Occurrence and risk of human infection and antimicrobial susceptibilities of escherichia coli isolates from beef sold for human consumption in Jos metropolis, Plateau state Nigeria, September 2018 – June 2019

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ABSTRACT

Introduction: Antimicrobial resistance poses a threat to infection management globally. We determined the prevalence and antimicrobial susceptibilities of Escherichia coli (E. coli) isolates from beef and assessed beef seller's practices and awareness of antimicrobial resistance (AMR) from Jos metropolis, Plateau State, Nigeria. **Methods:** We recruited 114 beef sellers and collected beef samples for the study. Information on socio-demographic characteristics, practices and awareness of AMR were collected using a semi-structured interviewer-administered questionnaire. The isolates were tested for susceptibilities to 14 antibiotics using the Kirby-Bauer disk diffusion method and the Minimum Inhibitory Concentration (MIC) of Ciprofloxacin using commercially prepared evaluator strips (Oxoid, UK). **Results:** The mean age of the respondents was 35 ±12.5 years. All were males among whom 90 (78.9%) had post-primary education. There were poor (110/114) beef handling practices among all age groups as well as poor awareness of AMR 110 (96.4%) among the respondents. Age, education and duration in the business had no significant impact on beef seller's handling practices and awareness on AMR ($P > 0.05$). Thirty E. coli isolates (26.3%) were obtained of which 29 (92.8%) exhibited Multi-Drug Resistance (MDR) with 4 (13.3%) isolates being positive for extended-spectrum beta-lactamase production. More than 90% of the isolates had multiple antibiotic resistance index of greater than 0.2. Twenty-two (75.9%) of the isolates were resistant to ciprofloxacin by MIC method. **Conclusion:** Beef handling practices were found to be inadequate to render beef wholesome for human consumption in Jos South LGA, Plateau State. Escherichia coli was prevalent on fresh beef and the E. coli isolates exhibited multidrug resistance phenotype. Most antibiotics tested in this study may no longer be very effective (> 50% resistance) for the treatment of E. coli infection in humans. We recommend to the Plateau State government through the Ministry of Agriculture to institute policies that will increase surveillance on zoonotic bacterial agents and antibiotic susceptibilities in food of animal origin. Also, the State should build/organise beef markets and institute proper hygiene in abattoir facilities and for beef handlers.

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Introduction

Escherichia coli (E. coli) are commensal bacteria in the intestine of cattle as well as humans [1,2]. Consumption of food or water contaminated with pathogenic *E. coli* can cause diarrhoea [3]. It can also cause pneumonia, respiratory problems and urinary tract infection [4]. Other strains of the organism produce toxins that damage the lining of the intestine, while strains like *E. coli* 0157:H7 cause severe illness that result in muscle cramp, abdominal pain, bloody diarrhoea and acute kidney failure in children. Some of the pathogenic *E. coli* strains may produce Shiga-like toxins that may cause severe illness and are members of a class of pathogenic group of *E. coli* known as enterohaemorrhagic *E. coli* (EHEC). They can also be classified by their toxin producing capabilities to include; verocytotoxin-producing *E. coli* (VTEC) or Shiga-like toxin producing *E. coli* (STEC) [3,5]. *E. coli* of animal origin may act as donors of antimicrobial resistance genes for other pathogenic *E. coli*. Thus, the intensive use of antimicrobial agents in food animals may add to the burden of antimicrobial resistance in the human population [6].

Globally, food borne illness due to *E. coli* is a growing concern today. It is estimated that 600 million people fall sick after consuming food contaminated with food-borne pathogens worldwide with 420,000 deaths including 125,000 children under the age of 5 years according to WHO [7]. Africa and South-East Asia regions were more affected. In Africa, outbreaks of Shiga-toxin-producing *E. coli* were reported in all parts of the continent [5,8] and isolation of entero-haemorrhagic *E. coli* 0157 have also been documented in humans and animals. Despite advances in food technology, foods of animal origin were still found to be contaminated with *E. coli*. In Ethiopia, susceptibility profiles of *E. coli* was reported to have substantial geographic variations as well as significant differences in various populations and environments [9]. In Nigeria, the prevalence of *E. coli* contamination of beef and beef product were reported in Kaduna, Kano and some states in the south west and south east [10,11].

Bacterial contamination of food of animal origin pose public health risks to humans, either through contact with contaminated food of animal origin or through cross-contamination with other food or through contamination with pathogenic bacteria. *E. coli* has been identified to be an indicator organism for the occurrence and spread of pathogens that can be transmitted through food-borne infections to humans. It is also an indicator for faecal contamination hence, the occurrence of *E. coli* indicates the likelihood of contamination with other food-borne pathogens of faecal origin [1]. It is also indicator for the spread of antimicrobial resistance (AMR) genes in the environment. Also, *E. coli* of animal origin may act as donors of antimicrobial resistance genes for other pathogenic *E. coli* and other bacteria [6]. Acquired antibiotic resistance among bacterial organisms is a growing challenge globally, that is made worse by overuse of antibiotics in humans and food animals [11]. Bacteria from the animal reservoirs that show resistance to antimicrobial agents that are regarded as highly or critically important in human therapy (e.g. aminoglycosides, fluoroquinolones, and third- and fourth-generation cephalosporin) [12] are of great concern in the world today as well as in Nigeria. Currently, there is limited information available on the occurrence and antimicrobial susceptibilities of *E. coli* in Jos South LGA of Plateau State.

Therefore, we investigated practice of beef sellers and their awareness on AMR, occurrence and antimicrobial susceptibilities of selected antimicrobials and the minimum inhibitory concentration (MIC) of Ciprofloxacin for resistance *E. coli* isolates from beef in Jos South LGA of Plateau state, Nigeria.

Methods

Description of study area

The study was conducted in Jos South Local Government Area of Plateau State located in the North central zone of Nigeria **Figure 1**. Jos South is one of the metropolitan LGAs of the state with its headquarters located in Bukuru town on 9°48′00" N 8°52′00" E. It occupies an area of 510 km^2 and a population of 306, 716 based on 2006 census. The major indigenous tribe is Berom, but English is the official language, although Hausa has gained acceptability as a medium of communication. The major occupation of the inhabitants is predominantly farming, tin mining, business and some few civil servants. Jos South LGA has five

districts, 20 wards, and three abattoirs. The city is located on the Jos Plateau at an elevation of about 1,238 meters above sea level.

Study design, study population and sample size determination

The study adopted a cross sectional study design. The study population comprised of beef sellers within abattoirs and retail markets in Jos South LGA. Beef samples were collected from each of the sellers. All fresh beef sold at retail points of sales in abattoirs and wards retail markets in Jos South LGA were included in the study, while all beef kept overnight or those which showed sign of spoilage were excluded. A total of 114 fresh beef samples were obtained and 114 questionnaires were administered concurrently to beef sellers to carry out the study. The sample size was calculated using the method and formula described in a study conducted on sample size calculation by Pourhoseingholi et al., (2013) [13].

$$n = \frac{Z^2 PQ}{d^2}$$

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

(population finite correction) x 1/(1-f)

Where - n = is the minimum sample size

Z = is the statistic corresponding to level of confidence at 95%

p =expected prevalence

q=1-p

d = level of precision will be taken at 5%

no = calculated sample size

N = total population

F = non response rate

Sampling technique

Multistage sampling technique was used for selection of the study respondents. Jos Metropolis is composed of three LGAs. Stage 1: Selection of LGA: The 3 LGAs in Jos metropolis were listed and selection of one LGA was done by balloting. Jos South LGA was the one selected. Stage 2: Selection of wards: All the wards in Jos South LGA were listed. Two wards were selected from each of the district using simple random sampling. Stage 3: Selection of beef sellers from each selected wards was done based on purposive sampling for each ward.

Data Collection and analysis (questionnaire)

Pre-tested semi-structured interviewer-administered questionnaire was used by trained data collectors to obtain data on beef sellers´ socio demography, practices, and their awareness on AMR. Beef samples from abattoir retail sellers and ward retail point of sales were collected from every beef seller until the required sample size was obtained (butcher pair). About 25g of beef samples were obtained from retail beef sellers aseptically into polythene bags that were placed on cold ice packs in a Coleman flask. These were transported from the points of sample collection to the Central Diagnostic Laboratory at the National Veterinary Research Institute (NVRI), Vom, for processing and processed immediately or kept in the refrigerator at 4°C and processed within 12 hours. Data generated from the questionnaires were analyzed using Epi info version 7 and Microsoft Excel 2007. Univariate analysis was carried out to determine the frequencies and measure of central tendency for the different variables. Chi-square analysis was used to determine the association between the independent variables (age of beef sellers´, education level and duration in the business) and dependent variables (beef sellers´ practices and the awareness on AMR) at 0.05 level of significance. The practices and the awareness were scored using median score (35) for awareness and 50% for beef sellers´ practices to categorize them into "poor" or "good" respectively.

Laboratory investigation

Isolation and identification of *E. coli*

Isolation and identification of *E. coli* was done using conventional test methods (indole, TSI, citrate, urease, Voges-Proskauer and Methyl red) and the commercially prepared kit (Microbact 24E (Oxoid) to purify the organism. The Micrbact reading was done by comparing with the Microbact 24E interpretation guide (colour chart) and the octal coding system was adopted for Microbact 24E, where each group of three Microbact chemical reactions produced a single digit of the code. These codes were inputted into the computer software package for the interpretation of possible organism carried out and interpreted based on the recommendations of the manufacturer (Oxoid, Basingstoke, UK).

Antibiotic susceptibility test of *E. coli* isolates

Susceptibility tests for the *E. coli* isolates was done using Kirby Bauer disc diffusion method [14]. Fourteen antibiotics namely; (Amoxicillin-Clavulanic acid (AMC)30 µg, Sulphamethoxazole-Trimethoprim (SXT)19:1(SXT) 25 µg, Ciprofloxacin (CIP) 5 µg, Chloramphenicol (C) 10 µg, Cephazolin (KZ) 30 µg, Ceftriaxone (CRO) 30 µg, Cefuroxime Sodium(CXM) 30 µ g, Cefepime (FEP) 30 µg, Gentamicin (CN) 10 µg, Tetracycline (TE) 30 µg, Meropenem (M) 10 µg, Erythromycin (E) 15 µg, Colistin (CT) 10 µg and Nalidixic acid (NA) 30 µg Oxoids) were used to carry out the tests. The interpretation of zones of inhibition was done according to Clinical and Laboratory Standards Institute (CLSI) 2018. *Escherichia coli* ATCC 43888 was used as quality control organism for the antibiotic disc. In addition, for true test of resistance for *E. coli*, Extended Spectrum Beta-Lactamase (ESBL) test was carried out using four antibiotic disc (Amoxicilin-clavulanate (AMC), Ceftazidime (CAZ), Ceftriazone (CRO) and Cefepime (FEP). The AMC was used as beta lactamase inhibitor. The ESBL production was inferred when the zone of inhibition around Ceftazidime and other disc were expanded by the clavulanate [15].

Minimum inhibitory concentration Test

Minimum Inhibitory Concentration (MIC) was conducted for Ciprofloxacin using commercially prepared evaluator strips (Oxoid, UK) and was interpreted according to CLSI, 2015 interpretive criteria used for decrease susceptibility testing of *Salmonella* and *E. coli*. This was done as it is considered an important tool for confirming resistance to a given antimicrobial agent [16].

Ethical considerations

Approval was obtained from the Research Ethical Committee of Plateau State Ministry of Health with reference number PSSH/ADM/ETH. Co/2019/005 and permission obtained from Plateau State Ministry of Agriculture. Informed consents of the participants were obtained and they were assured of their confidentiality of the information supplied. The study was harmless.

Results

Demographic characteristics of beef sellers

A total of 114 beef sellers participated in this study with one beef sample obtained per beef seller. Those aged 20-29 (29.8%) years accounted for the highest proportion. The mean age was 35 ± 12.5 years. All were males and 90 (78.9%) had post primary education. The years of experience in the business varied from 1-75 with the majority 76(66.7%) having <20 years´ experience. Beef handling practices was poor among all the age groups especially among those that had primary education 24 (100.0%). Duration in the business seemed to have little or no impact on beef handling practices among them Table 1.

However, this association was not significant (X^2 = 2.8561, 1.2553, 1.5405 P>0.05). There was poor awareness on AMR with 110 (96.4%) among the beef sellers being unaware. Unawareness was 100% among age groups 30-39 and 50-59 years and those that had primary education. Age (P-value = 0.7222, education level (P-value = 0.5339) and duration in the business (P-value = 0.8194) had no significant impact on beef seller´s beef handling practices and awareness on AMR (Age P-value = 0.0679, educational level P-value = 0.5523 and duration in the business = 0.8333) (X^2 = 10.2723, 1.1875, 1.4620, P>0.05) Table 2.

Most of the beef sellers 112 (98.25%) experienced sickness within a range of 1-12 times per year. Of these, only 59 (51.8%) indicated that they went to the hospital whenever they were sick highlighting the preponderance of self-medication which could promote AMR.

Occurrence and antibiotic susceptibilities of *E. coli* isolates from beef

Out of the 114 beef samples collected, 30 isolates were confirmed to be *E. coli* **Table 3** giving a prevalence of 26.3%. Susceptibilities of *E. coli* isolates showed that 29 (92.8%) out of the 30 isolates exhibited multi antibiotic resistance (MAR) to various antibiotics **Figure 2** and **Figure 3** with more than 90% of the isolates having multiple Antibiotic resistance index of > 0.2. However, only 4 (13.3%) were positive when subjected for extended spectrum beta lactamase test.

Minimum inhibitory concentration of ciprofloxacin

Minimum Inhibitory Concentration test was done for ciprofloxacin for the 29 *E. coli* isolates which were not susceptible to ciprofloxacin by disk diffusion. Of these, 22 (75.9%) of the isolates were confirmed to be resistant to ciprofloxacin by MIC method.

Discussion

The bacterial load found in beef sold for human consumption as seen in this study may be attributed to the unhygienic practices by the beef vendors from the point of processing to the point of sale. This predisposes the consumer to food-borne infection and intoxication [17]. Good hygiene practices remains the key in promoting public health as well as beef business in developing countries [18] including Nigeria.. Our findings disclosed that males dominated beef business in Jos South LGA, unlike other food processing business activities [19]. From this study, most of the beef sellers were found to have poor beef handling practices, which is in agreement with the findings of a study conducted in Turkey [20] and in the USA which found unsafe food hygiene practices in men than the women [21].

The study also demonstrates that those who attended secondary 72(63.2%) or tertiary 18(15.7%) education have significantly better beef handling practices compared to those that attended primary education 24 (21.1%), This may probably be due to the educational awareness exposure, which is consistent with the findings of the study done in South Western Nigeria [19] and in Iran [22]. Our study also, revealed that individuals with fewer years of working experience as beef sellers had good practices of safe beef handling, which is not consistent with the findings of a study conducted in Benin, Nigeria which found that food handlers with longer years of experience had better practice of food hygiene and safety [17].

However, our findings suggest that, there appears to be an increase in attitudinal negligence of hygiene practices by the beef sellers as their years of experience increased. This is consistent with the findings of a study conducted in South Western Nigeria, which found that meat handlers with lower years of working experience had significantly higher knowledge, attitude and practice levels of safe meat handling [19].

There was poor awareness of AMR among beef sellers. Antimicrobial resistance appears to be a phenomenon which is not known to many people. This finding is similar to the recent national survey on AMR conducted in Nigeria in 2017, a review on AMR [23] and a national survey conducted in Japan on public knowledge and perception about antimicrobials and AMR [24].

Raising awareness on AMR among beef sellers should be an urgent priority for public and animal health programs in Plateau State specifically and Nigeria in general, as part of the call for action as recommended by WHO [25]. This is because beef sellers are one of the groups that may contribute to the rapid spread of AMR in the course of their business. This is made more probable by beef sellers´ attestation of falling sick (98.25%) 1-12 times in a year with 58.8% illness attributed to malaria and typhoid fever with many adopting self-medication. This could be a contributor to outbreaks of MDR typhoid fever due to *Salmonella enterica* reported recently by WHO in Pakistan, across Asia and Africa and could also contribute to malaria resistance [26,27].

Creating public awareness on AMR through communication, education and training is essential to reduce the menace of AMR in public health [25]. However, this is contrary to the findings of a study conducted on effects of health communication which found that global campaign on AMR may not work, rather it will be counterproductive [28].

Our study revealed the contamination of beef with *E. coli* at retail points of sale in the study area was prevalent, which is consistent with the findings of the study conducted in Côte d´Ivoire [29] and the report in the Washington post 2019. Prevalence of *E. coli* on fresh beef at point of sales may pose a significant public health risk [30,31] which may possibly account for a substantial degree of morbidity and mortality in adult and children [32]. The effectiveness of treatment with drugs indicated for *E. coli* infections may be hampered by AMR that may have been developed by the organism [33].

The study also revealed that, most 29 (92.8%) of the isolates exhibited multi drug resistance to most commonly used antibiotics with more than 50% resistance rate to the antibiotics tested **Figure 3**, which is consistent with the findings of a study conducted in Spain and India [34,35] respectively, where the resistance of test organisms to similar drugs were found to be >50%. Resistance to gentamicin and cefepime were 50%, which is similar to the findings of a study conducted in Brazil and North East Ethiopia [9,36] respectively. Whereas resistance to sulphamethoxazole-trimothoprim were 43.3% which is lower than the findings of the study conducted in Uganda [37] but higher than the findings of a study conducted in Australia [38]. Fifty to 70% of the isolates were resistant to cefuroxime (CXM), amoxycilin-clavucilin and chloramphenicol. The highest rate of susceptibility to antimicrobials by the isolates was to colistin (90.0%) while MAR was found in 96.7% of the isolates. The overall low levels of non-susceptibility of the isolates were to ciprofloxacin that is indicated for the treatment of *E. coli* enteric infections [37].

This study also, determined the MIC value of ciprofloxacin for *E. coli* isolates that were found to be resistant to ciprofloxacin. The lowest MIC breakpoint value of <0.12 µg/ml was used [39] which is in line with the current CLSI, (2015) guidelines for decreased susceptibility to ciprofloxacin which states that MIC≥0.12 µg/ml should be used as a marker for the emerging fluoroquinolone resistance [39]. This was done to determine the lowest concentration of ciprofloxacin that can inhibit the growth of *E. coli* organisms. Greater percentage (75.9%) of the isolates was found to have resistant to Ciprofloxacin by MIC method. This poses a potential threat to public health as most of the isolates showed resistance to ciprofloxacin which is one of the drug of choice for treatment of *E. coli* infection in humans. This study revealed that the efficacy of the drug on *E. coli* is diminishing due to resistance which allow the organism to thrive.

Limitations

Due to financial constraint, only three (ciprofloxacin, AMC and ceftriaxone) out of the 14 antibiotics was selected for MIC. Consequently, due to unavailability of Amoxycilin-Clavulanate and ceftriaxone evaluator strips, only ciprofloxacin that was obtained was used for MIC test for resistant *E. coli* isolates after susceptibility test.

Conclusion

Beef handling practices was found to be inadequate to render beef wholesome for human consumption in Jos South LGA. *Escherichia coli* was found to be prevalent on fresh beef and the *E. coli* isolates exhibited multidrug resistance. Most antibiotics test in this study may no longer be very effective (> 50% resistance) for treatment of *E. coli* infection. We recommend that Plateau State government through the Ministry of Agriculture should institute policies that will increase surveillance on zoonotic bacterial agents and antibiotic susceptibilities in food of animal origin in the state. Also, the State should build/organise beef markets and institute proper hygiene in abattoir facilities and for beef handlers.

What is known about this topic

- Resistance in E. coli has been reported to be on increase worldwide
- It is also reported that consumption of food or water contaminated with pathogenic E. coli poses a public health risks to humans
- Escherichia coli of animal origin may act as donors of antimicrobial resistance genes for other pathogenic E. coli and are also identified as indicator for the spread of

antimicrobial resistance genes in the environment and to other bacteria
- In Nigeria, bacteriological quality of retailed beef in the market are not ascertained and there is reasonably scarce data relating to the levels of pathogens available in the commercially available fresh beef and non-enforcement of meat regulatory standard in the country

What this study adds

- This study provides baseline information on the beef sellers practices and their awareness on AMR and contribute to the limited information available on the occurrence and antimicrobial susceptibilities of E. coli isolated from retail beef in Jos South LGA of Plateau State
- This study presents the current prevalence of E. coli on beef sold for human consumption
- This study shows E. coli resistance to commonly used antibiotic including the ones used for its treatments

Competing interest

The authors declare no competing interest.

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Authors´ contribution

Iliya Yohanna, Yakubu Gunya Dogonyaro Dashe, Jacob Kwada Paghi Kwaga contributed in the conceptualization of the topic, methodology and writing of the original draft. Jacob Kwada Paghi Kwaga and Godwin Ojonugwa Agada supervised the laboratory investigation. Grace Sabo Kia, Muhammad Shakir Balogun and Charles Michael Akatobi reviewed the manuscript for intellectual content. All the authors read and reviewed the final draft, while Jacob Kwada Paghi Kwaga approved the final manuscript.

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Tables and figures

Table 1: Socio-demographic Characteristics of Beef Sellers in Jos South LGA Plateau State, (n=114)

Table 2: Association between Demographic Characteristics, Practices and Awareness on AMR of beef Sellers in Jos South LGA (n=114)

Table 3: Distribution of *E. coli* Isolates for Jos South LGA, Plateau State (n=30)

Figure 1: Map of Nigeria Highlighting Plateau State and Jos South LGA as the Study Area

Figure 2: Percentage Resistance of *E. coli* Isolates Against Antibiotics Disk concentrations in Jos South LGA, Plateau state.

Figure 3: Proportion of Resistance *E. coli* Isolates against the Number of Antibiotics to which Isolates were Resistant, Jos South LGA Plateau State (n=30)

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Table 1: Socio-demographic Characteristics of Beef Sellers in Jos South LGA Plateau State, (n=114)	
Variable	**Frequency**
Age group	
<20	11(9.65)
20-29	34(29.82)
30-39	28(24.56)
40-49	29(25.44)
50-59	9(7.89)
≥ 60	3(2.63)
Sex	
Male	114(100.0)
Female	0(0.0)
Marital status	
Married	78(68.42)
Single	36(31.5)
Educational level	
Primary	24(21.05)
Secondary	72(63.16)
Tertiary	18(15.79)
Duration in the Business by years	
<20 years	76(66.67)
20-29	18(15.79)
30-39	14(12.28)
40-59	4(3.51)
60-79	2(1.75)

Table 2: Association between Demographic Characteristics, Practices and Awareness on AMR of beef Sellers in Jos South LGA (n=114)

Variable	**Practice of beef sellers**			
	Poor (%)	**Good (%)**	**X^2**	**P-value**
Age of beef sellers				
<20 years	11(100.0)	0(0.0)	2.8561	0.7222
20-29	32(94.1)	2(5.9)		
30-39	28(100.0)	0(0.0)		
40-49	28(96.6)	1(3.45)		
50-59	9(100.0)	0(0.0)		
≥ 60 years	3(100.0)	0(0.0)		
Education Level				
Primary	24(100.0)	0(0.0)	1.2553	0.5339
Secondary	70(97.2)	2(2.8)		
Tertiary	17(94.4)	1(5.6)		
Duration in beef selling (years)				
<20	73(96.1)	3(3.1)	1.5405	0.8194
20-29	18(100.0)	0(0.0)		
30-39	14(100.0)	0(0.0)		
40-49	4(100.0)	0(0.0)		
≥ 50	2(100.0)	0(0.0)		
Awareness on AMR				
	No	**Yes**	**X^2**	**P-value**
Age of beef sellers				
<20 years	10(90.9)	1(9.1)	10.2723	0.0679
20-29	33(97.1)	1(2.9)		
30-39	28(100.0)	0(0.0)		
40-49	28(96.5)	1(3.45)		
50-59	9(100.0)	0(0.0)		
≥ 60 years	2(66.6)	0(0.0)		
Education Level				
Primary	24(100.0)	1(33.3)	1.1875	0.5523
Secondary	69(95.8)	1(4.2)		
Tertiary	17(94.4)	1(5.6)		
Duration in beef selling (years)				
<20	73(96.1)	3(3.1)	1.462	0.8333
20-29	18(100.0)	0(0.0)		
30-39	13(92.9)	1(7.1)		
40-49	4(100.0)	0(0.0)		
≥ 50	2(100.0)	0(0.0)		

Table 3: Distribution of *E. coli* Isolates for Jos South LGA, Plateau State (n=30)

Source	**Positive**
Bukuru ward	10(33.3)
Dashonong ward	3(10.0)
Du B ward	4(13.3)
Giring ward	3(10.0)
Gyal ward	4(13.3)
Kuru A ward	3(10.0)
Kuru B ward	3(10.0)
Du A	0(0.0)
Vwang	0(0.0)
Zawan	0(0.0)
	30(26.3%)

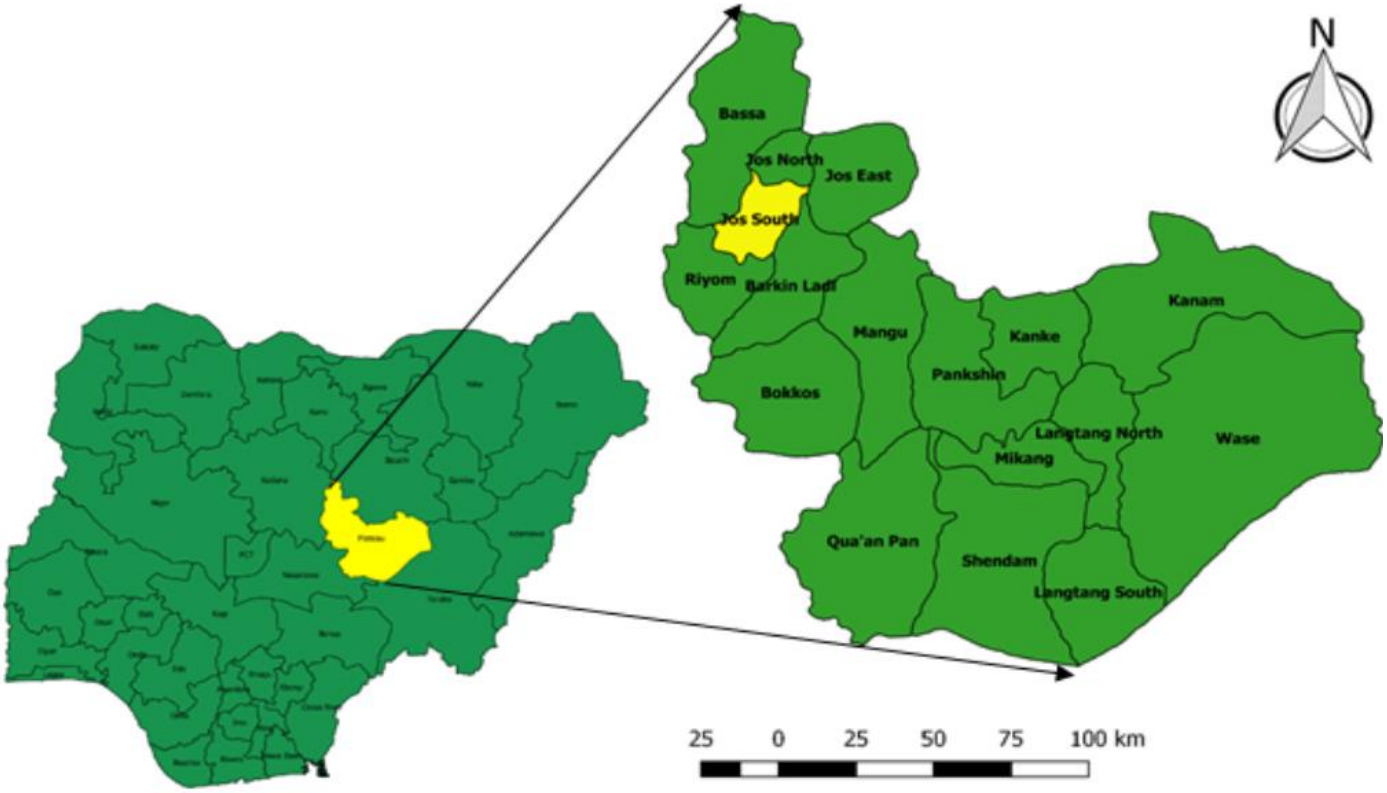

Figure 1: Map of Nigeria Highlighting Plateau State and Jos South LGA as the Study Area

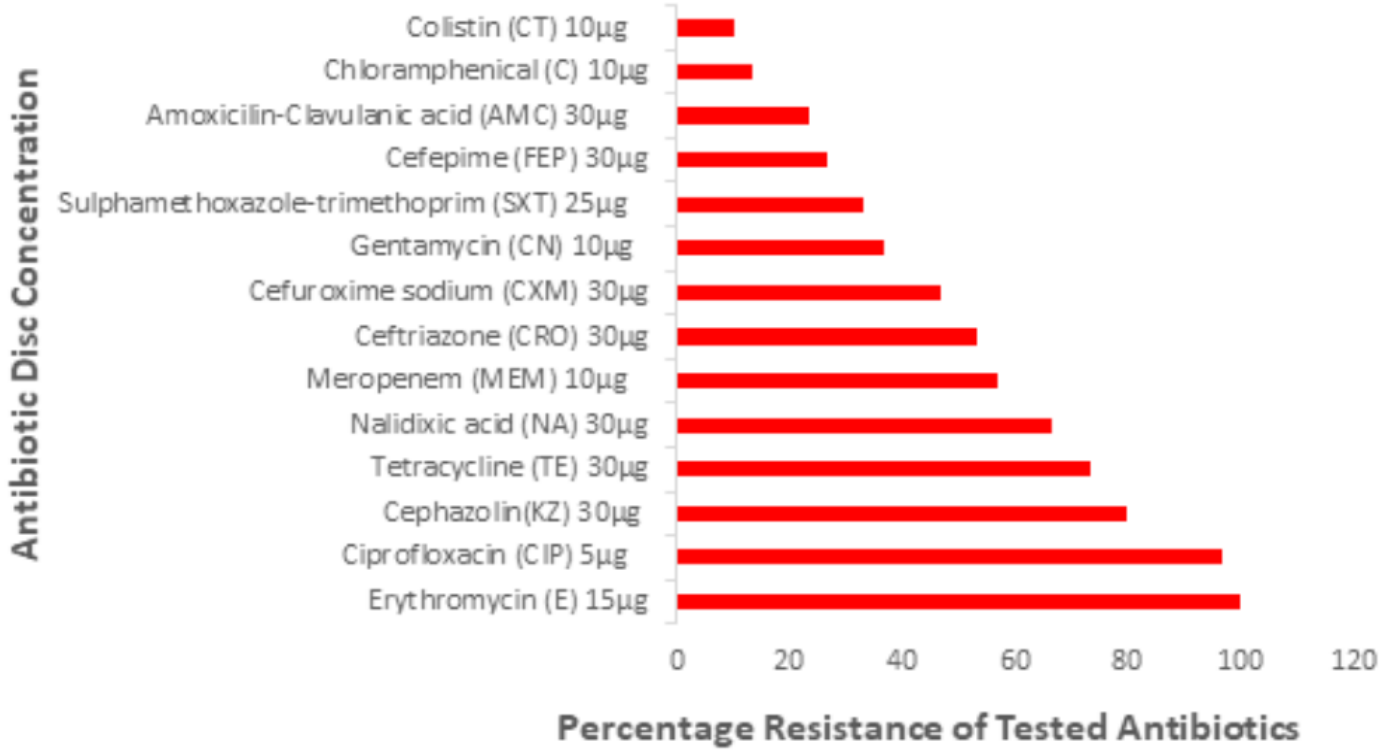

Figure 2: Percentage Resistance of E. coli Isolates Against Antibiotics Disk concentrations in Jos South LGA, Plateau state

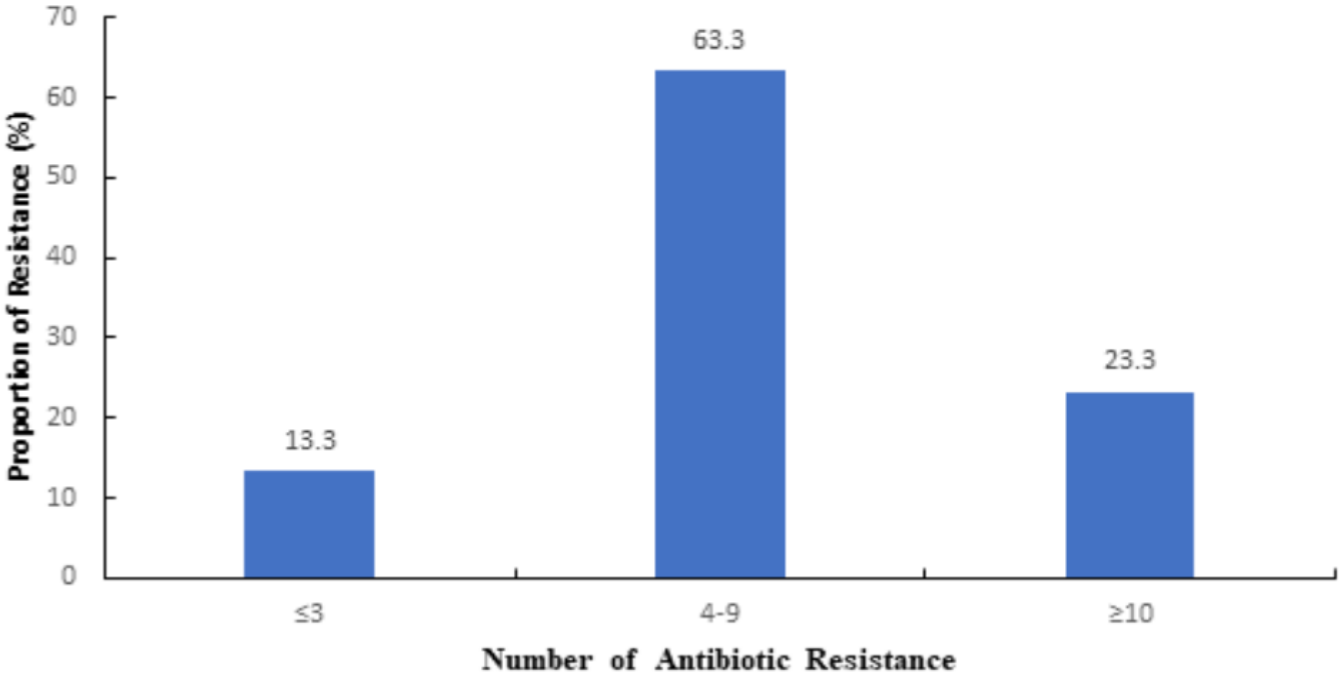

Figure 3: Proportion of Resistance E. coli Isolates against the Number of Antibiotics to which Isolates were Resistant, Jos South LGA Plateau State (n=30)