

Antibiotic Residue Accumulation in Poultry Meat and its Implications for Food Safety and Public Health in Keffi Metropolis, Nigeria

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Abstract

The extensive use of antibiotics in intensive poultry production has raised serious concerns regarding residual drug accumulation in edible tissues and the associated risks to animal health, food safety, and public health. This study assessed the presence, concentrations, and biological implications of residual antibiotics in broiler chicken breast and liver samples from poultry farms and retail supermarkets in Keffi metropolis. Broiler chickens were administered commonly used antibiotics, including fluoroquinolones, sulphonamides, gentamicin, oxytetracycline, neomycin, tylosin, and penicillin, while a control group received no antibiotics. Antibiotic residues in poultry and supermarket samples were analyzed using chromatographic and spectrophotometric techniques. Secondary exposure and bioaccumulation were assessed in albino rats fed antibiotic-contaminated chicken meat. Microbial isolation and antibiotic sensitivity testing were conducted using standard culture and disk diffusion methods. Antibiotic-treated broiler chickens exhibited altered locomotor activity, heat stress (body temperature increase of 0.5–1.0 °C), reduced feeding behaviour, and increased mortality, with some groups losing up to two birds. From weeks 5–8, all antibiotic-treated groups showed significantly higher body weight compared to controls ($P < 0.05$). Qualitative analysis confirmed the presence of multiple antibiotic residues in both breast and liver tissues, with liver samples consistently showing higher accumulation. Quantitatively, residue concentrations exceeded international Maximum Residue Limits, reaching 4.88 mg/g in poultry breast and 11.42 mg/g in poultry liver for penicillin. Supermarket frozen chicken samples showed even higher levels, with oxytetracycline concentrations as high as 30.08 mg/g. Gentamicin, oxytetracycline, and penicillin residues were detected in albino rat tissues, confirming dietary bioavailability. Microbial analysis revealed the presence of *Escherichia coli*, *Salmonella* spp., *Citrobacter*, and *Lactobacilli*, alongside retained antimicrobial activity of residues against selected bacteria. These findings highlight significant risks to animal welfare, food safety, and public health and underscore the urgent need for strengthened regulatory control, routine residue monitoring, and responsible antibiotic stewardship in poultry production.

Keywords: Antibiotics, Keffi Metropolis, Maximum Residue Limits (MRLs), Antimicrobial Resistance, Foodborne Pathogens.

Introduction

Antibiotics have played a pivotal role in modern poultry production by improving growth efficiency, preventing infectious diseases, and reducing mortality in commercial broiler flocks (Abdullahi *et al.*, 2025). Their use has become widespread as poultry production scales up to meet global demand for affordable animal protein. However, a direct consequence of this practice is the presence of antibiotic residues pharmacologically active substances or their metabolites in edible tissues such as breast meat and liver. Residues accumulate when antibiotics are administered without strict adherence to veterinary guidelines, particularly regarding withdrawal periods prior to slaughter (Pal *et al.*, 2025). The liver, due to its central role in xenobiotic metabolism, often exhibits higher residue concentrations compared with muscle tissue, underscoring its importance in residue monitoring (Muhammed-Sadiq *et al.*, 2025).

In many developing countries, including Nigeria, regulatory oversight of antibiotic use in livestock is limited by weak enforcement mechanisms, poor farmer awareness of proper dosages and withdrawal compliance, and inadequate residue monitoring systems (Ezenduka *et al.*, 2019). Empirical studies within Nigerian contexts have documented high prevalence rates of antibiotic residues in broiler tissues, indicative of extensive misuse and potential public health risk (Kamouh *et al.*, 2024). The situation is compounded by the emergence of antimicrobial resistant (AMR) bacteria, which persist in poultry food chains and compromise the efficacy of clinically important antibiotics (WHO, 2024). Antibiotic residues in poultry products constitute a One Health concern, linking animal health, food safety, and human public health. Residues can induce allergic reactions, disrupt gut microbiota, promote the development and spread of AMR, and exert toxic effects when consumed chronically at sub-therapeutic levels (Pal *et al.*, 2025). These consequences are recognized globally and pose a direct threat to consumer health, particularly in regions where poultry meat represents a major component of the diet (Izah *et al.*, 2025).

Statement of the Research Problem

Despite the recognized risks, there is a paucity of localized data on the prevalence and concentration of residual antibiotics in broiler chicken products within the Keffi metropolis. Current veterinary drug use practices in the area are not well documented, and there is limited empirical evidence on how residues affect both animal health and human health outcomes after consumption. Although studies in other Nigerian regions have shown that antibiotic residues are prevalent in commercial poultry and may exceed internationally accepted limits, the specific patterns, concentrations, and associated health effects in Keffi remain under-explored (Ezenduka, 2019; Abdullahi *et al.*, 2025). Furthermore, there is inadequate understanding of how antibiotic residues correlate with changes in animal behavior and physiology, and the potential transmission of resistant microbes within the poultry supply chain.

Aim and Objectives of the Research

This study aimed to assess the presence and concentrations of residual antibiotics in broiler chicken liver and breast meat samples and to evaluate the potential health effects on broiler chickens and mammalian consumers, with a focus on food safety and public health implications in Keffi metropolis. Specifically, the research sought:

- i. To assess changes in body weight, behavior, and movement patterns of broiler chickens from different poultry farm groups.
- ii. To determine and quantify residual antibiotics in chicken meat (muscle) and liver samples from poultry farms and supermarkets within the Keffi metropolis.
- iii. To determine the effects of antibiotic residues on Albino rats fed with antibiotic-treated chicken meat by assessing the presence, types, and concentrations of residues.
- iv. To investigate microbial presence in chicken crop and gizzard samples and evaluate the antibiotic activity against selected microorganisms.

Justification and Significance of the Study

The study is justified by the urgent need for evidence-based data on antibiotic residues in poultry food chains and their implications within a rapidly growing urban market in Nigeria. Poultry meats are widely consumed in Keffi, yet scant research has been conducted to elucidate the residue profiles of commonly used antibiotics and their biological effects. By quantifying residues and linking them to health outcomes in both poultry and mammalian models, this research addresses critical knowledge gaps with One Health relevance bridging veterinary science, toxicology, microbiology, and public health. Findings from this research will inform policy makers, regulatory agencies, veterinary practitioners, and poultry producers about the current status of antibiotic residue contamination in broiler products. This will aid in crafting targeted interventions, such as strengthening antimicrobial stewardship, enforcing compliance with withdrawal periods, implementing residue monitoring programs, and educating farmers on responsible antibiotic use. Moreover, the study contributes to global efforts to mitigate AMR by contextualizing local antimicrobial practices and providing data that may support national and international food safety standards.

Research Hypotheses

This study was designed to test the following hypotheses regarding the occurrence and biological implications of antibiotic residues in broiler chickens within Keffi metropolis:

Null Hypotheses (H_0)

1. **H_{01} :** There is no significant difference in body weight, behavioural patterns, and physiological responses between antibiotic-treated broiler chickens and the control group.

2. **H₀₂:** Antibiotic residues are not present in measurable concentrations in broiler chicken breast and liver samples obtained from poultry farms and retail supermarkets in Keffi metropolis.
3. **H₀₃:** The concentrations of antibiotic residues in poultry tissues do not exceed established Maximum Residue Limits (MRLs).
4. **H₀₄:** Consumption of chicken meat containing antibiotic residues does not result in detectable bioaccumulation of antibiotics in albino rat tissues.
5. **H₀₅:** Antibiotic residues present in poultry tissues do not exhibit antimicrobial activity against selected bacterial isolates.

Alternative Hypotheses (H₁)

1. **H₁₁:** Antibiotic administration significantly affects body weight, behavioural patterns, and physiological responses in broiler chickens.
2. **H₁₂:** Detectable antibiotic residues are present in broiler chicken breast and liver samples from poultry farms and retail supermarkets in Keffi metropolis.
3. **H₁₃:** Antibiotic residue concentrations in poultry tissues exceed established Maximum Residue Limits.
4. **H₁₄:** Consumption of antibiotic-contaminated chicken meat leads to bioaccumulation of antibiotic residues in albino rat tissues.
5. **H₁₅:** Antibiotic residues present in poultry tissues exhibit measurable antimicrobial activity against selected bacterial isolates.

Materials and Methods

Materials

Equipment

The material/equipment used in this study include the followings; Microplate reader, Printer, Homogenizer, nitrogen-drying device, rotary evaporator, syringes, test tubes, vortex, Centrifuge, Measuring pippets, Micropipettes (single channel 20-200uL and multi-channel 250uL), Jenway 7305 Spectrophotometer, Refrigerator, HSGF254 thin layer chromatography silica gel plate, UV lamp AC90-230V (365nm wavelength of visualization), medium scale grinding machine, Microscope, animal cages, surgical blades, weighing balance, Haematological analyzer (Celtrac G Mek-9100), Electrolyte analyzer, Beakers, Sample bottles, Microscopic slides, Petri dishes, Filter paper, Swap sticks, McFarland standard calibration tubes, Phosphate Buffer Saline (pH-6.5), HPTLC plate and UV lamp, TLC.

Reagents and the Antibiotics Standard Drugs

HCl, Methylene Chloride, acetonitrile (CH₃CN), N-hexane, Na₂HPO₄ × 12H₂O, Na₂HPO₄ × 12H₂O, Heparin sodium, Nitrogen., Methanol (JHD CAS 67-56-1), trichloroacetic acid (TCA), Diethyl ether, Oxytetracycline, Gentamycin, sulfonamide, Penicillin, Tylosin, Neomycin,

Fluroquinolone antibiotics, Acetone, Acetonitrile, McFarland standard solution, Normal saline, Microbial stains and Ethanol were obtained from various veterinary and pharmaceutical drug stores in Keffi, Nasarawa state. Standard solution was stored in 4°C.

Experimental Animals

A total of Fifty-five (55) chickens were used, forty (40) were purchased as day old chicks from a local poultry farm in Keffi, fifteen (15) were purchased as fully grown frozen chickens from three notable Supermarkets in keffi (Divine Favour Supermarket, Small Gate Supermarket and Terry Close Supermarket). The chicks were fed ad libitum twice in a day and are given starter feed without any antibiotics every day for the first four weeks and later on, they were fed with finisher feed along an administered antibiotics according to their groupings for four weeks. The antibiotics were administered in 1 litre of their drinking water in the morning alongside their chicken feed, they were given 2 litres of water in the afternoon with feed. After which, they were left to fast overnight. This was done for all groups except the control group which were fed the same amount normal feed with no antibiotic in their drinking water.

The Chicks were raised until the end of the experimental period (For a total of eight weeks) under the natural summer conditions.

Ethical Approval

This research work was conducted following the Declaration of Department of Biochemistry and Molecular Biology protocol as approved by the Ethics Committee of Nasarawa State University Keffi. However, the consent from all the subjects was taken appropriately before inclusion in the study.

Methods

Experimental Design

This study was carried out in Keffi, Nasarawa State, located 35 KM away from Abuja Nigeria. The second largest Local Government of the state in the year 2024. A data survey consisting of 100 questionnaires were distributed amongst poultry farmers, veterinary doctors, and pharmacist and veterinary practitioners in the poultry sector within Keffi LGA. The survey was carried out amongst individuals to assess the occurrence of diseases, the method of their diagnosis, the commonly used antibiotics in poultry farms and their impact on the Consumers health. After the survey, seven (7) of the most commonly used antibiotics were chosen in the order of Oxytetracycline, Penicillin, Neomycin, Tylosin, Gentamicin, Sulfonamide, Fluoroquinolone. The chickens were treated and dosage were according to standard prescription by the vets;

The first phase contained a total of 40 broiler chicks, with 5 chickens in each group, which was divided in groups one to eight;

Group one: The normal control group which were given a normal diet without any antibiotics.

Group two: Administered Fluoroquinolone (300mg/kg body weight)

Group three: Administered Sulfonamide (200mg/kg body weight)

Group four: Administered Gentamycin (330mg/kg body weight)

Group five: Administered Oxytetracycline (400mg/kg body weight)

Group six: Administered Neomycin (220mg/kg body weight)

Group seven: Administered Tylosin (500mg/kg body weight)

Group eight: Administered Penicillin (500mg/kg body weight)

The average weight of chickens in each group was considered to ensure even distribution of the antibiotic drugs in drinking water.

The second phase consisted of 15 broiler chickens in total, with 5 chickens in each group, which were purchased from three notable markets in Keffi namely; Divine Favour Supermarket, Small Gate Supermarket and Terry Close Supermarket and they were referred to as the supermarket frozen chicken Group;

Group 1: Chickens obtained from Divine Favour Supermarket

Group 2: Chickens obtained from Small Gate Supermarket

Group 3: Chickens obtained Terry Close Supermarket

PHASE C - The third phase contained a total of 40 albino rats, with 5 rats in each group, which was divided from one to eight as follows;

Group one: The normal control group which were given a normal diet without any chicken containing residual antibiotics.

Group two: Feeds with chicken meats containing Fluoroquinolone residual antibiotics (300mg/kg body weight)

Group three: Feeds with chicken meats containing Sulfonamide residual antibiotics (200mg/kg body weight)

Group four: Feeds with chicken meats containing Gentamycin residual antibiotics (330mg/kg body weight)

Group five: Feeds with chicken meats containing Oxytetracycline residual antibiotics (400mg/kg body weight)

Group six: Feeds with chicken meats containing Neomycin residual antibiotics (220mg/kg body weight)

Group seven: Feeds with chicken meats containing Tylosin residual antibiotics (500mg/kg body weight)

Group eight: Feeds with chicken meats containing Penicillin residual antibiotics (500mg/kg body weight)

The average weight of Albino rats in each group was considered to ensure even distribution of the chicken containing residual antibiotics in their feeds.

Collection of the Chicken Sample for Analysis

The chicks were grown for the first four weeks and antibiotic administration lasted for four weeks; after eight weeks, the animals were sacrificed in accordance with the guidelines of

the European Convention for the Protection of Vertebrate Animals and other Scientific Purposes ETS-123 (European Treaty Series, 2005). Whole blood was collected using sterile syringe and needle. The blood sample of each chicken was collected into respective capped tubes. The blood samples in the test tubes were centrifuged at 1000 rpm for 10 minutes using a bench top centrifuge to separate cells from serum. A necropsy was performed to access the internal organs of the chickens. After which, the breast muscle, liver, gizzard and crop samples were collected and placed in a sterile container filled with normal saline to preserve the integrity of the samples.

Extraction of Residual Antibiotics of Chicken Breast (Chest), Liver, Gizzard and Crop Samples

Sample extraction was performed according to Poppelka *et al.*, (2005). 4 grams of each sample was cut into small pieces and grinded. 10 mL Phosphate Buffer Saline (pH-6.5) was added and mixed. It was then centrifuged 6000 rpm 15 °C for 20 min after mixing with 2 mL 30% TCA. Supernatant was collected and filtered by Whatman filter paper and funnel. The filtered chicken extract was concentrated using a rotary evaporator, gentle heat of 40 °C, allowing the solvent to evaporate. Final volume of the extracts was pooled carefully into screw cap vial and kept into refrigerator for future analysis.

Biochemical Analysis

Determination of the Presence and Type of Antibiotic Residues in the Chicken Breast and Liver Samples

HPTLC plate and UV lamp were used. TLC was performed according to Tajick and Shohreh, (2006) with some required adjustments.

Procedure

HPTLC plates with a thin, uniform layer of 100 to 200 micro metres were used. Spots were applied to the plate using micropipettes. A volume of 50 µl was used for spotting. The plate was placed in TLC tank (contained mobile phase; Acetone and Acetonitrile: 1:1) and covered by lid and it was left until the mobile phase reached the upper line. Spots were visualized with the UV lamp at 365 nm. Spots marking was done by pencil on the reverse side or on the plate's edge for calculation of retention factor (Rf).

Calculation of Rf values: These measurements are the distance travelled by the solvent, and the distance travelled by individual sample spots. Same Rf value of standard and sample were considered as similar compound.

Determination of Residual Antibiotic Concentrations in Chicken Breast and Liver Sample

UV Spectroscopy analysis was performed according to Smith *et al.* (2024).

Procedure

For the identification of extracted solutions, the ultraviolet absorption spectra of these compounds and the standard antibiotics i.e. Oxytetracycline (3 ppm concentration), Sulfonamide (3 ppm concentration), Fluoroquinolone (3 ppm concentration), Tylosin (3ppm concentration), Gentamycin (3 ppm concentration), Penicillin (3 ppm concentration) and Neomycin (3 ppm concentration) were recorded and examined using UV Spectrophotometer.

Second phase of Biochemical Analysis

Determination of the presence and types of residual antibiotics in albino rat meat samples that were fed with chicken meat from poultry farm groups containing antibiotic residues

HPTLC plate and UV lamp were used. TLC was performed according to Tajick and Shohreh, (2006) with some required adjustments.

Procedure

HPTLC plates with a thin, uniform layer of 100 to 200 micro metres were used. Spots were applied to the plate using micropipettes. A volume of 50 µl was used for spotting. The plate was placed in TLC tank (contained mobile phase; Acetone and Acetonitrile: 1:1) and covered by lid and it was left until the mobile phase reached the upper line. Spots were visualized with the UV lamp at 365 nm. Spots marking was done by pencil on the reverse side or on the plate's edge for calculation of retention factor (Rf).

Calculation of Rf values: These measurements are the distance travelled by the solvent, and the distance travelled by individual sample spots. Same Rf value of standard and sample were considered as similar compound.

Determination of concentrations of residual antibiotics in albino rat meat samples that were fed with chicken meat from poultry farm groups containing antibiotic residues

UV Spectroscopy analysis was performed according to Panera-Martínez *et al.* (2025).

Principle

The extracted samples absorb light at specific wavelengths in the UV-Vis range (200-400nm). The absorbed light is directly proportional to the concentration of antibiotic residues present in the sample. The absorption intensity is measured and compared to a calibration curve to determine the concentration of the antibiotic residues.

Procedure

For the identification of extracted solutions, the ultraviolet absorption spectra of these compounds and the standard antibiotics i.e. Oxytetracycline (3 ppm concentration), Sulfonamide (3 ppm concentration), Fluoroquinolone (3 ppm concentration), Tylosin (3ppm

concentration), Gentamycin (3 ppm concentration), Penicillin (3 ppm concentration) and Neomycin (3 ppm concentration) were recorded and examined using UV Spectrophotometer.

Microbial analysis

Sensitivity test of Antibiotics using chicken breast and liver sample

The disk diffusion method was performed according to Smith *et al.* (2024).

Procedure

The Mueller-Hinton agar is poured into a sterile plate and allowed to solidify. The desired bacterial culture *staphylococcus aureus*, *bacillus*, *Escherichia coli* and *Streptococcus Pneumoniae* is adjusted to a desired density (McFarland standard turbidity) to prepare the inoculum. The inoculum is spread evenly over the agar surface using a sterile swab and then the antibiotic discs are placed into the inoculated agar surface and spread evenly apart. The plate is placed into an incubator at 35degree Celsius +/- 2degree Celsius for 24 hours. The diameter of clear zones around each disc are measured using a ruler or caliper. The zone diameters are compared to established breakpoints to determine the level of antibiotic susceptibility. These zones are referred to as zones of inhibition.

Interpretation

Zone diameter: The size of the zone of inhibition correlates with the level of antibiotic susceptibility

Breakpoints: Established zone diameter breakpoints determine the level of susceptibility

Susceptible(S) - Zone diameter greater than /equal to breakpoint

Intermediate (I) - Zone diameter=breakpoint plus/minus 1mm

Resistant(R) - Zone diameter less than breakpoint

Microbial Tissue Culture Test

The microbial tissue culture test was performed according to Smith *et al.* (2024).

Procedure

The chicken gizzard and crop samples are collected and homogenized to release the isolated bacteria. The homogenized samples are plated onto selected agar media such as MacConkey agar, Mannitol Salt agar, Xylose lysine deoxycholate agar and so on. The plates are incubated at 37degree Celcius (98.6 degrees Fahrenheit) for 24-48 hours. The bacterial colonies are identified based on morphology, colour and size. Biochemical tests such as API, VITEK are carried out to confirm their identity.

Results

Result Interpretations

Locomotor/Movement and Behavioural Patterns in the Poultry Farm groups During Antibiotic Administration/Treatment

The poultry farm group was administered with antibiotics for four weeks.

a) Group I: Normal Control

Locomotor activity: Stable, Normal movement patterns

Body temperature: 40°C- 41°C

b) Group II: Fluoroquinolone Antibiotic

Locomotor activity: Decrease in stable movement due to increased body weight from 1 to 8 with feather pecking or loss.

Body temperature: 42°C-43°C and the chickens suffered from heat stress.

c) Group III: Sulfonamide Antibiotic

Locomotor activity: Decrease in stable movement due to increase in body weight from 1 to 20, movement stabilized in the final week, reddening of the eyes, Agitated and restless behavior, feather pecking or feather loss, mortality rate increased which led to the loss of two chickens.

Body temperature: 42°C-43°C and the chickens suffered from heat stress.

d) Group IV: Gentamicin antibiotic

Locomotor activity: Decrease in stable movement due to increased body weight from day 1 to 8 with a gradual recovery and movement stabilized in the final week day from 20 to 28. However, there is reduced feeding rate, reddening of the eyes, agitated and restless behavior, feather pecking or feather loss, mortality rate increased which led to the loss of one chicken.

Body temperature increases by 0.5°C to 1°C and the chickens suffered from heat stress.

e) Group V: Oxytetracycline antibiotic

Locomotor activity: Unstable movement due to increased body weight and heat stress from day 1 to 10 with a gradual recovery and movement stabilized from Day 17 to 28, there is reduced feeding rate, reddening of the eyes, restlessness, and feather loss. No loss of birds.

Body temperature increased by 0.5°C to 1°C and the chickens suffered from heat stress.

f) Group VI: Neomycin antibiotic

Locomotor activity: Decrease in stable movement due to increased body weight, gradual recovery and movement stabilized from day 20 to 28 with reduced feeding rate, reddening of the eyes, agitated and restless behavior, feather pecking or feather loss, mortality rate increased which led to the loss of two chickens.

Body temperature increased by 0.5°C to 1°C and the chickens suffered from heat stress.

g) Group VII: Tylosin antibiotic

Locomotor activity: Decrease in stable movement due to increased body weight from day 1 to 8 with a gradual recovery and movement stabilized from the 15th day of administration, reduced feeding rate, reddening of the eyes, agitated and restless behavior, feather pecking or feather loss, mortality rate increased which led to the loss of one chicken. Body temperature increase by 0.5°C to 1°C and the chickens suffered from heat stress.

h) Group VIII: Penicillin antibiotic

Locomotor activity: Decrease in stable movement due to increased body weight from day 1 to 8 with a gradual recovery and movement stabilized in the final week of day 20 to 28 with a reduced feeding rate, reddening of the eyes, agitated and restless behavior, feather pecking or feather loss, mortality rate increased which led to the loss of two chicken. Body Temperature increases by 0.5°C to 1°C and the chickens suffered from heat stress.

Effects of Antibiotics on Body Weight in Chickens

The results of the study on the effects of antibiotics on body weight in poultry groups are shown in Table 1. The time frame from week 0 to week 8 represents the duration over which the chickens' body weight was measured. No significant differences ($P > 0.05$) were observed in the initial body weight across all groups when compared to the control group. Group I exhibited a consistent increase in body weight from week 0 to 8, as expected for growing chickens, providing a baseline for comparison. In the first week, there was no significant difference ($P > 0.05$) in weight between groups, suggesting that antibiotics may not have an immediate effect on weight. Similarly, by week 4, with no treatment, no significant difference ($P > 0.05$) was observed across the groups compared to the control. However, from weeks 5 to 8, a significant increase ($P < 0.05$) in body weight was noted in all antibiotic-treated groups when compared to the control.

Table 1: Effects of Antibiotics on Body Weight in poultry farm Chickens groups

Group	Week0	Week1	Week2	Week3	Week4	Week5	Week6	Week7	Week8
I	31.5±2.89 ^a	89.00±7.62 ^a	157.00±36.48 ^a	322.25±4.19 ^b	414.25±27.83 ^a	545.50±37.55 ^a	649.00±48.48 ^a	803.00±12.52 ^a	1072.50±98.45 ^a
II	33.25±3.30 ^a	89.50±6.95 ^a	176.25±11.95 ^{ab}	258.25±47.70 ^a	393.75±25.06 ^a	735.75±27.32 ^b	1162.50±137.69 ^b	1517.59±92.51 ^b	2102.50±180.81 ^b
III	32.5±3.11 ^a	91.00±6.68 ^a	186.75±14.52 ^b	296.25±22.49 ^{ab}	405.50±23.53 ^a	754.25±22.23 ^b	1127.50±160.70 ^b	1575.00±170.78 ^b	2180.00±124.63 ^b
IV	35.00±3.56 ^a	90.00±5.35 ^a	177.25±11.95 ^{ab}	284.00±21.79 ^{ab}	396.50±25.49 ^a	766.25±29.55 ^b	1018.25±55.42 ^b	1430.00±162.07 ^b	2075.00±170.78 ^b
V	33.50±4.80 ^a	93.00±5.48 ^a	184.25±14.45 ^{ab}	294.25±21.96 ^{ab}	393.00±31.95 ^a	743.25±31.03 ^b	1105.00±82.26 ^b	1662.50±137.69 ^b	2200.00±182.57 ^b
VI	34.25±2.63 ^a	88.75±5.06 ^a	176.25±11.67 ^{ab}	280.75±22.87 ^{ab}	366.25±42.19 ^a	741.75±33.84 ^b	1137.50±110.87 ^b	1650.00±129.10 ^b	2337.50±179.70 ^b
VII	35.00±2.45 ^a	92.00±7.16 ^a	176.75±14.24 ^{ab}	288.75±22.34 ^{ab}	399.50±24.50 ^a	771.75±25.25 ^b	1124.00±151.12 ^b	1605.00±75.94 ^b	2252.50±127.90 ^b
VIII	32.50±1.29 ^a	86.75±6.80 ^a	174.75±11.70 ^{ab}	276.25±33.84 ^a	380.00±44.43 ^a	755.00±28.42 ^b	1142.50±121.48 ^b	1610.00±66.33 ^b	2242.50±180.07 ^b

Results are expressed as mean ± standard deviation, n=5. Mean values with different alphabets superscripts across the groups indicates significant differences at $P < 0.05$. I=Control; II=Fluoroquinolones; III=Sulphonamide; IV=Gentamicin; V=Oxytetracycline; VI=Neomycin; VII=Tylosin; VIII=Penicillin

Detection of the presence and types of Antibiotics Residues in Poultry Farm and Supermarket frozen chicken (Qualitative Analysis).

The analysis results for antibiotic residues in all chicken groups are summarized in Tables 2, Table 3 and Table 4. In the poultry farm groups, no antibiotic residues were detected in the normal control group. However, fluoroquinolone, sulphonamide, gentamicin, oxytetracycline, neomycin, Tylosin, and penicillin residues were identified in groups II through VIII in both breast and liver samples, as shown in Table 4.2. In comparison, supermarket frozen chicken breast (chest) samples revealed the presence of oxytetracycline in group 1, penicillin in group 2, and sulphonamide and fluoroquinolone residues in group 3. Liver samples from the supermarket frozen chicken displayed penicillin and oxytetracycline residues in group 1, penicillin and sulfonamide in group 2, and penicillin and gentamicin residues in group 3, as indicated in Table 4.3

Table 2: Detection of the presence and type of Antibiotics Residues in the Breast sample of Poultry Farm chicken.

GROUPS	RETENTION FACTOR (RF VALUE)	PRESENT/ABSENT	ANTIBIOTIC DETECTED
Group I	ND	-	ND
Group II	0.71	+	Fluoroquinolones
Group III	0.65	+	Sulfonamide
Group IV	0.55	+	Gentamicin
Group V	0.57	+	Oxytetracycline
Group VI	0.75	+	Neomycin
Group VII	0.57	+	Tylosin
Group VIII	0.69	+	Penicillin

Interpretation; ND (not detected), + (Present), and – (Absent), I=Control; II=Fluoroquinolones; III=Sulphonamide; IV=Gentamicin; V=Oxytetracycline; VI=Neomycin; VII=Tylosin; VIII=Penicillin.

Table 3: Detection of the presence and type of Antibiotics Residues in the Liver sample of Poultry Farm chicken

GROUPS	RETENTION FACTOR (RF VALUE)	PRESENT/ABSENT	ANTIBIOTIC DETECTED
Group I	ND	-	ND
Group II	0.71	+	Fluoroquinolones
Group III	0.65	+	Sulfonamide
Group IV	0.55	+	Gentamicin
Group V	0.57	+	Oxytetracycline
Group VI	0.75	+	Neomycin
Group VII	0.57	+	Tylosin
Group VIII	0.69	+	Penicillin

Interpretation; ND (not detected), + (Present), and – (Absent), I=Control; II=Fluoroquinolones; III=Sulphonamide; IV=Gentamicin; V=Oxytetracycline; VI=Neomycin; VII=Tylosin; VIII=Penicillin

Table 4: Detection of Antibiotic Residues presence and Their Types in Breast (Chest) and Liver Samples of Supermarket Frozen Chicken.

BREAST (CHEST) SAMPLE				LIVER SAMPLE		
GROUPS	RF VALUE	PRESENT/ ABSENT	ANTIBIOTIC DETECTED	RF VALUE	PRESENT/ ABSENT	ANTIBIOTIC DETECTED
1. Divine Favour Supermarket	0.67	+	Oxytetracycline	0.57 and 0.69	+	Penicillin and Oxytetracycline
2. Small Gate Supermarket	0.57	+	Penicillin		+	Oxytetracycline and Sulfonamide
3. Terry Close Supermarket	0.66 and 0.70	+	Sulfonamide and Fluoroquinolone	0.56 and 0.76	+	Penicillin and Gentamicin

Interpretation; RF (Retention Factor), ND (not detected), + (Present), and – (Absent).

Quantitative Analysis of Antibiotic Residue Concentrations in Poultry Farm and Supermarket Frozen Chicken Samples

The results of residual antibiotic concentrations found in Poultry Farm chickens and Supermarket Frozen Chicken (Divine Favour Supermarket, Small Gate Supermarket, and Terry Close Supermarket) are summarized in Figure 1, and Figure 2 for both breast and liver samples. The analysis indicated that residual antibiotic concentrations exceeded the Maximum Residue Limits (MRL) in groups III, IV, VII, and VIII, with group VIII (penicillin) showing the highest concentration in the breast sample (4.88mg/g). In the liver sample, all groups exhibited higher concentrations, with group VIII (penicillin) at 11.42mg/g, group VII (tylosin) at 4.66mg/g, and group III (fluoroquinolone) at 4.43mg/g having the highest values. In comparison, Supermarket Frozen Chicken samples showed even higher concentrations in both breast and liver samples, with group 2 (Small Gate Supermarket) showing the highest concentration of Oxytetracycline at 30.08 mg/g, followed by group 1 (Divine Favour Supermarket) at 23.49 mg/g, and group 3 (Terry Close Supermarket) at 9.15 mg/g of fluoroquinolone. All detected antibiotic residues were above the MRLs established by US and EU standards.

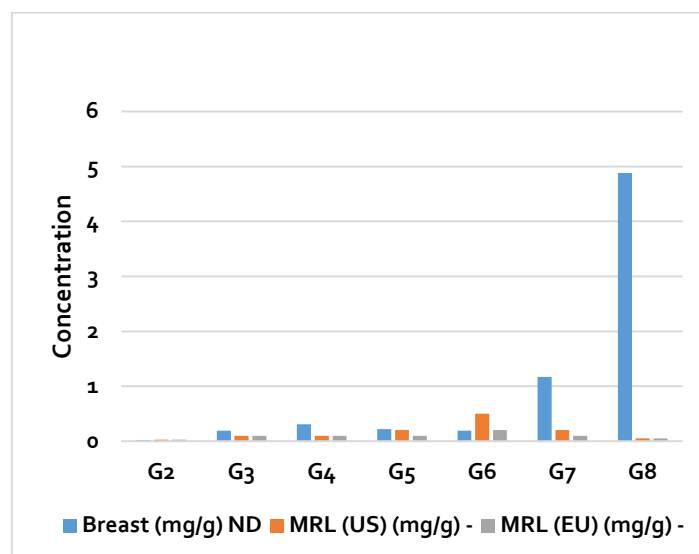


Figure 1: Quantitative Analysis of Antibiotic Residue Concentrations in Poultry Farm and Supermarket Frozen Chicken Samples. MRL (Maximum Residue Limit), ND (Not detected), and – (Absent). G2 = Fluoroquinolones; G3 = Sulphonamide; G4 = Gentamicin; G5 = Oxytetracycline; G6 = Neomycin; G7 = Tylosin; G8 = Penicillin.

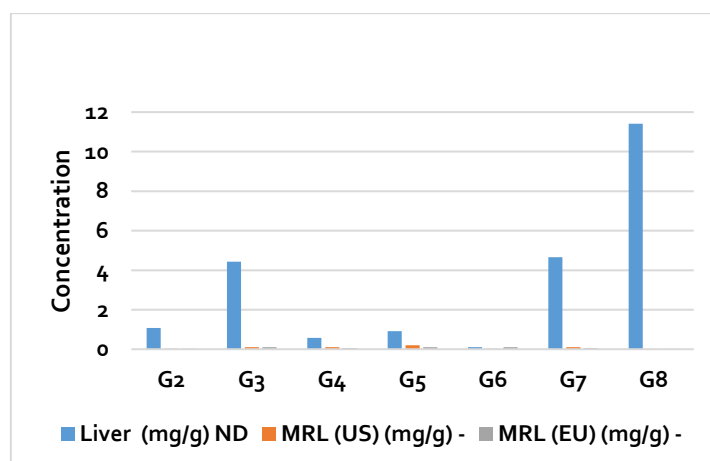


Figure 2: Quantitative Analysis of Antibiotic Residue Concentrations in Poultry Farm and Supermarket Frozen Chicken Samples. MRL (Maximum Residue Limit), ND (Not detected), and – (Absent). G2 = Fluoroquinolones; G3 = Sulphonamide; G4 = Gentamicin; G5 = Oxytetracycline; G6 = Neomycin; G7 = Tylosin; G8 = Penicillin.

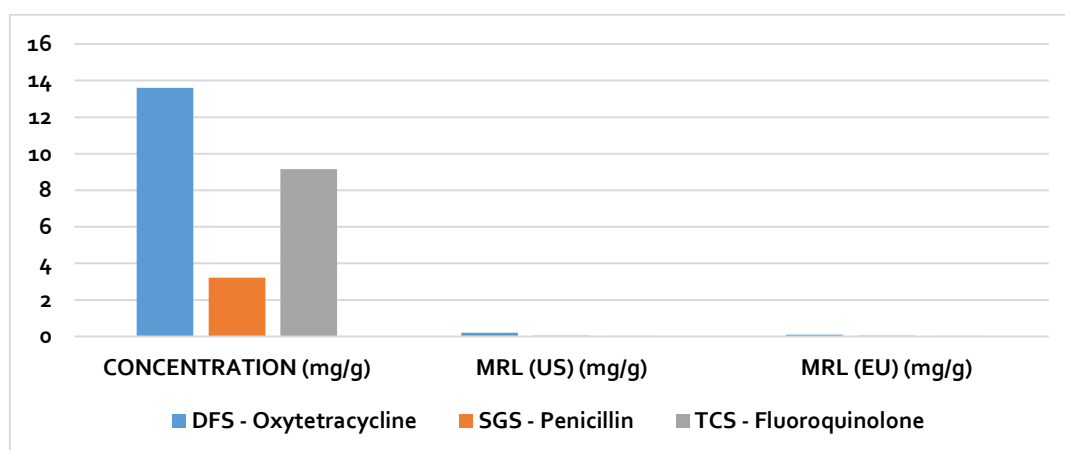


Figure 3: Quantitative Analysis of Antibiotic Residue Concentrations in Breast (Chest) of Supermarket Frozen Chicken Samples. MRL (Maximum Residue Limit). DFS= Divine Favour Supermarket; SGS = Small Gate Supermarket; TCS = Terry Close Supermarket

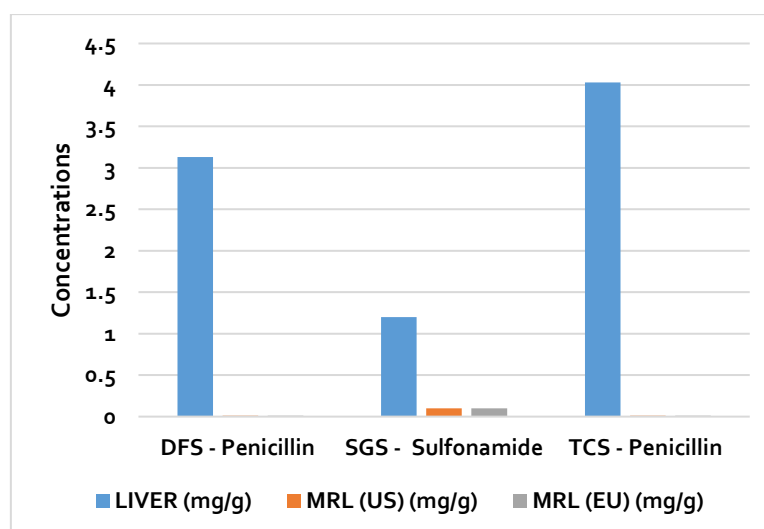


Figure 4: Quantitative Analysis of Antibiotic Residue Concentrations in Liver (Chest) of Supermarket Frozen Chicken Samples. Interpretation; MRL (Maximum Residue Limit). DFS= Divine Favour Supermarket; SGS = Small Gate Supermarket; TCS = Terry Close Supermarket

Detection of the Presence and Types of Residual Antibiotics in Albino Rats Fed Chicken Meat Containing Residues of Poultry Farm Chicken Groups (Qualitative Analysis)

The Tables 5, shows the detection of residual antibiotics in albino rats after being fed chicken meat from poultry farm groups no antibiotic residues were detected in the group I (normal control group), II (fluoroquinolone), III (sulphonamide), VI (neomycin) and VII (tylosin). However, gentamicin (Group IV), oxytetracycline (Group V), and penicillin (Group VIII) residues were identified.

Table 5: Determination of the presence and types of residual antibiotics in albino rat meat samples that were fed with chicken meat from poultry farm groups containing antibiotic residues

GROUPS	RETENTION FACTOR (RF VALUE)	PRESENT/ABSENT	ANTIBIOTIC DETECTED
Group I	ND	-	ND
Group II	0.00	-	Fluoroquinolones
Group III	0.00	-	Sulfonamide
Group IV	0.56	+	Gentamicin
Group V	0.58	+	Oxytetracycline
Group VI	0.00	-	Neomycin
Group VII	0.00	-	Tylosin
Group VIII	0.69	+	Penicillin

Interpretation; ND (not detected), + (Present), and - (Absent), I=Control; II=Fluoroquinolones; III=Sulphonamide; IV=Gentamicin; V=Oxytetracycline; VI=Neomycin; VII=Tylosin; VIII=Penicillin.

The Quantitative Analysis of Antibiotic Residue Concentrations in Albino Rats Fed with Chicken Meat Treated with Antibiotics

The figure 5, indicate the presence of gentamicin, oxytetracycline and penicillin residues in albino rats fed with chicken meat from chickens treated with these antibiotics. The concentrations of these antibiotics exceed the established MRLs set by both US and EU, raising potential concerns about the food safety and the development of antibiotic resistance. The absence of detectable levels of other antibiotics does not necessarily indicate their absence but could be due to factors such as low concentration, metabolism or limitation of detection methods.

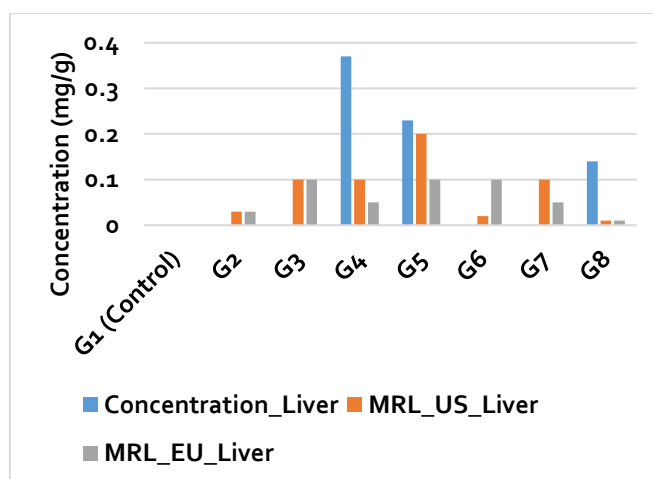


Figure 5: Determination of concentrations of residual antibiotics in albino rat meat liver samples that were fed with chicken meat from poultry farm groups containing antibiotic residues. G2 = Fluoroquinolones; G3 = Sulphonamide; G4 = Gentamicin; G5 = Oxytetracycline; G6 = Neomycin; G7 = Tylosin; G8 = Penicillin.

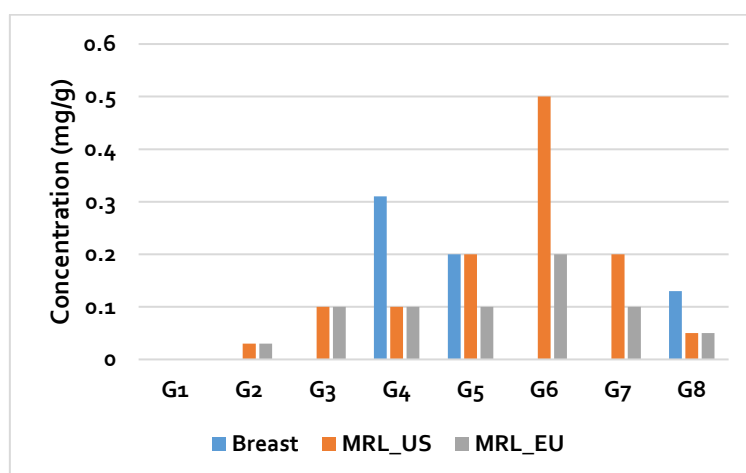


Figure 6: Determination of concentrations of residual antibiotics in albino rat meat breast samples that were fed with chicken meat from poultry farm groups containing antibiotic residues. G2 = Fluoroquinolones; G3 = Sulphonamide; G4 = Gentamicin; G5 = Oxytetracycline; G6 = Neomycin; G7 = Tylosin; G8 = Penicillin.

Antibiotic Sensitivity Test on Poultry Farm Chicken Group and Supermarket Chicken Samples (Microbial Analysis).

The antimicrobial activities of antibiotics in both poultry farm and supermarket frozen chicken samples are presented in Tables 6, Table 7 and Tables 8, For the antibiotic sensitivity test which show variations in the zones of inhibition across different antibiotics and organism. The variation is expected as different antibiotics have different mechanism of action and varying effectiveness against different bacteria. The test organisms included *E. coli*, *B. subtilis*, *S. pneumoniae*, and *Staphylococcus aureus*. Bacterial growth inhibition was observed in all eight antibiotic residue groups. Growth inhibition of *B. subtilis* was noted in Group II (Fluoroquinolone), Group V (Oxytetracycline), and Group VI (Neomycin), while no inhibition zones were found in Group III (Sulfonamide), Group IV (Gentamycin), Group VII (Tylosin), and Group VIII (Penicillin). For *Staphylococcus aureus*, inhibition zones were found only in Group II (Fluoroquinolone) and Group IV (Gentamycin), with no inhibition observed in Group III (Sulfonamide), Group V (Oxytetracycline), Group VI (Neomycin), Group VII (Tylosin), or Group VIII (Penicillin). In the case of *E. coli*, bacterial growth inhibition was observed in all eight antibiotic residue groups. For *S. pneumoniae*, growth inhibition zones were found in Group II (Fluoroquinolone), Group IV (Gentamycin), Group V (Oxytetracycline), and Group VII (Tylosin), with no inhibition zones in Group VIII (Penicillin), Group III (Sulfonamide), and Group VI (Neomycin). All supermarket chicken samples showed bacterial growth inhibition. *B. subtilis* growth inhibition was observed only in Divine Favour Supermarket chicken samples. *Staphylococcus aureus* growth inhibition zones were found in samples from Small Gate Supermarket and Terry Close Supermarket. However, no growth inhibition zones were observed for *E. coli* and *S. pneumoniae* in any of the supermarket chicken samples.

Table 6: Antimicrobial activities of Antibiotics in the Poultry Farm Chicken Groups

Organisms	Normal. Control	GROUP II	GROUP III	GROUP IV	GROUP V
<i>Bacillus subtilis</i>	A 00	28mm	00	00	27mm
	B 00	26mm	00	00	30mm
<i>Staphylococcus aureus</i>	A 00	36mm	00	21mm	00
	B 00	27mm	00	23mm	00
<i>Escherichia coli</i>	A 00	30mm	26mm	27mm	34mm
	B 00	24mm	34mm	34mm	30mm
<i>Streptococcus pneumonia</i>	A 00	33mm	00	27mm	18mm
	B 00	30mm	00	21mm	21mm

Numbers in mm- Zones of inhibition; A-Breast sample, B-Liver sample, Group II- Fluoroquinolone, Group III- Sulphonamide, Group IV-Gentamycin, Group V- Oxytetracycline, Group VI-Neomycin, Group VII-Tylosin, Group VIII-Penicillin

Table 7: Antimicrobial activities of Antibiotics in the Poultry Farm Chicken Groups

Organisms	GROUP VI	GROUP VII	GROUP VIII
<i>Bacillus subtilis</i>	A 18mm	00	00
	B 20mm	00	00
<i>Staphylococcus aureus</i>	A 00	00	00
	B 00	00	00
<i>Escherichia coli</i>	A 33mm	24mm	18mm
	B 30mm	33mm	20mm
<i>Streptococcus pneumonia</i>	A 00	20mm	00
	B 00	24mm	00

Numbers in mm- Zones of inhibition; A-Breast sample, B-Liver sample, Group II- Fluoroquinolone, Group III- Sulphonamide, Group IV-Gentamycin, Group V- Oxytetracycline, Group VI-Neomycin, Group VII-Tylosin, Group VIII-Penicillin

Table 8: Antimicrobial activities of Antibiotics in the supermarket chicken samples

Organisms	Divine Favour Supermarket	Small Gate Supermarket	Terry Close Supermarket
<i>Bacillus subtilis</i>	A 24mm	00	00
	B 22mm	00	00
<i>Staphylococcus aureus</i>	A 00	19mm	19mm
	B 00	21mm	18mm
<i>Escherichia coli</i>	A 00	00	00
	B 00	00	00
<i>Streptococcus pneumonia</i>	A 00	00	00
	B 00	00	00

Numbers in mm- Zones of Inhibition, A- Breast sample and B- Liver samples.

Microbial Identification test for Bacterial Colonies in all Chicken Samples

The results of the microbial identification test conducted on all chicken samples are summarized in Table 9, which provide valuable preliminary data regarding the bacterial isolates from poultry farm and three selected local market chicken samples. The findings suggest the presence of four potential bacterial pathogens, including *E. coli* and *Salmonella spp.*, as well as bacteria commonly found in the gut flora, such as *Citrobacter* and *Lactobacilli*. Cultural morphology revealed *E. coli* with greenish colonies exhibiting a metallic sheen on EMB agar, alongside positive catalase and indole biochemical reactions, which confirm the presence of *E. coli*. For *Salmonella spp.*, cultural morphology showed smooth, whitish colonies on Nutrient agar and black deposits on Salmonella-Shigella agar (SSA). Biochemical tests were positive for Methyl Red and Oxidase, further supporting the identification of *Salmonella spp.* *Citrobacter* was identified by its mucoid or pinkish colonies on Nutrient agar, with positive results for catalase, indole, and Methyl Red tests. Lastly, *Lactobacilli* appeared as white or creamy colonies on MRS agar, a selective medium for Lactobacilli, and tested positive for the catalase test.

Table 9: Cultural Morphology and Biochemical Characteristics of Bacteria Isolated from Poultry Farm and Local Market Chicken Samples

Cultural and morphological			Biochemical							
Inference			MP	GS	CAT	COA	IN	VP	MR	OX
Greenish	on	EMB	Rod	-	+	-	+	-	-	-
<i>E. coli</i>										
Smooth		Whitish	Rod	-	+	-	-	+	-	+
<i>Salmonella spp</i> on NA,										
Black deposit on SSA										
Mucoid	or	Pinkish	Rod	-	-	+	+	-	-	+
<i>Citrobacter</i> on NA										
White	or	Creamy	Rod	-	+	-	-	-	-	-
on MRS <i>Lactobacilli</i>										

KEY: MP- Morphology, GS- Gram staining, CAT- Catalase, COA- Coagulase, IN- Indole, VP- Vogesproskauer's, MR, Methyl red, OX- Oxidase, NA- Nutrient Agar, MRS- de Man Rogosa and Sharpe, CT- Citrase, EMB- Eosin Methyl Blue, + present, - Absent.

Microbial Identification test for Poultry Farm Groups and Three Local market Chicken using Crop and Gizzard Samples

The results of the microbial identification test conducted on poultry farm chicken groups and local market chicken using crop and gizzard samples are summarized in Table 10 and Table 11. The research findings revealed the presence of *Lactobacilli*, *Citrobacter*, and *E. coli* in all chicken samples. *Lactobacilli* and *Citrobacter* were found in the normal control group, as well as in Group I (Fluoroquinolone), Group IV (Gentamicin), Group VII (Tylosin), and Group VIII (Penicillin). *Citrobacter* was also detected in Group III (Sulfonamide) and Group VI (Neomycin), while *E. coli* and *Citrobacter* were both present exclusively in Group V

(Oxytetracycline). No *Salmonella* spp. were found in any of the eight experimental groups. When comparing these results with the chicken samples from local markets, different trends emerged. In Kara market chicken, both *Citrobacter* and *Salmonella* spp. were present in both crop and gizzard samples, while *Lactobacilli* appeared only in the crop sample. *E. coli* was found only in the gizzard and not in the crop. In Sambisa market chicken, both *E. coli* and *Salmonella* spp. were detected in crop and gizzard samples. Finally, in Gunduma market chicken, *E. coli* and *Citrobacter* were present in both crop and gizzard samples, *Lactobacilli* was only found in the gizzard, and *Salmonella* spp. was present only in the crop.

Table 10: The Microbial screening of Poultry farm chicken Groups using Crop and Gizzard samples

GROUPS	<i>Lactobacilli</i>		<i>E. coli</i>		<i>Citrobacter</i>		<i>Salmonella</i>	
	A	B	A	B	A	B	A	B
I	+	+	-	-	+	+	-	-
II	+	+	-	-	+	+	-	-
III	-	-	-	-	+	+	-	-
IV	+	+	-	-	+	+	-	-
V	-	-	+	+	+	+	-	-
VI	-	-	-	-	+	+	-	-
VII	+	+	-	-	+	+	-	-
VIII	+	+	-	-	+	+	-	-

Keys: + = present; - = absent, A- Crop samples, B- Gizzard samples, Group II- Normal Control, Group II-Fluoroquinolone, Group III- Sulphonamide, Group IV-Gentamicin, Group V- Oxytetracycline, Group VI-Neomycin, Group VII-Tylosin, Group VIII-Penicillin.

Table 11: The Microbial Screening of Three Selected Local Market Chickens Using Crop and Gizzard Samples

GROUPS	<i>Lactobacilli</i>		<i>E. coli</i>		<i>Citrobacter</i>		<i>Salmonella</i>	
	A	B	A	B	A	B	A	B
Kara Market	+	-	-	+	+	+	+	+
Sambisa Market	-	-	+	+	-	-	+	+
Gunduma market	-	+	+	+	+	+	+	-

Keys: + = present; - = absent; A- Crop samples, B- Gizzard samples

Discussion

Antibiotic-Induced Alterations in Behaviour, Thermoregulation, and Survival of Broiler Chickens

The behavioural and physiological responses of broiler chickens are sensitive indicators of systemic stress, metabolic disruption, and toxicological burden. Locomotor instability, altered feeding behaviour, feather pecking, and elevated body temperature are widely used welfare indicators reflecting neuro-metabolic imbalance and inflammatory stress. Antibiotics, particularly when administered continuously or at supra-therapeutic doses, have been shown to disrupt gut microbiota homeostasis, mitochondrial energy

metabolism, and immune regulation, all of which directly influence behaviour and thermoregulation. In the present study, chickens administered sulfonamides, neomycin, penicillin, and gentamicin exhibited pronounced behavioural abnormalities, including reduced locomotion, agitation, and poor feeding efficiency, accompanied by hyperthermia and increased mortality. These findings suggest that prolonged antibiotic exposure imposed a substantial physiological burden on the birds. The observed elevation in body temperature (42–43 °C) is indicative of heat stress and systemic inflammation, conditions that are exacerbated under tropical environmental temperatures such as those prevailing in Keffi, Nigeria. Comparable findings have been reported by Abd El-Hack *et al.* (2020), who demonstrated that prolonged antibiotic exposure in broilers induces oxidative stress, disrupts hypothalamic thermoregulation, and impairs neuromuscular coordination. Similarly, Kallam and Sejian (2021), reported that antibiotic-induced gut dysbiosis alters short-chain fatty acid production, leading to increased metabolic heat production and behavioural stress responses. Aminoglycosides such as gentamicin and neomycin are also known to exert mitochondrial toxicity, which may explain the neuromotor instability and increased mortality observed in these treatment groups (Mujyambere *et al.*, 2022). The mortality recorded in several antibiotic-treated groups further underscores the toxicological implications of uncontrolled antibiotic use. In low- and middle-income countries, inadequate veterinary oversight often results in overdosing and prolonged administration, significantly increasing the risk of systemic toxicity (Kabir *et al.*, 2004). Collectively, these findings demonstrate that antibiotic use in poultry, beyond therapeutic necessity, compromises animal welfare and survivability.

Antibiotic-Associated Growth Promotion and Its Physiological Trade-Offs

Body weight gain is traditionally used as a primary metric of production efficiency in poultry systems. Antibiotics have historically been employed as growth promoters due to their ability to suppress pathogenic gut bacteria, reduce immune activation, and enhance nutrient absorption. However, this growth advantage may mask underlying metabolic and immunological dysfunction. The antibiotic-treated groups showed no significant difference in body weight during the first four weeks but exhibited significantly higher body weights from weeks 5 to 8 compared to controls. This delayed response suggests cumulative microbiota-mediated effects rather than immediate anabolic action. Fluoroquinolone, oxytetracycline, and penicillin groups demonstrated the greatest weight gains, consistent with their broad-spectrum antimicrobial activity. These findings are consistent with Dibner and Richards (2020), who reported that antibiotic-mediated growth promotion is primarily driven by reduced gut inflammation and enhanced feed conversion efficiency. More recent studies by Wu *et al.* (2022) further demonstrated that antibiotics increase fat deposition and alter lipid metabolism genes in broilers. Importantly, such growth is often accompanied by impaired immune competence and increased oxidative stress. In the present study, increased body weight coincided with behavioural stress, hyperthermia, and mortality, suggesting that weight gain may not reflect improved physiological health. Gadde *et al.*

(2017) similarly reported that antibiotic-driven growth often occurs at the expense of immune resilience, making birds more vulnerable to environmental stressors and disease. These observations challenge the continued justification of antibiotics as growth promoters, particularly in regions lacking residue monitoring and welfare enforcement.

Detection of Antibiotic Residues in Poultry Farm and Retail Chicken Samples

Antibiotic residues in edible animal tissues represent a critical food safety issue with direct implications for human health. Qualitative detection of residues provides essential evidence of non-compliance with withdrawal periods and improper veterinary drug use. In this study, no residues were detected in control samples, confirming the reliability of the analytical methods. However, all experimentally treated poultry samples contained detectable residues in both breast and liver tissues. Furthermore, retail frozen chicken samples obtained from supermarkets showed multiple antibiotic residues, despite originating from commercial food chains. These findings are consistent with widespread reports of antibiotic residue contamination in poultry meat across Africa and Asia. Manyi-Loh *et al.* (2018) documented high prevalence of tetracycline and sulfonamide residues in retail chicken meat in sub-Saharan Africa, attributing this to weak regulatory enforcement. Oladeji *et al.* (2025) similarly reported multiple antibiotic residues in frozen poultry products sold in Nigerian markets. The higher detection frequency in liver tissues aligns with the liver's role as the primary site of drug metabolism and accumulation. Canton *et al.* (2021) demonstrated that hepatic tissues retain higher antibiotic concentrations due to repeated enterohepatic circulation. The detection of residues in supermarket samples is particularly alarming, as it indicates that contaminated products are entering the human food chain.

Quantitative Residue Levels and Regulatory Non-Compliance

Quantitative analysis revealed that residue concentrations in both poultry farm and supermarket samples exceeded established Maximum Residue Limits (MRLs) set by the European Union and the United States Food and Drug Administration. Oxytetracycline and penicillin showed particularly high concentrations, especially in liver tissues. These findings indicate severe regulatory non-compliance and pose significant toxicological risks. Thapa *et al.* (2023) reported similar excessive residue levels in poultry meat, linking them to overdosing and failure to observe withdrawal periods. Mgonja and Paul (2023), further demonstrated that chronic dietary exposure to antibiotic residues can induce hepatotoxicity, disrupt gut microbiota, and promote antimicrobial resistance. The significantly higher residue concentrations in supermarket samples compared to experimental birds suggest systemic failures in food safety surveillance. According to the World Health Organization (2023), chronic exposure to antibiotic residues increases the risk of allergic reactions, endocrine disruption, and selection of resistant bacterial strains in humans.

Bioaccumulation and Secondary Exposure in Albino Rats

The albino rat feeding model used in this study provides critical evidence of secondary exposure and bioaccumulation of antibiotic residues through dietary intake. The detection of gentamicin, oxytetracycline, and penicillin residues in rat tissues confirms that these compounds remain bioavailable after ingestion.

Mbarga Manga *et al.* (2022) demonstrated similar tissue accumulation of antibiotics in rodents fed contaminated animal products, highlighting the risk of long-term exposure. The absence of detectable residues for some antibiotics may reflect rapid metabolism rather than complete elimination. Importantly, residue levels detected in rat tissues exceeded recommended safety thresholds, indicating potential risks to consumers with repeated exposure. FAO (2022) emphasized that chronic low-dose exposure to antibiotics can disrupt gut microbiota, impair immune development, and accelerate antimicrobial resistance.

Antimicrobial Activity and Resistance Implications of Residual Antibiotics

The disk diffusion assays demonstrated that residual antibiotics retained antimicrobial activity, as evidenced by inhibition zones against selected bacterial pathogens. However, variable inhibition patterns and reduced susceptibility in some organisms suggest emerging resistance.

E. coli showed inhibition across most poultry farm samples, while inconsistent inhibition was observed for *Staphylococcus aureus* and *Bacillus* species. Notably, supermarket samples exhibited minimal inhibition, indicating prior exposure and resistance development. These findings align with Prestinaci *et al.* (2015) and O'Neill (2016), who identified foodborne antibiotic residues as major drivers of antimicrobial resistance dissemination. The presence of sub-inhibitory antibiotic concentrations in food is particularly concerning, as it promotes horizontal gene transfer and resistance selection.

Microbial Contamination and One-Health Implications

The isolation of *E. coli*, *Salmonella* spp., *Citrobacter* spp., and *Lactobacillus* spp. from poultry samples highlights the dual burden of microbial contamination and antibiotic residues. While *Lactobacillus* represents beneficial flora, the presence of *Salmonella* and pathogenic *E. coli* poses serious foodborne disease risks. Ogunleye *et al.* (2008) and WHO (2023) reported similar contamination profiles in retail poultry meat in Nigeria. The coexistence of pathogenic bacteria and antibiotic residues creates a favourable environment for resistance amplification, representing a significant One-Health challenge linking animal, human, and environmental health.

Conclusion and Recommendations

This study comprehensively assessed the presence, concentration, and biological implications of residual antibiotics in broiler chicken meat and liver within the Keffi metropolis, with particular emphasis on animal health, food safety, and public health. The

findings clearly demonstrate that indiscriminate and prolonged use of antibiotics in poultry production results in detectable and, in many cases, excessive residues in edible tissues, notably the liver and breast muscle. Behavioural alterations, elevated body temperature, reduced survivability, and altered growth patterns observed in antibiotic-treated broiler chickens indicate that antibiotic exposure imposes measurable physiological stress on the birds. While some antibiotics appeared to enhance body weight gain during later growth stages, this apparent production benefit was accompanied by compromised welfare indicators, suggesting that growth promotion occurred at the expense of physiological stability. Qualitative and quantitative analyses confirmed the presence of multiple antibiotic residues in both experimentally treated chickens and retail frozen chicken samples obtained from supermarkets. Residue concentrations frequently exceeded internationally established Maximum Residue Limits, with higher accumulation consistently observed in liver tissues. The detection of antibiotic residues in commercially sold poultry products underscores a critical failure in adherence to withdrawal periods and regulatory oversight. The albino rat feeding model further demonstrated that antibiotic residues present in poultry meat remain bioavailable after consumption and can bioaccumulate in secondary consumers. This finding provides strong experimental evidence of dietary exposure risks to humans, particularly in populations with frequent poultry consumption. Microbial analyses revealed the coexistence of pathogenic bacteria and biologically active antibiotic residues in poultry tissues. The retained antimicrobial activity of residues against selected microorganisms, coupled with reduced susceptibility in some isolates, highlights the role of contaminated poultry meat in the selection and dissemination of antimicrobial resistance. This study provides compelling evidence that the misuse of antibiotics in poultry production within Keffi metropolis poses significant risks to animal welfare, compromises food safety, and represents a tangible public health threat. These findings reinforce the urgent need for coordinated interventions guided by the One Health framework to mitigate antibiotic residue contamination and its downstream consequences.

Based on the findings of this study, the following recommendations are proposed:

1. **Strengthening Regulatory Enforcement**
Regulatory agencies should intensify monitoring and enforcement of veterinary drug use, particularly strict compliance with prescribed dosages and withdrawal periods before slaughter.
2. **Routine Residue Surveillance**
Regular screening of poultry meat and organs for antibiotic residues should be institutionalized at farms, slaughter points, and retail outlets, including supermarkets and cold rooms.
3. **Farmer and Veterinarian Education**

Poultry farmers and veterinary practitioners should receive continuous training on responsible antibiotic use, antimicrobial stewardship, and the health implications of residue violations.

4. **Restriction of Antibiotics as Growth Promoters**

The use of medically important antibiotics for growth promotion should be discouraged, with a gradual transition to safer alternatives such as probiotics, prebiotics, and improved biosecurity measures.

5. **Consumer Awareness**

Public health authorities should raise consumer awareness regarding the risks associated with antibiotic residues in poultry products and promote informed food choices.

6. **Policy Integration under One Health**

Policymakers should integrate animal health, food safety, and public health strategies to address antimicrobial resistance and residue contamination in a coordinated manner.

Further Research

Future studies should focus on long-term human exposure assessment, molecular characterization of resistant bacteria, and evaluation of alternative disease control strategies in poultry production.

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