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Prevalence of Resistant *Escherichia coli* Isolated from Local Meats Sold in Tema Metropolis, Ghana

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Abstract

Contamination of meat by *Escherichia coli* (*E. coli*) can take its source from the live animal or by cross contamination. The study determined the prevalence of resistance of *E. coli* isolated from locally produced meats in the Tema Metropolis. Beef (*n* = 200), chicken (*n* = 200) and pork (*n* = 200) were randomly selected and evaluated for the presence of *E. coli* using the procedure in the Bacteriological Analytical Manual of USA-FDA. The disc diffusion method was used for antibiotic susceptibility test of *E. coli* (*n* = 55) isolates. Locally produced beef (67%), chicken (41%) and pork (23%) were contaminated by *E. coli*. *Escherichia coli* isolates were resistant (≥60%) to amoxicillin, tetracycline and trimethoprim, but susceptible (≥60%) to imipenem, ceftriaxone and gentamicin. Some local meat samples produced in Tema Metropolis, Ghana are contaminated by antibiotic resistant *E. coli*. Proper cooking of meat prior to consumption is recommended.

Keywords: Antibiotic resistance, Contamination, *E. coli*, Ghana, Tema metropolis

1. Introduction

The Meat is a protein rich source food for many people worldwide. Besides protein, meat contains minerals such as iron, phosphorus, selenium and zinc, and vitamins such as vitamins A and B complex (Ahmad et al., 2018). The rich nutrient composition of meats makes them potential sources of pathogenic microorganisms (Adzitey et al., 2013; Anachinaba et al., 2015; Arslan & Eyi, 2011; Rahman et al., 2017). Meats such as beef, chicken and pork and the products have been reported to be sources of *Escherichia coli* (*E. coli*) (Abass et al., 2020; Dsani et al., 2020; Zhao et al., 2012) and this organism include those that have also been implicated in foodborne diseases. For instance, the consumption of ground meat contaminated by *E. coli* resulted in 18 infections, 6 hospitalizations and a death (Centers for Disease Control and Prevention-CDC 2018).

In animal production, antibiotics are normally used to treat sick animals, as prophylactics and...
sometimes as growth promoters (Jammoul & El Darra, 2019). They are also sometimes used to treat human infections which could be as a result of consuming meat contaminated by bacteria such as E. coli. Using antibiotics for animal production and treatment of humans is responsible for the development of resistant bacteria (Katakweba et al., 2012). Escherichia coli of meat origin resistant to antibiotics such as tetracycline, gentamicin, chloramphenicol among others have been reported (Adzitey, Assoah-Peprah, et al., 2020; Rahman et al., 2017; Rizaldi et al., 2019).

Escherichia coli species are members of Enterobacteriaceae family that dwell in the intestines of humans and animals, but pathogenic E. coli can infest humans (Feng et al., 2017). Their presence also serves as predictors for contamination of carcasses/meats. Meat serves as part of the daily menu of some Ghanaians (Nkegbe et al., 2013) and can serve as source of foodborne infection when consumed without proper cooking. The Tema Metropolis is one of the industrial towns in Ghana with people from different parts of Ghana and the world at large. Subsequently, meat consumption actively take place in this Metropolis. Nonetheless, there is dearth of published information on safety and resistant of E. coli in meats in the Metropolis. There, this study determined the prevalence of resistant E. coli from meats in the Tema Metropolis of Ghana.

2. Materials and methods

2.1. Study area

The study was conducted in the Tema Metropolis which lies between latitude 5°38’32’ North and longitudes 0°09’9”West (Tema Metropolitan Assembly, 2021). Tema is entirely urban and has a population of 29,2773 (Ghana Statistical Service, 2014).

2.2. Sample (meat) collection for microbiological analysis

A total of 300 meat samples made up of local beef (n = 100), local chicken (n = 100) and local pork (n = 100) were collected from the markets of Tema Metropolis between the hours of 8:00 to 12:00 GMT and examined for the presence of Escherichia coli (E. coli) species. Sampling was done from April 2020 to September 2020, and 100 samples (locally produced and imported beef, chicken and pork) were examined each month. Collected samples were transported on ice in an ice chest for microbiological analysis at University for Development Studies Spanish Laboratory, Nyankpala Campus. Microbiological analysis was carried out immediately upon reaching the laboratory.

2.3. Isolation of Escherichia coli

The isolation of E. coli was done according to Feng et al. (2017), with slight modifications. Ten (10 g) of each meat sample was pre-enriched in 90 ml of buffered peptone water and incubated at 37 °C for 24 h. The aliquots (10 μl) were streaked on Levine’s Eosin-methylene Blue Agar and incubated at 37 °C for another 24 h. Presumptive E. 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 °C for 24 h. They were then identified and confirmed using Gram stain (Gram negative rod shaped), E. coli latex agglutination test kit (by coagulation) and growth in Brilliant Green Bile Broth with Durham tube (turbidity with gas production). Escherichia coli isolates were also confirmed by polymerase chain reaction according to a modified method of Bai, Shi, and Nagaraja (2010) and Upadhyay et al. (2010) done by Adzitey et al. (2020a). All incubations were done under aerobic conditions and all media used were purchased from Oxoid Limited, Basingstoke, UK.

2.4. Antibiotic sensitivity of E. coli isolates

Antibiotic sensitivity test was performed according to Bauer et al. (1966). Purified colonies of E. coli isolates were examined against the following antibiotics: amoxicillin 30 μg (A), azithromycin 15 μg (Ath), ceftriaxone 30 μg (Cro), chloramphenicol 30 μg (C), ciprofloxacin 5 μg (Cip), gentamicin 10 μg (Gm), imipenem 10 μg (Imi), tetracycline 30 μg (T) and trimethoprim 2.5 μg (Tm), purchased from MAST Group Limited, UK. Purified colonies of E. coli (n = 60) were inoculated in Trypticase Soy Broth (TSB, Oxoid Limited, Basingstoke, UK) and incubated aerobically at 37 °C for 15 h. The turbidity was adjusted to 0.5 McFarland Standard Solution using sterile TSB and spread plated on Müller Hinton Agar (MHA, Oxoid Limited, Basingstoke, UK). Four or five antibiotic discs were placed on the MHA plates and the plates were incubated aerobically at 37 °C for 24 h after which the inhibition zones were measured and the results interpreted according to the Clinical Laboratory Standard Institute (2017).

2.5. Statistical analysis

Prevalence data was analyzed using Statistical Package for Social Sciences version 20, Armonk, NY. Chi square ($\chi^2$) was used to determine the
relationship among some of the data obtained at 5%. The results were presented in tables and figures.

3. Results and discussion

3.1. Prevalence of E. coli in locally produced beef, chicken and pork in tema metropolis

The prevalence of E. coli in locally produced beef, chicken and pork obtained from the Tema Metropolis, Ghana is shown in Fig. 1. *Escherichia coli* was isolated from 67.0% of beef, 41.0% of chicken and 23.0% of pork samples. There were significant differences ($P < 0.05$) in prevalence among the meat samples. Beef samples positive for E. coli were significantly higher ($P < 0.05$) than chicken and pork samples. Prevalence in pork samples were also significantly higher ($P < 0.05$) that chicken samples. *Escherichia coli* normally harbor the gastrointestinal tract of animals and cross contaminate meats during inappropriate slaughtering and processing. *Escherichia coli* include species responsible for conditions such as hemolytic uremic syndrome, urinary tract infections, respiratory illnesses, pneumonia, severe stomach cramps, bloody diarrhea and vomiting (Centers for Disease Control and Prevention, 2014; Feng et al., 2017). Outbreak of E. coli from the consumption of ground beef led to 18 infections, 6 hospitalizations and 1 death (Centers for Disease Control and Prevention, 2018). In this study, some of the locally produced beef samples were positive for E. coli. The percentage of locally produced beef samples positive for E. coli was higher than that of locally produced chicken, and that of locally produced chicken was also higher than that of locally produced pork. Adzitey, Assoah-Peprah, et al. (2020) reported that beef (86.7%), chicken meat (80.0%), mutton (88.9%) and chevon (75.6%) samples collected from Tamale Metropolis were contaminated by E. coli. Another study in Wa Municipality by Adzitey (2020) reported that 88.0% of beef muscle, 98.0% beef liver and 92.0% beef kidney samples were contaminated by E. coli. These findings were higher than the current study. In Accra, the rate of contamination of beef, chevon and mutton were 61.7%, 40.7% and 25%, respectively (Dsani et al., 2020), which was lower than the 67.0% reported in this study for beef. Also, a lower E. coli contamination rate of 4.8% was recorded for raw broiler chicken collected from Accra (Pesewu et al., 2018).

3.2. Antibiotic resistance of E. coli in locally produced beef, chicken and pork in tema metropolis

The antibiotic resistance of E. coli isolated from the various locally produced meats is shown in Table 1. The E. coli isolates were highly resistant to amoxicillin (86.7%), tetracycline (73.3%) and trimethoprim (60%), but susceptible to imipenem (100.0%). ceftriaxone (70.0%) and gentamicin (70.0%). Intermediate resistance was relatively high for ciprofloxacin (36.7%) and azithromycin (30.0%). Antibiotic resistance of E. coli isolates from meat origin is as a result of the use of antibiotics in animal farming or cross contamination of resistant E. coli unto meats. Adzitey, Assoah-Peprah, et al. (2020) found that E. coli isolated from various meat samples in Tamale Metropolis were resistant to tetracycline (73.33%), but susceptible to gentamicin (88.33%), ciprofloxacin (85.00%), chloramphenicol (83.33%) and ceftriaxone (80.00%). Resistance to tetracycline was similar to this study, but lower
susceptibility was observed for gentamicin, ciprofloxacin, chloramphenicol and ceftriaxone. Furthermore, E. coli from beef samples were resistant to tetracycline (44.4%) and chloramphenicol (44.4%), but susceptible to ciprofloxacin (95.6%), gentamicin (75.6%) and ceftriaxone (62.2%) (Adzitey, 2015). Comparatively, resistance to tetracycline was higher in the present study, while it was lower for chloramphenicol. Also, susceptibility was better for ceftriaxone but not ciprofloxacin and gentamicin in this study. Resistant to 3 or more classes of antibiotics was defined as multidrug resistance and it is linked to the heavy use of antibiotics in animal production (Pollari et al., 2017). About 71.8% of the E. coli isolates exhibited multidrug resistant, suggesting that the meats were obtained from animals subjected to heavy antibiotic usage or were cross contaminated by resistant E. coli isolates. Contamination of meats by multi-drug resistant E. coli has also been reported by Adzitey (2015), Abdissa et al. (2017), Pollari et al. (2017) and Adzitey, Sulleyman, and Kum (2020).

4. Conclusions

The Overall, 44% of locally produced meats were contaminated by E. coli. The E. coli isolates from locally produced meat source exhibited high resistance to amoxicillin, tetracycline and trimethoprim, but susceptible to imipenem, ceftriaxone and gentamicin. The contamination of locally produced beef, chicken and pork by E. coli resistant to some antibiotics poses a threat to public health.

Authors’ contributions

Frederick Adzitey, Innocent Allan Anachinaba, and Charles Addo-Quaye Brown developed the idea and plan for this project. Innocent Allan Anachinaba did the data collection. Frederick Adzitey, did data analysis and drafted the manuscript. Frederick Adzitey and Charles Addo-Quaye Brown supervised the entire research. Nurul Huda and Masmuniri Ramli provided financial support, corrected and proofread the manuscript.

Conflict of interest

We declare that there is no conflict of interest in the publication of this article.

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