Antimicrobial Resistance Profile and Extended Spectrum Beta-Lactamase Resistance Genes in *Escherichia coli* from Poultry Droppings in Nasarawa, Nigeria

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**Authors’ contributions**

This work was carried out in collaboration among all authors. Author YBN designed the study, authors SCT conducted the experiments. Author SMJ wrote the first draft of the manuscript. Authors RHA and IHN managed the literature searches and analysis of the study. Author GRIP wrote the protocol. All authors read and approved the final manuscript.

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**Original Research Article**

**ABSTRACT**

**Aims:** This study investigated the antimicrobial resistance profile and extended spectrum beta-lactamase resistance genes of *Escherichia coli* isolated from droppings of from selected poultry farms in Nasarawa, Nigeria.

**Study Design:** Investigative

**Place and Duration of Study:** Department of Microbiology, Nasarawa State University, Keffi, between November 2019 and February 2020.

**Methodology:** A total of 90 samples from poultry droppings were collected from selected farms. *Escherichia coli* was isolated from the samples using standard cultural and microbiological methods. Antibiotic susceptibility testing and minimum inhibitory concentrations were evaluated as described.
by the Clinical and Laboratory Standards Institute (CLSI). The detection of extended-spectrum beta-lactamase (ESBL) production in *E. coli* isolates was carried out using double disc synergy test. In addition, molecular detection of ESBL genes was carried out using Polymerase Chain Reaction (PCR) method.

**Results**: The prevalence of *E. coli* was 100%. Antibiotic resistances of *E. coli* were recorded as follows: streptomycin (S: 94.4%), sulphonamethaxozole / trimethoprim (SXT: 90.0%), ampicillin (AMP: 88.9%), gentamicin (CN: 68.9%), amoxicillin/clavulanic acid (AMC: 55.6%), ciprofloxacin (CIP: 41.1%), ceftoxin (FOX: 35.6%), ceftazidime (CAZ: 34.4%), cefotaxime (CTX: 22.2%), and imipemens (IPM: 17.8%). The most common antibiotic resistant resistance phenotype was AMP-CTX-CAZ-CIP-CN (11.1%). Multiple antibiotic resistance (MAR) was observed in 97.7% (88/90) of the isolates, with the common MAR index being 0.5 (33.3%). Twenty five of the thirty beta-lactam resistant isolates (83.3%) were confirmed ESBL producers. The 25 ESBL positive isolates carried *bla* genes as follows: *bla*<sub>TEM</sub> (11/25, 44.0%) and *bla*<sub>CTX-M</sub> (18/25, 72.0%). *bla*<sub>SHV</sub> was not found in any isolate.

**Conclusion**: *E. coli* isolated from the droppings of selected poultry farms in Nasarawa were less resistant to imipenem, cefotaxime, ceftazidime and ceftoxin in the study location. This implies that the antibiotics are useful in the treatment of infection caused by *E. coli*. Also, ESBL-positive *E. coli* isolates harbored ESBL genes, with *bla*<sub>CTX-M</sub> as the most common.

**Keywords**: *Escherichia coli*; poultry; antibiotic; resistance; ESBL; genes.

1. **INTRODUCTION**

The United Nations, through the Food and Agricultural Organization (FAO) has reported an increase in the consumption of animal protein of poultry origin, especially in developing countries [1]. The Nigerian poultry industry comprises of about 180 million birds, and has the largest annual egg production as well as second largest chicken population in Africa [1]. Poultry has been reported as one of the common hosts and carriers of *Escherichia coli* [2,3], and is an important sector for study because of the common usage of antibiotics in the industry [4,5].

*Escherichia coli* is one of the most widely studied pathogens in relation to antimicrobial resistance in Nigeria [6]. It is a common inhabitant of the intestinal tract of poultry, animals, and humans [7]. Although many *E. coli* strains have been reported to be harmless commensals, some are known to cause diverse infections in humans and animals [8,9]. In poultry, *E. coli* causes infection known as colibacillosis which results in morbidity and mortality of poultry by septicemia, making it a disease of economic importance [10].

Antimicrobials are a helpful means for preventing and treating diseases caused by microorganisms, as well as for growth promotion [11,12]. Classes of antimicrobials used in agriculture include penicillins, cephalosporins, fluoroquinolones, sulfonamides, amino glycosides, and tetracyclines [13]. The high utilization of antibiotics is considered as a great factor in the emergence, selection and dissemination antibiotic-resistant organisms, including extended-spectrum beta-lactamase (ESBL) producers [14], and this is a growing public health concern worldwide [15]. ESBLs are plasmid coded beta-lactamases which are capable of hydrolyzing broad spectrum cephalosporins, penicillins and monobactam, but not cephamycins or carbapenems; and are inhibited by beta-lactamase inhibitors such as clavulanic acid, sulbactam and tazobactam [16]. The ESBL enzymes are of different types; SHV, TEM, CTX-M, and OXA types, among others [17]. The trend of antimicrobial resistance among *E. coli* in food animals and birds such as chickens is a cause of concern, especially due to the possibility and potential for the transfer of these pathogens to the human population [18].

In recent years, the poultry industry in many developing countries including Nigeria, has evolved from small farms for home consumption to large commercial poultries, assuming greater importance in creating jobs, and improving food production all in the absence of proper regulations and laws guiding antimicrobial use [19]. This study investigates, in droppings of selected poultry farms in Nasarawa, Nigeria, the prevalence of *E. coli* pathogen, its pattern of antimicrobial resistance, and ESBL genes.

2. **MATERIALS AND METHODS**

2.1 **Sample Collection**

A total of 90 chicken droppings (30 from each of the three poultry farms) were randomly collected using appropriate sterile sample containers and transported to the Microbiology Laboratory at the
Nasarawa State University, Keffi, for same-day analysis or stored in a refrigerator (Model PRN 1313 HCA, BEKO, Germany) at 5°C for later-day analysis. Three poultry farms, designated A, B and C, were randomly selected from Nasarawa Local Government Area of Nasarawa State, in North Central Nigeria. Farm A is a commercial poultry farm located in Tamah, a suburb in Nasarawa Local Government, housing over 2000 chickens. Farm B is a medium sized poultry farm in Laminga, a town about 15km from Nasarawa, and housing about 600 to 1,000 chickens aged from 50 to 60 days as at the time of sampling. Farm C is a large scale poultry farm having a large population of chickens, and situated at Marmara, in Nasarawa Local Government Area. Samples were collected between November 2019 and March 2020.

2.1.1 Isolation of Escherichia coli

The samples collected were subjected to isolation procedure; presumptive *E. coli* was isolated from the poultry droppings as follows: 1.0 g of poultry dropping was inoculated into 9 ml of nutrient broth (NB: Oxoid Ltd., UK) and incubated in an incubator (Quincy Lab Inc, Model12-140E, USA) at 37°C for 24 hrs. A loopful of the 24-hrs broth was streaked on MacConkey agar (MCA: Oxoid Ltd., UK) plate and incubated at 37°C for 24 h. Pinkish colonies from the 24-hrs MCA plates were further streaked on Eosine Methylen Blue agar (EMB: Oxoid Ltd., UK) plates and incubated at 37°C for 24 hrs. Colonies with a greenish-metallic sheen appearance were selected as presumptive *E. coli* [20].

2.1.2 Identification of Escherichia coli

*Escherichia coli* was identified done by morphological, cultural and biochemical characteristics using Gram staining, Motility Test and biochemical tests (Indole, Methyl Red-Voges-Proskauer, Citrate, Nitrate Reduction Test, Urease Test, H₂S production Test, etc.) as described in the Bacteriological Analytical Manual [21] and Cheesbrough [20]. The API20E system (Analytical Profile Index) (BioMerieux™, USA), a commercial kit designed for the identification of Enterobacteriaceae and other non-fastidious Gram negative bacteria, was used to confirm the suspected isolates as described in the manufacturer’s manual. Colonies with a characteristic pink color on MCA, which grew with a greenish-metallic sheen on EMB agar, Gram-negative, rods, indole positive, citrate negative, methyl-red positive, Voges-Proskauer negative, urease negative, nitrate reduction positive, and a positive motility test indicated *E. coli*. The bacterium was stored in the refrigerator on nutrient agar (Oxoid Ltd., UK) slants and reactivated by sub-culturing on MCA for use in further research.

2.2 Antimicrobial Susceptibility Testing

The antibiotic susceptibility test for *E. coli* isolates from poultry droppings was carried out using the Kirby-Bauer disc diffusion method as modified by the Clinical and Laboratory Standards Institute (CLSI) [22]. Briefly, 5 colonies of *E. coli* isolates were inoculated into 5 ml of Mueller-Hinton broth (MHB: Oxoid Ltd, UK) and incubated at 37°C for 24 hrs after which the 24-hrs MHB was standardized to the turbidity equivalent to 0.5 McFarland Standard. The 0.5 McFarland Standard was prepared as follows: 99.5 ml of 1% (w/v) H₂SO₄ + 0.5 ml of 1.172% (w/v) BaCl₂.2H₂O. A sterile cotton swab stick was dipped into the standardized *E. coli* suspension and streaked on Mueller-Hinton Agar (MHA: Oxoid Ltd, UK) plates. Antibiotics discs (Oxoid Ltd, UK) were gently placed 15mm apart on the MHA surface using a pair of sterile forceps and the plates were allowed to incubate at room temperature for 1 h before re-incubating at 37°C for 17 hrs. The discs used include: Amoxicillin/Clavulanic acid (AMC: 10/20 μg), Sulphamethoxazole/Trimethoprim (SXT: 25 μg), Ampicillin (AMP: 10 μg), Cefotaxime (CTX: 30 μg), Cefoxitin (FOX: 30 μg), Streptomycin (S: 30 μg), Gentamicin (CN: 10 μg), Ceftazidime (CAZ: 30 μg), Ciprofloxacin (CIP: 5 μg) and Imipenem (IPM: 30 μg). After incubation, the diameters of the zones of inhibition were measured to the nearest millimeter (mm) using a ruler, and the result of the susceptibility test was interpreted using susceptibility breakpoint earlier described by CLSI [22].

2.3 Extended Spectrum β-Lactamase Production Test

The phenotypic confirmatory test for ESBL production by isolates resistant to cefotaxime and ceftazidime was carried out using Double-Disc Synergy Test (DDST) method earlier described by Giriyaipur et al. [23]. Briefly, 10⁶ cfu/ml bacterial suspension was streaked on sterile Mueller-Hinton agar plates and amoxicillin/clavulanic acid (30 μg) disc was placed at the centre of the plate. Cefotaxime (30 μg) and ceftazidime (30 μg) discs were then placed 15 mm (edge-to-edge) from the disc at the centre. Enhancement of zone of inhibition in
the area between the amoxicillin-clavulanic acid disc and any one of the β-lactam discs compared with the zone of inhibition on the far side of the drug disc was interpreted as indicative of the presence of an ESBL in the tested strain.

2.3.1 Determination of Multiple Antibiotic Resistance (MAR) Index

The multiple antibiotic resistance index (MARI) of the \( E.\ coli \) isolates were determined as described by [24]. MARI is defined as resistance to at least two (2) antibiotics, hence obtaining a MAR value higher than 0.2 indicated a significant and high risk source of acquiring the multidrug resistant \( E.\ coli \) from the tested samples.

\[
\text{MAR Index} = \frac{a}{b} \quad \text{(Number of antibiotics isolate is resistant to)}
\]

\[
\text{MAR Index} \quad \text{(Number of antibiotics tested)}
\]

2.3.2 Molecular detection of ESBL resistance genes

2.3.2.1 DNA extraction

The DNA extraction of ESBL positive \( E.\ coli \) was performed by the boiling method as described previously [25]. Bacterial DNA was isolated from a 24-hrs culture in Luria-Bertani broth (LB: Oxoid Ltd, UK) prepared according to the manufacturers’ protocol. The bacterial cells were harvested by centrifugation at 3200 rpm for 10 min. Cell debris was removed after centrifugation was done at 3200 rpm for 1 min and the supernatant was discarded. 0.5 ml of sterile normal saline and the microcentrifuge tubes were placed in the vortex for 5 sec. The harvested cells were re-suspended in 1 ml of sterile normal saline and the microcentrifuge tubes were placed in the vortex for 5 sec. The reaction tubes were placed in the holes of the thermocycler (Model TC-312, Techne, England) and the door of the machine was closed. Conditions for amplification of all the genes during the reactions were set as 3 min of initial denaturation at 95°C, followed by 35 amplification cycles of denaturation at 95°C for 30 sec, annealing at 56°C for 40 sec, initial extension at 72°C for 50 sec, final extension at 72°C for 3 min and a hold at 4°C infinitely.

2.3.2.2 DNA amplification of target genes by polymerase chain reaction

Simplex Polymerase Chain Reaction (PCR) was performed in order to amplify the ESBL genes being assessed in the isolates. The presence of \( \text{bla}_\text{CTX}, \text{bla}_\text{SHV} \) and \( \text{bla}_\text{TEM} \) genes were tested for using previously published primer sets and conditions. The primer sequences and expected amplicon sizes for each gene are listed in Table 1. The reactions were carried out in 20 μl reaction volume made up of 10 μl of Mastermix (Inqaba Biotech, South Africa), 0.32 μl of primers (0.16 μl each of forward and reverse primers), 3 μl of DNA and 6.68 μl of nuclease-free water. The primer concentration stood at 0.2 M [24]. The reaction tubes were placed in the holes of the thermocycler (Model TC-312, Techne, England) and the door of the machine was closed. Conditions for amplification of all the genes during the reactions were set as 3 min of initial denaturation at 95°C, followed by 35 amplification cycles of denaturation at 95°C for 30 sec, annealing at 56°C for 40 sec, initial extension at 72°C for 50 sec, final extension at 72°C for 3 min and a hold at 4°C infinitely.

2.3.2.3 Agarose gel electrophoresis

Exactly 7 μl of the amplified DNA was transferred into the wells of a 1.5% Agarose gel by stabbing the wells using a micropipette and this was done carefully to ensure that each well had only one sample. Each gel had one well which contained a DNA ladder (1500 bp, Inqaba Biotech, South Africa) in order to estimate the size of the DNA amplicons. Electrophoresis was run at 125 volts for 20 min, after which the gels were viewed using ultra-violet trans-illuminator (Vilber Lourmat TFX-35-M serial no NoV02 8104, France).

3. RESULTS AND DISCUSSION

3.1 Prevalence of \textit{Escherichia coli}

The isolated bacterium had characteristics of \textit{Escherichia coli} earlier described in the “Materials and Methods” section in tandem with
3.2 Antibiotic Resistance Profile of the *Escherichia coli* Isolates

The antibiotic resistance profile of the *E. coli* isolates is shown in Table 2. The highest resistance was to streptomycin (94.4%), and the least resistance was to Imipenem (17.8%). Low resistance rates were also observed to Cefotaxime (22.2%), ceftazidime (34.4%) and cefoxitin (35.6).

3.3 Antibiotic Resistance Phenotypes of the *Escherichia coli* Isolates

The antibiotic resistance phenotypes of *E. coli* isolates are as shown in Table 3. The most common phenotype observed was AMP-CTX-CAZ-CIP-CN (11.1%).

3.4 Multiple Antibiotic Resistance (MAR) Index

The MAR indices of the isolates are as shown in Table 4. All but 2 of the isolates were MAR isolates, showing resistance to at least two antibiotics tested. The most common MAR index was 0.5 (33.3%); and 63.3% of the *E. coli* isolates had MAR index of 0.5 and above.

3.5 Phenotypic Confirmation of Extended-Spectrum Beta-Lactamase Production

Twenty-five (83.3%) out of the 30 tested beta-lactam resistant isolates showed enhanced zones of clearing towards the amoxicillin-clavulanic acid disc when examined by DDST method. Hence, most of isolates resistant to beta-lactam antibiotics were ESBL positive.

3.6 Molecular Detection of Extended-Spectrum Beta-Lactamase Genes

The distribution of the ESBL resistance genes in the ESBL-positive *E. coli* isolates is as follows: 18 (72.0%) isolates harbored *bla*~*CTX-M* genes, 11 (44.0%) harbored *bla*~*TEM* gene, and no isolate harbored *bla*~*SHV* gene.

The observed 100% prevalence of *E. coli* from all the samples of the poultry droppings is similar to the 100% and 98% reported by [26] and [27] respectively. A study by [28] and [29] both reported lower isolation rates of 53.4% and 57% respectively. Factors such as environmental conditions, geographical locations, and mixed infection of samples with other microbes have been suggested to affect prevalence of bacteria including *E. coli* [30] and this could be the causes of the differences in prevalence.

### Table 1. Primers and their sequences [44]

| Target Gene | Primer Name | Sequence (5’ – 3’) | Product Size (bp) | Reference |
|-------------|-------------|--------------------|------------------|-----------|
| *bla*~*SHV* | *bla*~*SHV*-F | TCAGCGAAAAACACCTTG | 472 | [43] |
|             | *bla*~*SHV*-R | TCCCGGAGATATAATCACC |               |           |
| *bla*~*CTX-M* | *bla*~*CTX-M*-F | CGCTTTGCGATGTGCAG | 550 | [43] |
|             | *bla*~*CTX-M*-R | ACCGGGATACCTGGTGTG |               |           |
| *bla*~*TEM* | *bla*~*TEM*-F | CTTCCTGTTTTGCTCAAC | 636 | [43] |
|             | *bla*~*TEM*-R | AGCAATAAACCAGCAGC |               |           |

### Table 2. Antimicrobial resistance profile of *Escherichia coli* isolates from droppings of selected poultry farms in Nasarawa, Nigeria

| Antibiotics                          | Disc Content (μg) | No. (%) resistance in *E. coli* (n=90) |
|--------------------------------------|------------------|--------------------------------------|
| Ampicillin (AMP)                     | 10               | 87 (96.7)                            |
| Gentamicin (CN)                      | 30               | 47 (52.2)                            |
| Amoxicillin/Clavulanic acid (AMC)    | 30               | 55 (61.1)                            |
| Sulphamethoxazole/Trimethoprim (SXT) | 25               | 79 (87.8)                            |
| Cefotaxime (CTX)                     | 30               | 28 (31.1)                            |
| Streptomycin (S)                     | 10               | 85 (94.4)                            |
| Ceftazidime (CAZ)                    | 30               | 32 (35.6)                            |
| Ciprofloxacin (CIP)                  | 5                | 36 (40.0)                            |
| Cefoxitin (FOX)                      | 30               | 12 (13.3)                            |
| Imipenem (IPM)                       | 10               | 20 (22.2)                            |
Table 3. Antimicrobial resistance phenotypes of *Escherichia coli* isolated from droppings of selected poultry farms in Nasarawa, Nigeria

| Antibiotic Resistance Phenotypes | Frequency (%) (n=90) |
|----------------------------------|----------------------|
| AMC                              | 2(2.2)               |
| AMC,AMP,CN                       | 1(1.1)               |
| AMC,AMP,CTX                      | 1(1.1)               |
| AMP,CIP,FOX,CN                   | 2(2.2)               |
| AMP,SXT,CTX                      | 1(1.1)               |
| AMP,SXT,S,AMC                    | 3(3.3)               |
| AMC,CAZ,CN,S,XT                  | 4(4.4)               |
| AMC,CIP,CN,S,S,XT                | 2(2.2)               |
| SXT,FOX,S,CAZ,CTX                | 4(4.4)               |
| AMP,CTX,CIP,CN                   | 10(11.1)             |
| AMP,CAZ,CIP,CN,S                 | 2(2.2)               |
| AMP,CN,FOX,S,CTX                 | 3(3.3)               |
| AMC,AMP,CN,S,S,XT                | 3(3.3)               |
| AMC,CTX,CIP,CN,S                 | 3(3.3)               |
| AMC,CAZ,FOX,S,XT                 | 3(3.3)               |
| AMC,AMP,CAZ,CTX,S,XT             | 1(1.1)               |
| AMP,SXT,CAZ,CTX,CIP,AMC          | 2(2.2)               |
| AMC,AMP,CAZ,FOX,S,XT             | 2(2.2)               |
| AMC,CTX,CIP,CN,S,S,XT            | 1(1.1)               |
| AMC,AMP,CAZ,CTX,CN,              | 2(2.2)               |
| AMP,CAZ,CTX,FOX,IPM,S,S,XT       | 3(3.3)               |
| AMP,CIP,CTX,FOX,IPM,S,XT         | 2(2.2)               |
| AMP,CAZ,IPM,FOX,IPM,S            | 4(4.4)               |
| AMP,SXT,S,FOX,CAZ,CI,CTX,AMC,IPM | 2(2.2)               |
| AMC,AMP,CTX,CAZ,IPM,FOX,S,XT     | 2(2.2)               |

*AMP: Ampicillin, CN: Gentamicin, AMC: Amoxicillin/Clavulanic Acid, SXT: Sulphamethoxazole/Trimethoprim, CTX: Cefotaxime, S: Streptomycin, CAZ: Ceftazidime, CIP: Ciprofloxacin, FOX: Cefoxitin, IPM: Imipenem*

Table 4. Multiple Antibiotic Resistance (MAR) Index of *Escherichia coli* isolated from droppings of selected poultry farms in Nasarawa, Nigeria

| No of antibiotics isolate resistant to (a) | No. of antibiotics tested (b) | MAR Index \( \frac{a}{b} \) | No. (%) MAR isolates (n=90) |
|-------------------------------------------|-------------------------------|-----------------------------|-----------------------------|
| 10                                        | 10                            | 1.0                         | 2(2.2)                      |
| 9                                         | 10                            | 0.9                         | 1(1.1)                      |
| 8                                         | 10                            | 0.8                         | 0(0.0)                      |
| 7                                         | 10                            | 0.7                         | 9(10.0)                     |
| 6                                         | 10                            | 0.6                         | 15(16.7)                    |
| 5                                         | 10                            | 0.5                         | 30(33.3)                    |
| 4                                         | 10                            | 0.4                         | 10(11.1)                    |
| 3                                         | 10                            | 0.3                         | 2(2.2)                      |
| 2                                         | 10                            | 0.2                         | 2(2.2)                      |

*MAR isolates are those with resistance to at least two antibiotics [24]*

From this study, *E. coli* isolates were more resistant to streptomycin, sulphamethoxazole/trimethoprim, and ampicillin, which is similar to studies by [27], [31], and [32], but less resistant to imipenem, cefotaxime and ceftazidime. This finding is similar to a study by [33]. The observed resistance of the *E. coli* from this study to commonly used antibiotics is not extraordinary as many studies worldwide have reported it [34,35]. A significant observation from this study is that most of the isolates have MAR index above 0.2, and this implies that there is a possibility that the isolates originated from an environment where misuse and abuse of antibiotics is common [24].

The detection of both *bla*<sub>TEM</sub> and *bla*<sub>CTX-M</sub> resistance genes in the ESBL-producing *E. coli* suggests that these genes may be responsible for the observed resistance to beta-lactam antibiotics. The detection of *bla*<sub>TEM</sub> agreed with
reports by [36] where 70% of ESBL-producing *E. coli* harbored *bla*<sub>TEM</sub> genes and [37] where TEM genes were also discovered. [34] reported 68.2% of isolates carrying *bla*<sub>TEM</sub> genes. The detection of *bla*<sub>CTX-M</sub> genes in this study is not surprising, as many reports all over the world have shown *bla*<sub>CTX-M</sub> to be expressed where antimicrobial resistance in ESBL positive isolates is involved. This study discovered *bla*<sub>CTX-M</sub> genes in 72.0% of ESBL positive isolates and this was in agreement with [38] and [39], where 97.8% and 44.4% of isolates carried the gene. Other studies by [40] and [41] supported this result. The absence of *bla*<sub>SHV</sub> gene in the isolates tested in this study is also noteworthy. [39] reported the absence of *bla*<sub>SHV</sub> gene among ESBL positive isolates, similar results reported by [42]. This report is in disagreement with a study by [34] where *bla*<sub>SHV</sub> was discovered in 95.5% of tested ESBL positive isolates. Few isolates carried both *bla*<sub>TEM</sub> and *bla*<sub>CTX-M</sub> genes.

As research continues on the worldwide prevalence of antimicrobial resistance, regular and proper surveillance is needed; the reality of resistance to antibiotics poses a public health concern to workers in the farms, consumers of meat, and the general populace. There is a need for serious campaigns and awareness programs as well as sanctions against abuse of antibiotics in the poultry industry. Implementation of policies to control or reduce the abuse of these antibiotics will go a long way in checking abuse and misuse.

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**Fig. 1.** Agarose gel electrophoresis of the TEM gene of ESBL *E. coli* isolates from Nasarawa. Lane T1, failed amplification, Lanes T2-T11 represents the TEM gene bands (636bp), Lane N represents the negative control, lane L represents the 1500bp molecular ladder

**Fig. 2.** Agarose gel electrophoresis of the CTX-M gene of ESBL *E. coli* isolates from poultry droppings in Nasarawa. Lanes 1-6, 7-11 represent the CTX-M gene bands (550bp), and lane L represents the 1500bp molecular ladder
4. CONCLUSION

The prevalence of E. coli from poultry droppings was high, and the isolates were less resistant to imipenem, ceftazidime, cefoxitin and cefotaxime. With the low resistance rates observed to these antibiotics, they may be useful for the successful treatment of infections caused by E. coli in the study location. ESBL genes (blaTEM and blaCTX-M) were discovered in the ESBL-positive E. coli isolates with a high detection rate for blaCTX-M.

DISCLAIMER

The products used for this research are commonly and predominantly used products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

Consent was obtained from the various poultry farm managers before sample collection. Samples were collected only with the farmer’s consent and willingness to participate in the research.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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