB) and incubated at 37 ºC for 15 h. The turbidity was adjusted to 0.5 McFarland Standard Solution using sterile TSB and spread plated on Müller Hinton Agar (MHA). Four or five antibiotic discs were placed on the MHA plates and the plates were incubated at 37 ºC for 24 h. After which, the inhibition zones were measured with ruler and the results interpreted according to the Clinical Laboratory Standard Institute [25]. Multiple Antibiotic Index (MAR) was calculated 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 examined [26]. All incubations were done under aerobic conditions and all media used were purchased from Oxoid Limited, Basingstoke, UK.

F. Data analysis

Data obtained from the occurrence of *Escherichia coli* in guinea fowl samples were analyzed using binary logistic generalized linear model of Statistical Package for Social Sciences version 20, Armonk, NY. Significant differences were determined using wald chi-square at 5% significant level. Results in the study are presented in a Figure and Tables.

III. RESULT AND DISCUSSION

A. Contamination of guinea fowl samples by Escherichia coli

The occurrence of *Escherichia coli* in the guinea fowl samples collected from wet markets is shown in Figure 1. Processing knife (96.0%), faeces (88.0%), processing floor (76.0%), processor's hands (76.0%), meat (64.0%), water used for washing meat (64.0%), processing table (56.0%) and water from main source (28.0%) were contaminated by *Escherichia coli*. There were significant differences ($P < 0.05$) in occurrence of *Escherichia coli* among the guinea fowl and it related samples collected from the wet market. Processing knife and faecal samples positive for *Escherichia coli* were significantly higher ($P < 0.05$) than those from meat, processing table, water from main source and water used for washing meat. Furthermore, processing knife, but not faecal samples positive for *Escherichia coli* were significantly higher ($P < 0.05$) than those from processing floor and processor's hands. Processing floor and processor's hands samples positive for *Escherichia coli* did not differ significantly ($P > 0.05$) from each other, but, were significantly higher ($P < 0.05$) than water from main source. Also, meat and water for washing meat samples positive for *Escherichia coli* did not differ significantly ($P > 0.05$) from each other, but, were significantly higher ($P < 0.05$) than water from main source. Meat, water for washing meat and processing table samples positive for *Escherichia coli* did not differ significantly ($P > 0.05$) from each other. Processor table and water from main source samples positive for *Escherichia coli* did not differ significantly ($P > 0.05$) from each other.

Escherichia coli as part of coliform is a more accurate indicator of faecal contamination and its presence indicates the availability of potential harmful bacteria [6]. Therefore, the presence of *Escherichia coli* in guinea fowl meat and its related samples reveal lapses in the slaughtering and selling of guinea fowls. During slaughtering of guinea fowls, their carcasses can become contaminated by *Escherichia coli* from the feathers and rupture of the gastrointestinal tract that carry feces and dirts [27]. Furthermore, the rupture of the intestinal tract during the evisceration procedure can cause spillage of faecal material and lead to contamination of the carcasses [28]. According to Sofos [29], other sources that are responsible for cross-contamination of carcasses with microorganisms are the processing environment, the equipment used and the workers, while insects, rodents and birds can also carry and transmit microorganisms to meat. Furthermore, microbial contamination and growth may also take place after processing, and during storage and distribution of meat products [30, 31]. In the present study, *Escherichia coli* was highest in processing knife (environment), followed by faeces (animal), processing floor (environment), processor's hands (humans), meat (animal), water used for washing meat (environment), processing table (environment) and water from main source (environment). Therefore, all the samples examined at the wet market, that is, samples from humans, animal, and the environment were all contaminated by *Escherichia coli,* revealing unhygienic processing of guinea fowls and subsequent contamination by faeces. Faeces are primary sources of *Escherichia coli* and might have cross contaminated other samples. Similarly, to this study Kilonzo-Nthenge *et al*. [32] in the USA reported that chicken and guinea fowl carcasses were positive for *Escherichia coli*. A study conducted by Adzitey *et al*. [33] in Ghana revealed that, all contents of guinea fowl intestines harbored *Escherichia coli*, and this study found that, 88.0% of guinea fowl faeces were positive for *Escherichia coli*. Another study by Adzitey *et al*. [34] in Ghana reported that 88.9% of guinea fowl meats were contaminated by *Escherichia coli*, which was higher than what was found in the present study. The study of Adzitey *et al*. [28] concentrated on the antibacterial effect of aloe vera gel extract on *Escherichia coli* and *Salmonella enterica* isolated from the gastrointestinal tract of guinea fowls, while Adzitey *et al*. [34] examined the prevalence and antimicrobial resistance of *Escherichia coli* isolated from various meat types. The afore-mentioned studies differed from the current study which examined the contamination rate of

guinea fowl meats and its related samples by *Escherichia coli* using one health approach. In Nigeria, Sowunmi *et al.* [35] reported a prevalence rate of 87.5% for guinea fowl meats sold in Sobo markets, which was also higher than what was found in this study. Furthermore, a study by Touglo *et al.* [36] revealed that all imported guinea fowl wings (100.0%) sampled from cold stores in Togo were positive for *Escherichia coli*. In RTE guinea fowl meats in Ghana, Abass *et al*. [37] found a lower prevalence rate of 18.0% for *Escherichia coli* compared to what was found from the raw guinea fowl in this study, which is expected due to the heat treatment the guinea fowl meats were subjected to.

Polymerase chain reaction (PCR) was performed to confirm the *Escherichia coli* isolates prior to antibiotic susceptibility test. The PCR was done on the presumptive *Escherichia coli* isolates using *uidA* specific primers. The partial fragment of the *uidA* gene of *Escherichia coli* was amplified and visualized on 2% agarose gel. The PCR amplification and separation of DNA from *Escherichia coli* successfully yielded a band of ~147 bp fragment (Figure 2) and confirms that the isolates were *Escherichia coli*.

B. Antibiotic resistance of Escherichia coli from guinea fowl wet markets

The antibiotic resistance of *Escherichia coli* isolated from guinea fowl wet markets in Tamale metropolis is shown in Table 2. The *Escherichia coli* isolates were resistant to amoxicillin (52.6%), ceftriaxone (60.5%) and tetracycline (55.3%). Resistance between 2.6% and 31.6% was observed for azithromycin, amoxicillin/clavulanic acid, chloramphenicol, ciprofloxacin and tetracycline. However, the *Escherichia coli* isolates were highly susceptible to azithromycin (94.7%) and chloramphenicol (71.1%). Susceptibility was also 60.5%, 65.8% and 55.3% for ciprofloxacin, sulfamethoxazole/trimethoprim and amoxicillin/clavulanic acid, respectively. Intermediate resistance was relatively high for gentamicin (34.2%), amoxicillin/clavulanic acid (26.3%), ciprofloxacin (23.7%) and tetracycline (26.3%).

C. *Multiple antibiotic resistance index and antibiotic resistance profile of individual Escherichia coli isolated from guinea fowl wet markets*

The multiple antibiotic resistance index and antibiotic resistance profile of individual *Escherichia coli* isolated from guinea fowl wet markets in Ghana is presented in Table 3. The multiple antibiotic resistance index ranged from 0.0 to 0.8, and 24 different resistance profiles were observed. The resistance profile, CRO (resistant to only ceftriaxone) was the commonest and was exhibited by five (5) *Escherichia coli* isolates, that is, three (3) from processing knife) and two (2) from processor's hands. This was followed by the resistant pattern, CRO-TE (resistant to ceftriaxone-tetracycline) and was exhibited by four (4) *Escherichia coli* isolates, one (1) each from faeces, processing floor, processing knife and processing table. The contamination observed on the processing knife may have come from contaminated tables or hands of processors. It may also have resulted from improper cleaning and sterilizing after being used. The processor's hands could have been contaminated by touching contaminated surfaces. Resistant to 7, 6, 5, 4, 3, 2, 1 and 0 different antibiotics were 5.3%, 5.3%, 2.6%, 10.5%, 26.3%, 21.1%, 18.4% and 10.5%, respectively. Resistant to 3 or more different classes of antibiotics was 50.0%. Two Escherichia coli isolates from water from main source and processing table were resistant to as many as 7 different antibiotics, that is, CRO-AML-C-TE-SXT-AUG-CIP (ceftriaxone-amoxicillin-chloramphenicol-tetracycline-sulfamethoxazole/trimethoprim-amoxicillin/clavulanic acid-ciprofloxacin) and CRO-AZM-AML-TE-SXT-AUG-CIP (ceftriaxone-azithromycin-amoxicillin-tetracycline-sulfamethoxazole/trimethoprim-amoxicillin/clavulanic acid-ciprofloxacin), respectively. Antibiotic resistant is definitely a global problem threatening human and animal health. Many factors contribute to the day to day increases in resistance, but the misuse of antibiotics for prevention, treatment, growth promotion and other purposes in animal production continue to play a major role. Ekli *et al.* [38] reported that, farmers in Wa municipality of Ghana use antibiotics such as ciprofloxacin (32.0%), sulphamethoxazole/trimethoprim (17.1%), gentamicin (1.8%), ceftriaxone (0.9%), chloramphenicol (0.9%), and tetracycline (0.9%) as prophylactics or to treat animal diseases. Resistant bacteria from the site of animal production are carried to the points of slaughtering of animals and sale. Under unhygienic and faulty handling conditions they can be transferred unto meats and finally consumed under improper cooking conditions. In this study, *Escherichia coli* from guinea fowl wet markets exhibited varying resistant patterns comparable to other studies.

In the same country where this work was carried out, Adzitey *et al*. [34] found that, *Escherichia coli* from meat sources were 73.3%, 16.7%, 10.0%, 8.3%, 8.3% and 6.7% resistant to tetracycline, ceftriaxone, chloramphenicol, ciprofloxacin, sulphamethoxazole/trimethoprim and gentamicin, respectively. Resistant to tetracycline and gentamicin, but not the rests of the antibiotics were higher in Adzitey *et al*. [34], than the present study. Adzitey *et al.* [34] also found MAR index of 0.0 to 1.0 with 23 different resistant patterns. This study found MAR index to range from 0.0 to 0.8 with 24 different resistant patterns. This suggests that some of the *Escherichia coli* were isolated from sources where antibiotics are used in animal production, which needs the attention of all relevant stakeholders in Ghana. According to Amoako *et al*. [43]. , *Escherichia coli* isolates of meat origin with a MAR index of 0.4 and above are associated with human faecal contamination, while a MAR index of less than 0.4 is associated with nonhuman faecal contamination. The commonest pattern was tetracycline-ampicillin-erythromycin for Adzitey *et al*. [34] and the present study was resistant to only ceftriaxone. In Poland, Racewicz *et al.* [39] found that *Escherichia coli* from poultry meat were resistant to amoxicillin/clavulanic acid (42.1%), ciprofloxacin (78.9%), gentamicin (3.8%) and sulfamethoxazole/trimethoprim (94.7%). This study found higher resistances to amoxicillin/clavulanic acid and gentamicin, but lower resistances to ciprofloxacin and sulfamethoxazole/trimethoprim.

TABLE 1:

PRIMERS AND CYCLING CONDITIONS FOR PCR-BASED ASSAYS

Organism	Primer/sequences (5' – 3')	Cycling conditions *(Expected fragment size)*
Escherichia coli	*uidA-F* AAAACGGCAAGAAAAAGCAG	95 °C for 5 min, 40 cycles of 95 °C for 30s, 57 °C for 30s
	uidA-R ACGCGTGGTTAACAGTCTTGCG	72 °C for 30s and a final extension at 72 °C for 5 min.
		(~ 147 bp)

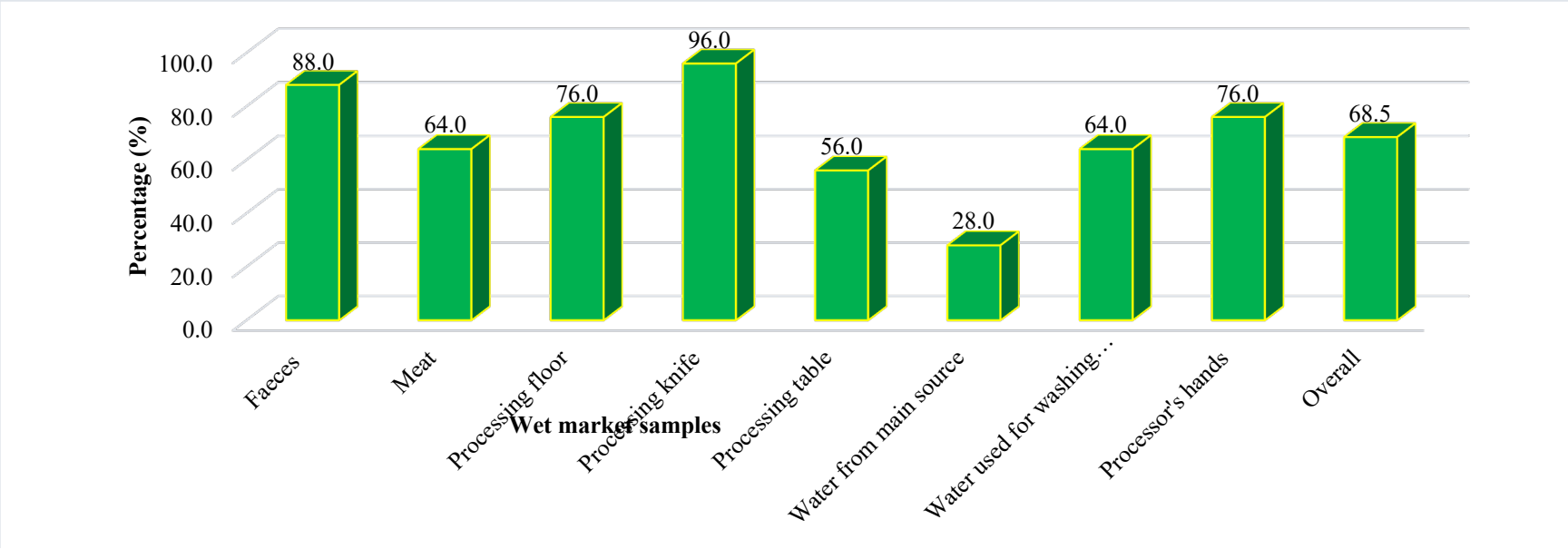

Fig. 1. Occurrence of *Escherichia coli* in guinea fowl wet markets in Ghana

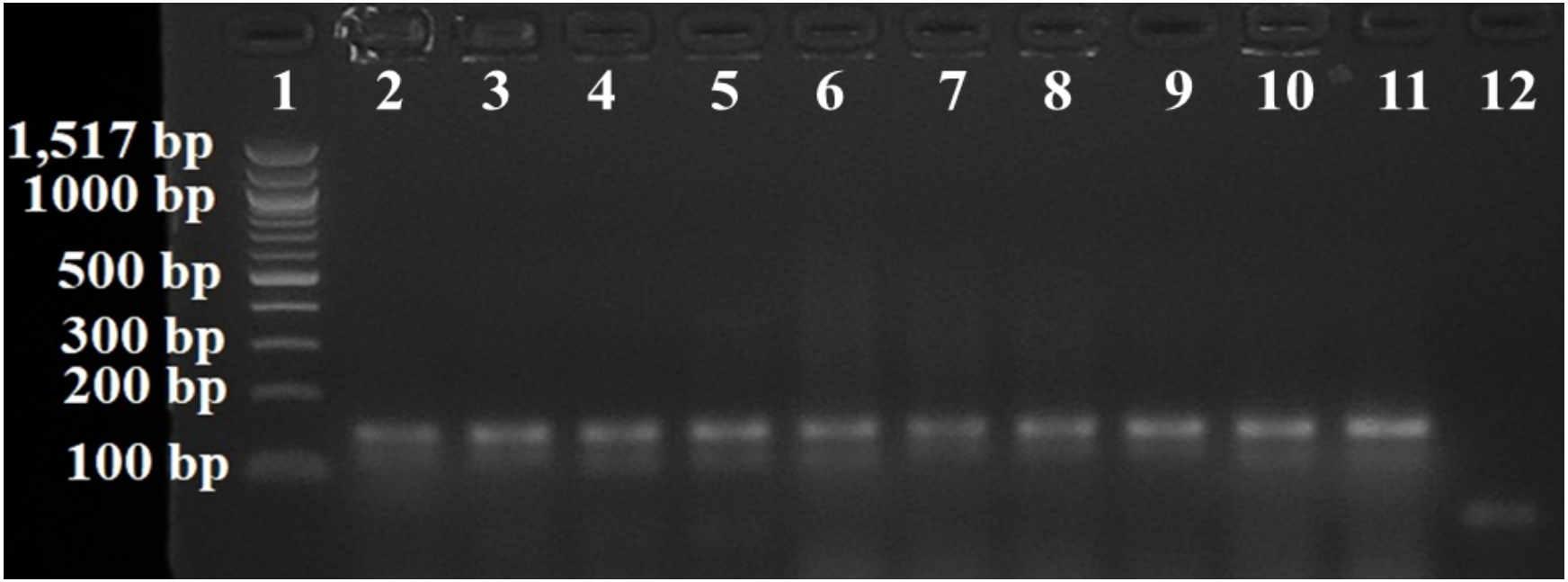

Fig. 2: Polymerase chain reaction products for the confirmation of *Escherichia coli* isolates.

Lane 1: Quick-Load® Purple 100 bp DNA Ladder (New England Biolabs); lanes 2 to 10 *Escherichia coli* isolates from guinea fowls (~147 bp fragment), lane 11, positive control (ATCC 25922); and lane 12, negative control (no DNA).

TABLE 2:

ANTIBIOTIC RESISTANCE OF ESCHERICHIA COLI FROM GUINEA WET MARKET IN GHANA

Antimicrobial	Susceptible	Intermediate resistant	Resistant
Amoxicillin 30µg (AML)	28.9	18.4	52.6
Amoxicillin/clavulanic acid 30µg (AUG)	55.3	26.3	18.4
Azithromycin 15µg (AZM)	94.7	2.6	2.6
Ceftriaxone 30µg (CRO)	36.8	2.6	60.5
Chloramphenicol 30µg (C)	71.1	7.9	21.1
Ciprofloxacin 5µg (CIP)	60.5	23.7	15.8
Gentamicin 10µg (CN)	60.5	34.2	5.3
Tetracycline 30µg (TE)	23.7	26.3	55.3
Sulfamethoxazole/trimethoprim 22µg (SXT)	65.8	2.6	31.6
Overall	55.3	16.1	29.2

TABLE 3:

MULTIPLE ANTIBIOTIC RESISTANCE INDEX AND ANTIBIOTIC RESISTANCE PROFILE OF INDIVIDUAL ESCHERICHIA COLI ISOLATED FROM GUINEA FOWL WET MARKETS IN GHANA

Isolate code	Source	No. of antibiotics	Antibiotic resistance profile	MAR index
AFF5	Faeces	4	CRO-AML-C-TE	0.4
LFF4	Faeces	3	CRO-TE-SXT	0.3
TMFF5	Faeces	2	CRO-TE	0.2
GFF5	Faeces	2	CN-TE	0.2
AGFF4	Faeces	0	0	0.0
AH2	Processor's hands	6	CRO-AML-C-TE-SXT-AUG	0.7
TMM3	Meat	3	AML-TE-AUG	0.3
AM5	Meat	3	AML-SXT-CIP	0.3
LM4	Meat	2	CRO-AML	0.2
AGM3	Meat	0	0	0.0
LF1	Processing floor	6	CRO-AML-C-TE-SXT-CIP	0.7
GF4	Processing floor	3	CRO-AML-TE	0.3
AF4	Processing floor	2	CRO-TE	0.2
TMF2	Processing floor	2	AML-SXT	0.2
AGF3	Processing floor	2	AML-AUG	0.2
TMK5	Processing knife	5	CRO-AML-C-TE-SXT	0.6
AK5	Processing knife	4	CRO-AML-C-TE	0.4
LK4	Processing knife	2	CRO-TE	0.2
AGK3	Processing knife	1	CRO	0.1
GK2	Processing knife	1	CRO	0.1
AGK5	Processing knife	1	CRO	0.1
TMT1	Processing table	7	CRO-AZM-AML-TE-SXT-AUG-CIP	0.8
LT1	Processing table	4	CRO-AML-TE-SXT	0.4

AT5	Processing table	3	CRO-AML-AUG	0.3
AGT3	Processing table	3	CRO-CN-CIP	0.3
GT4	Processing table	2	CRO-TE	0.2
AGH2	Processor's hands	1	CRO	0.1
LH5	Processor's hands	1	CRO	0.1
TMH2	Processor's hands	1	AML	0.1
GH2	Processor's hands	0		0.0
AWS3	Water from main source	7	CRO-AML-C-TE-SXT-AUG-CIP	0.8
LWS5	Water from main source	1	AML	0.1
GWS2	Water from main source	0	0	0.0
LWU5	Water used for washing meat	4	AML-TE-SXT-CIP	0.4
GWU5	Water used for washing meat	3	CRO-C-TE	0.3
TMWU2	Water used for washing meat	3	AML-TE-SXT	0.3
AGWU3	Water used for washing meat	3	C-TE-AUG	0.3
AWU3	Water used for washing meat	3	AML-TE-SXT	0.3

Amoxicillin 30µg (AML), Amoxicillin/clavulanic acid 30µg (AUG), Azithromycin 15µg (AZM), Ceftriaxone 30µg (CRO), Chloramphenicol 30µg (C), Ciprofloxacin 5µg (CIP), Gentamicin 10µg (CN), Tetracycline 30µg (TE), Sulfamethoxazole/trimethoprim 22µg (SXT)

A study conducted by Altalhi *et al*. [40] in Saudi Arabia, reported that *Escherichia coli* obtained from retail raw chicken meat were resistant to chloramphenicol (32.4%), and gentamicin (24.3%), which were higher than the present study. In Mexico, *Escherichia coli* from retail meats exhibited 75.0% resistant to tetracycline [41], which was higher than the present study. In Sri Lanka, *Escherichia coli* from chicken meat and offals exhibited MAR index of 0.1 to 0.8 with the resistant pattern chloramphenicol-ciprofloxacin-erythromycin-tetracycline being the commonest [42]. In this study, 71.1% of the *Escherichia coli* isolates from the wet markets had MAR index of > 0.2 and indicates a high contamination risk, that is, come from areas where antibiotics are frequently used [43]. Furthermore, Kaneene *et al.* [44] stated that *Escherichia coli* isolates with MAR index of 0.4 and above are linked to human faecal contamination, while those with less than 0.4 are linked to non-human faecal contamination. The result also reveals that the use of antibiotic is uncontrolled in this study. Based on this statement, 23.7% of the samples were contaminated by human faeces. The contamination of guinea fowl meat and processor's hands is worrying and of public health concern since that can easily get into humans via improper cooking, consumption or cross contamination via hands. Similarly, to this study, other poultry species have been reported to be sources of antibiotic resistance meat-borne pathogens [45-48].

IV. CONCLUSION

The overall contamination rate of *Escherichia coli* was 68.5%. Processing knife and water from main source were the most and least contaminated source of *Escherichia coli,* respectively. The highest resistance of *Escherichia coli* occurred for ceftriaxone and the least occurred for azithromycin. Intermediate resistance was highest for gentamicin and multidrug resistance was 50.0%. Thus, some guinea fowl samples from humans, animals and the environment collected from wet markets were contaminated with *Escherichia coli* which exhibited varying resistance to antibiotics. These findings could be due to handling of guinea fowls under relatively unhygienic conditions and their exposure to antibiotics, which is a potential threat to public health. Proper handling of guinea fowl meats by butchers, meat sellers and consumers is recommended. Training of butchers and good processing hygiene in the wet market is necessary to improve on food safety for consumers. This study is limited by lack of molecular characterization to confirm the genetic relatedness of the *Escherichia coli* isolates and to determine whether cross contamination among the samples examined occurred.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest or personal relationships with other people or organizations that can inappropriately influence this work.

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