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RESEARCH ARTICLE

Antibiotic Resistance of *Escherichia coli* and *Salmonella spp*. Strains Isolated from Some Selected Poultry Farms in the Oforikrom Municipality Kumasi, Ghana

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ABSTRACT

Antimicrobial resistance (AMR) is a serious worldwide issue that poses a significant risk to human and animal health. In this study, isolates of *Salmonella spp*. and *Escherichia coli* from poultry farms in the Kumasi Metropolis, Ghana, were evaluated for AMR prevalence and trends. Samples were gathered from different farms using cloacal swabs and surgical shoe covers. The resistance and susceptibility levels were assessed using the Kirby Bauer disk diffusion method. Twenty-four isolates of *Salmonella* spp. and *E. coli* were identified. The *E. coli* bacteria that were found were resistant to Ciprofloxacin, Tetracycline, Ampicillin, Cefotaxime, Co-trimoxazole, and Cefuroxime but susceptible to Gentamicin and Amikacin. The *Salmonella* strains that were identified were resistant to Cefuroxime, Tetracycline, Ampicillin, Ciprofloxacin, Cefotaxime, Co-Trimoxazole, and Gentamicin but susceptible to Amikacin, Ofloxacin, and Chloramphenicol. This study suggests broader research on antibiotic resistance in birds and educating poultry farmers about changing medication practices due to increasing pathogen resistance.

Keywords: Antibiotics, Antimicrobial resistance, Resistance, Salmonella.

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1. Introduction

The condition known as "antimicrobial resistance" (AMR) occurs when some bacteria, viruses, fungi, and other parasites either become immune to medications or cease to react to them [1]. In addition to making infection treatment more challenging, this raises the risk of disease spread, severe illness, and death. Consequently, due to the development of drug resistance, antibiotics and other antimicrobial drugs lose their effectiveness, rendering infections progressively more challenging or even impossible to manage [2].

To understand the factors contributing to antimicrobial resistance, it is essential to evaluate the complete antibiotic usage lifecycle. This encompasses antibiotic production, distribution, prescription, dispensing, and ultimately, their utilization in animal farming practices. Antimicrobial resistance is a significant concern because the proliferation of drug-resistant pathogens, armed with new resistance mechanisms, consistently jeopardizes the capacity to effectively treat everyday infections [3], [4]. Microorganisms like *Shigella* and *E. coli*, which are accountable for infections that do not respond to current antimicrobial therapies such as antibiotics, evoke significant apprehensions within the domain of animal farming [5]. This resistance issue presents a pressing challenge to animal health and the agricultural sector. The persistent problem of insufficient access to potent antimicrobial drugs to fight harmful microorganisms continues to be a significant concern.

Antibiotic efficacy is declining due to the global expansion of drug resistance, which is increasing the incidence of illnesses that are difficult to treat and increasing the number of fatalities [6], [7]. The pressing need for novel antibacterial medications is underlined, particularly in the fight against gram-negative bacteria that are resistant to antibiotics, such as *Salmonella*. This requirement emphasizes the significance of dedicated efforts in research and development to counteract the growing threat posed by these resilient pathogens.

Despite efforts to mitigate AMR through antibiotic stewardship programs and improved hygiene practices, the prevalence of resistant *E. coli* and *Salmonella* in poultry production continues to rise [8]. The capacity to effectively treat bacterial infections is threatened by the worldwide public health problem of antimicrobial resistance. Microbiologists and specialists in infectious diseases have long acknowledged this issue. Even Sir Alexander Fleming, the individual who discovered penicillin, emphasized the risk of resistance resulting from inadequate dosing as far back as 1954. However, the realization of the extensive scale of the resistance problem is only now spreading to a broader audience. Many infectious agents that were previously treatable with various drug classes have now developed resistance to most, and in some cases, nearly all of these drugs [9], [10]. It is evident that the excessive usage of these valuable medications across various domains, including human, animal, and agriculture, constitutes the central issue that necessitates attention [10], [11].

This research is critical for understanding how common organisms like *Salmonella* and *E. coli* respond to medicines, including ciprofloxacin, tetracycline, penicillin, and chloramphenicol. Overall, it can help fight bacterial infections and protect public health by increasing our understanding of the processes behind antibiotic resistance and efficacy. Antibiotics are often utilized in modern poultry farms for growth stimulation, prevention, or treatment, according to Sharma *et al*. [12]. Repeated antibiotic usage, on the other hand, promotes the development of antibiotic resistance. *E. coli* is one of the most prevalent bacteria found in the microflora of poultry farms and is responsible for colibacillosis, which causes financial losses for the business [13]. Among the *E. coli* strains that cause disease in poultry, zoonotic strains are known to be responsible for infections in humans, including strains classified as extraintestinal pathogenic *E. coli* [14], [15]. This study seeks to uncover and clarify the levels of resistance found in prevalent pathogenic microorganisms in poultry farms in the Oforikrom municipality, Kumasi, Ghana, with a specific focus on *E. coli* and *Salmonella spp*. Our primary inquiry revolves around understanding how these microorganisms react to commonly prescribed antibiotics. Additionally, this research is strategically designed to determine, guided by the findings, which antibiotic proves to be the most robust and effective in fighting bacterial infections. This study has the potential to significantly enhance our comprehension of antibiotic efficacy and the evolving dynamics of microbial resistance.

2. Materials and Methods

2.1. Study Design and Experimental Sites

The study was carried out using a cross-sectional study and sampling protocol to obtain cloacal swabs from poultry birds and floor samples from three selected farms in the Oforikrom municipality, Kumasi, Ghana. The farms that were randomly selected included the Dufie farms (DF), KNUST, Department of Animal Science farms (AS), and Eggshell farms (ESF), all within the study area. The study adopted a 3 × 2 factorial design made up of three randomly selected farms and two samples (cloacal swabs and floor samples) from each farm. The laboratory work was carried out at the Soil Microbiology Laboratory at the Faculty of Agriculture KNUST, and the Clinical Analysis Laboratory of the College of Science, KNUST.

2.2. Medium and Materials

The media used in the study were products of Oxoid, England and included bacteriological peptone, MacConkey agar, Bismuth sulphate agar, EMBA (Eosin-methylene blue agar), Simmons citrate, SIM agar, tryptone soya broth, Nutrient agar and glycerol. Standard antibiotic disks (multidisc) housing Amikacin, Ciprofloxacin, Chloramphenicol, Cefuroxime, Ofloxacin, Cefotaxime, Azithromycin, Tetracycline, Gentamicin, Levofloxacin, Ciprofloxacin, Ceftriaxone, Co-trimoxazole, and Ampicillin were also used for the sensitivity study. The confirmation of *E. coli* isolates was done using the Kovacs reagent in the indole test.

2.3. Sample Collection

The samples collected for the study were cloacal swabs from the birds and floor samples from the farms. Sterile swab sticks were inserted into the cloaca of randomly selected fowls from the farms visited. They were then placed in sterile bacteriological peptone (1%) in labelled tubes and immediately placed on ice for transportation to the designated laboratories for analysis. The floor samples were obtained by using sterile surgical shoe covers, which were shoes worn after sanitizing them with 70% ethanol. An area of about 4 m^2 of the farm floor was covered on foot to allow contact with the shoe covers in an attempt to collect floor samples, which were also put in bacteriological peptone (1%) and transported on ice to the laboratory. The cloacal samples in peptone were incubated at 37°C overnight to enrich the target bacterial isolates of interest, which were *E. coli* and *Salmonella spp*. After incubation, samples were pulled into sterilized glass tubes and labelled as stock inoculum for further assays.

2.4. Isolation of E. coli

The isolation of *E. coli* was carried out on MacConkey agar, a selective and differential media that supports gram-negative bacteria and differentiates between bacteria that are lactose fermenters and non-lactose fermenters. The agar was prepared, autoclaved, and then poured into sterilized labelled plates and allowed to settle. The sterile plates were inoculated using the streak plate technique, where a loopful of the stock inoculum of the various samples was transferred using a sterile inoculation loop onto the agar and streaked. The inoculated plates were incubated overnight at 37°C. After incubation, observed pink colonies with different colonial morphology, distinct colonies were picked from the first MacConkey agar plates and sub-cultured on a second MacConkey plate (MAC 2) to obtain pure colonies of suspected *E. coli* for confirmation.

2.5. Isolation of Salmonella spp.

The *Salmonella spp*. was isolated on bismuth sulphate agar which is a selective media for the isolation of

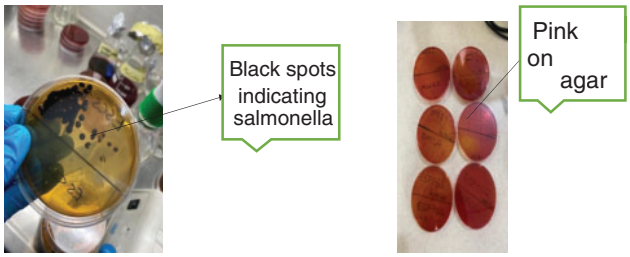

Fig. 1. Growth of Salmonella on bismuth sulphate (left), *and* growth of E. coli on MacConkey (right).

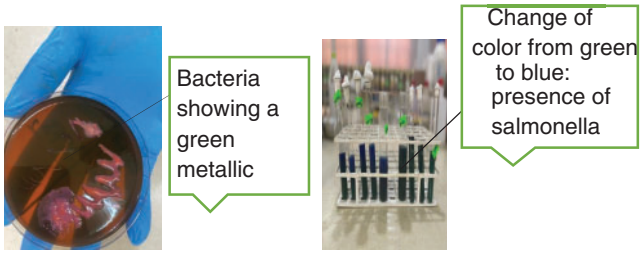

Fig. 2. Growth of E. coli on EMBA (left) and growth of Salmonella on Simmon Citrate (right).

Salmonella and *Shigella* species. The isolation was carried out following the same streak plate method as described earlier and incubated at 37°C overnight. The observation of black colonies was indicative of *Salmonella spp*., which were picked and sub-cultured on nutrient agar.

2.6. *Confirmation of E. coli Isolates*

The identities of the isolated bacteria were confirmed using morphological characteristics on the various selective media and some biochemical tests, as described in this section. The identity of the suspected *E. coli* isolates was confirmed using the formation of a green metallic sheen on EMBA, indole test, citrate, and SIM tests. Eosin Methylene Blue Agar (EMBA) was prepared, autoclaved and poured into sterilized, labelled plates and allowed to settle. Isolated colonies with pink coloration from MacConkey plates were picked and streaked on the EMBA plates and incubated at 37°C overnight. After incubation, the observed growth with a green metallic sheen was indicative of *E. coli* (Fig. 1). The colonies were further inoculated into 2% bacteriological peptone and incubated at 37°C overnight. Drops of Kovacs reagent were added and the formation of a golden brown/red indole ring was confirmatory of *E. coli*. The Simmons citrate utilization test was carried out by inoculating suspected *E. coli* colonies into tubes containing Simmons citrate agar and incubating overnight at 37°C. The presence of a color change from green to blue was indicative of citrate utilization and, thus, a positive test, while no color change was indicative of a negative test. *E. coli* is citrate negative; thus, the negative tubes were recorded as confirmation for *E. coli* isolates (Fig. 2). The colonies were stabbed into sterile tubes containing SIM agar and incubated overnight at 37°C. The absence of dark coloration due to the production of Sulphur and the formation of turbid growth, which is divergent from the stab line, was indicative of motility and confirmatory for *E. coli*.

2.7. *Confirmation of Salmonella Isolates*

The suspected *Salmonella* isolates were also subjected to confirmatory tests using citrate utilization, indole production, and SIM tests. The suspected *Salmonella* colonies were further inoculated into 2% bacteriological peptone and incubated at 37°C overnight. Drops of Kovacs reagent were added, and the formation of a yellowish or green ring was indicative of a negative test and confirmatory of *Salmonella*. The suspected *Salmonella* colonies were stabbed into sterile tubes containing SIM agar and incubated overnight at 37°C. The presence of dark coloration due to the production of Sulphur and the formation of turbid growth, which is divergent from the stab line, was indicative of motility and confirmatory for *Salmonella* (Fig. 1). The Simmons citrate utilization test was carried out by inoculating suspected Salmonella colonies into tubes containing Simmons citrate agar and incubating overnight at 37°C. The presence of color change from green to blue was indicative of citrate utilization and thus a positive test and confirmatory for *Salmonella* (Fig. 2).

2.8. *Susceptibility of Bacteria Isolates to Antibiotics*

The identified isolates confirmed to be *E. coli* and *Salmonella* isolates were diluted to obtain a 0.5 McFarland turbidity index in sterile physiological saline, which was used as inoculum in the Kirby Bauer disk diffusion assay. Plates of Muller Hinton agar were prepared and inoculated using the swab plate technique by dipping sterile Dacron swab sticks into the inoculum and swabbing the entire surface of the agar plates. Antibiotic disks were aseptically transferred onto the plates using sterile forceps after incubation at 37°C. The presence of zones of clearance was indicative of antibiotic action, which was measured and compared with the Clinical and Laboratory Standards Institute (CLSI) table to indicate the resistivity or susceptibility of the isolate.

2.9. *Storage of Pure Isolates*

Tryptone soya broth was prepared for harvesting and storage of pure bacteria isolates. This was done by inoculating the bacteria into the tryptone soya broth and incubating overnight at 37°C. After incubation, 500 µL of the enriched inoculum was transferred into labelled Eppendorf tubes with 50% glycerol for storage at 50°C.

3. Results

3.1. *Bacteria Isolates from Cloaca and Floors of Poultry Farms*

The environment is replete with bacteria, and thus, they are said to be ubiquitous and are found everywhere in and on living organisms, including man and chicken. The findings of the study indicated the cloaca of the birds and floors of the poultry farms indeed are colonized by *E. coli* and *Salmonella spp*. as they were detected and isolated from all birds and floors sampled (100%) together with some other unidentified Coliforms. The MacConkey agar plates all showed positive growth for Coliforms with diverse morphologies representing both lactose and non-lactose fermenting Coliforms. Some colonies were

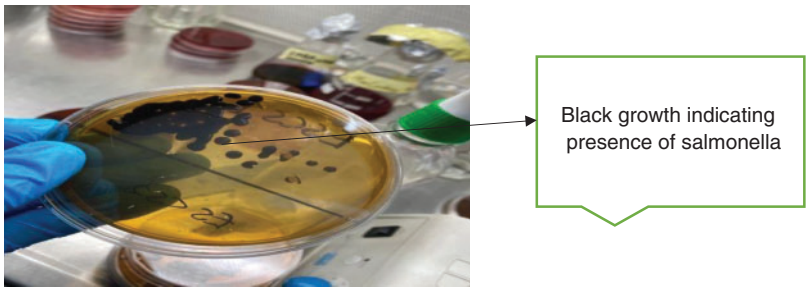

Fig. 3. Black colonies indicating *Salmonella spp*. on Bismuth.

observed with dry, rough surfaces, while others showed mucoid, shiny, and smooth surfaces. However, they were all opaque and pigmented (pink, red, and cream), as detailed in Fig. 3. The Bismuth sulphate agar (BSA) plates also recorded positive growth for all samples analyzed indicating the colonization of the cloaca of the birds and floors of the poultry farms by *Salmonella spp*. The results indicated that all BSA recorded black colonies, which is typical of *Salmonella spp*. growth.

The plates indicated positive growth for all samples from all three farms. Throughout the studies, it could be inferred that these farms had their poultry exposed to these pathogens, which may be the probable cause of the disease conditions on the farms visited. On Dufie farms, Pen Strep plus with Penicillin was observed as one of the major components for disease treatment. One detoxifying agent that was employed on the farm was Macox Plus. Rifampicin, Pyrazinamide, and Isoniazid, similar to Azithromycin, Amikacin, and Ciprofloxacin, are the main ingredients of Macox Plus. Additionally, the majority of antibiotics used to treat these diseases could be ineffective since, as shown in Fig. 4, both the *Salmonella* and *E. coli* samples recuperated during the laboratory trial were resistant to the majority of antibiotics.

3.2. *Characterization and Identification of Bacteria Isolates*

The morphological characterization of the isolates alone is insufficient to establish and confirm their identities (Fig. 5). Therefore, additional biochemical profiling was performed to identify the bacteria using their motility, indole, citrate utilization, and sulphur production characteristics. The results presented in Table I show that *Salmonella spp*. and *E. coli* were present in all of the research samples from the birds as well as the floors of the farms that were selected for the study. The results indicated some of the colonies were negative to indole and were not *Salmonella* either, thus implying they are other coliforms likely to be *Klebsiella* from their mucoid appearance and others likely to be *Proteus spp*. Those isolates were ignored as they did not meet the inclusion criteria for isolates of interest in this study.

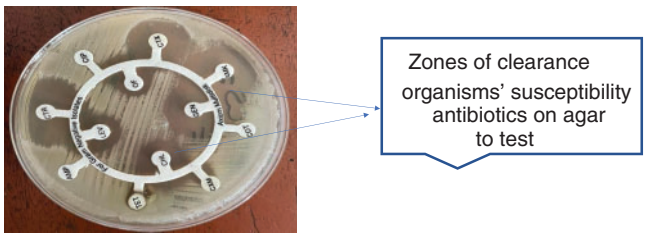

Fig. 4. Antibiotic susceptibility test on *E. coli* using the Kirby Bauer disk diffusion assay.

3.3. *Antibiotic Susceptibility of Isolates*

The condition of much concern is the development of resistance to antibiotics by the normal flora and pathogenic organisms, which makes it difficult to manage them when they exceed the normal thresholds and move into the infectious state, thus warranting the investigation into the resistance profiles of the isolates. The findings of the study indicated that the E. coli and Salmonella isolates from the cloaca and floors are resistant to a number of the standard antibiotics used on farms and administered to humans. Zones of clearance depicting organisms' susceptibility to test antibiotics on agar (Fig. 6). These values in Table II were obtained by measuring the clearance zones of the samples as a result of bacteria reaction to the various antibiotics used, which were compared with CLSI standard values (Table III). The values in millimeters were compared to the CLSI table to ascertain if they are resistant or susceptible to *E. coli* and *Salmonella*. The degree of *E. coli* susceptibility to common antibiotics is shown in Fig. 7. The *E. coli* isolated from the farms was sensitive to 100% of Amikacin and 100% of Gentamicin but resistant to 100% of Tetracycline, 80% of Ampicillin, 90% of Ciprofloxacin, 100% of Cefotaxime, 100% of Cotrimoxazole, and 100% of Cefuroxime. Furthermore, Fig. 8 shows how susceptible *Salmonella* is to common antibiotics. While the *Salmonella* from the farms was resistant to Tetracycline (80%), Ampicillin (100%), Ciprofloxacin (70%), Cefotaxime (100%), Co-trimoxazole (100%) and Cefuroxime (90%), it was sensitive to Amikacin (80%), Gentamicin (90%), Chloramphenicol (60%) and Ofloxacin (60%).

4. Discussion

The prevalence of infections in the selected farms and the high frequency of antibiotic-resistant strains of *Salmonella spp.* and *E. coli* in chicken cloaca underscore the pressing need to address antimicrobial resistance in poultry production. In addition to the health and well-being of animals, there is a significant risk to the public's health through the food supply chain if this is not done. Collaboration among stakeholders at all organizational levels is necessary to fight antimicrobial resistance (AMR) and maintain the sustainability of the poultry industry

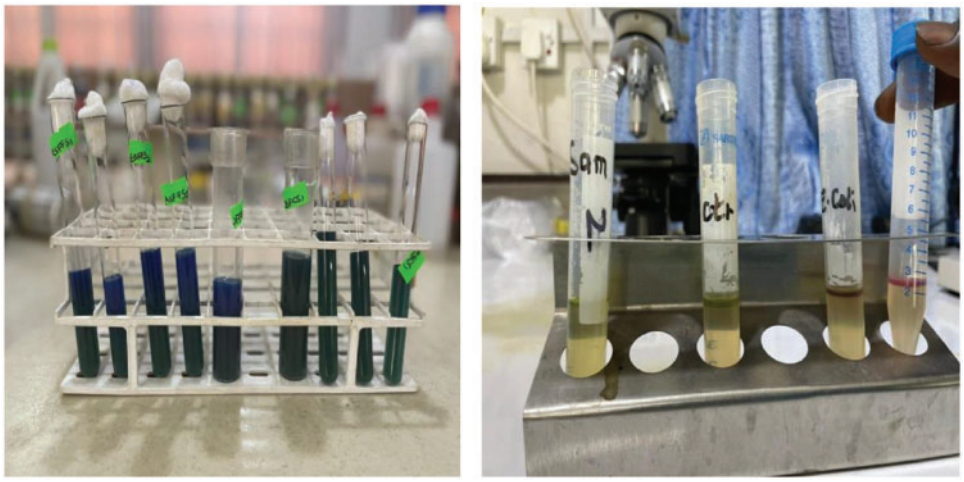

Fig. 5. Citrate utilization (left) and Indole (right) tests on bacteria isolates.

TABLE I: Biochemical Confirmation of the Isolates of *E. coli* and *Salmonella spp*.

Farm	Sample	Isolate	Number	Citrate	Indole	Inference
ASF 1&2	Floor	E	2	–	+	*Escherichia coli*
	Cloaca	E	2	–	+	*Escherichia coli*
ESF 1&2	Floor	E	2	–	+	*Escherichia coli*
	Cloaca	E	2	–	+	*Escherichia coli*
DF 1&2	Floor	E	2	–	+	*Escherichia coli*
	Cloaca	E	2	–	+	*Escherichia coli*
ASF 1&2	Floor	S	2	+	–	*Salmonella spp.*
	Cloaca	S	2	+	.	*Salmonella spp.*
ESF 1&2	Floor	S	2	+	–	*Salmonella spp.*
	Cloaca	S	2	+	–	*Salmonella spp.*
DF 1&2	Floor	S	2	+	–	*Salmonella spp.*
	Cloaca	S	2	+	–	*Salmonella spp.*

Note: E-*E. coli*, S-*Salmonella*, – means absence, + means presence.

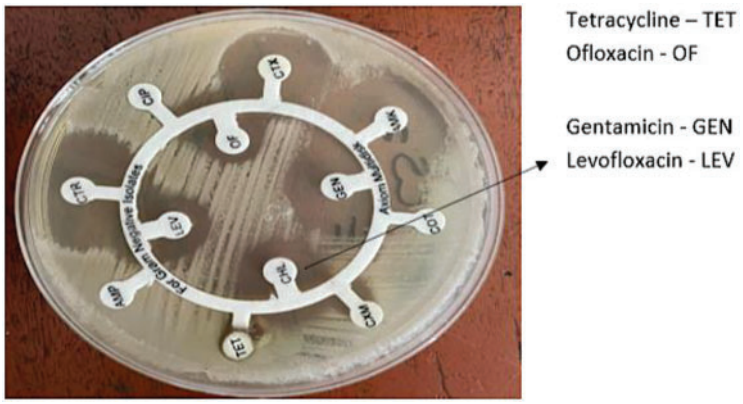

Fig. 6. Antibiotics susceptibility using the Kirby Bauer disk diffusion method.

while safeguarding public health. In their study, Kalın *et al*. state that antimicrobial resistance is a major global public health problem that resulted in at least 1.27 million deaths globally and was connected to almost 5 million deaths in 2019 [16].

The global use of antibiotics in animal production requires close monitoring [15]. In the pursuit of combating the growing global threat of antimicrobial resistance (AMR), this present study sought to shed light on the prevalence and resistance patterns of two significant pathogens, *E. coli* and *Salmonella spp.* in poultry farming. The results of this experiment revealed several crucial insights that merit in-depth discussion and reflection.

This experiment sheds light on the critical issue of AMR in poultry farming. The high prevalence of pathogens, risks of cross-contamination, and antibiotic resistance profiles underscore the urgency of adopting comprehensive strategies to mitigate AMR. Collaboration between stakeholders in the poultry industry, healthcare, and regulatory agencies could lead to current efforts toward preserving the efficacy of antibiotics, protecting public health, and ensuring the sustainability of poultry production. Addressing AMR is

TABLE II: Zones of Inhibition Values from the Sensitivity Test (mm)

Sample	ORG	TET	AMP	CTR	CIP	CTX	AMK	COT	CXM	CHL	LEV	OF	GEN
ASFFS1	E	9	21	19	20	15	19	0	0	20	25	22	22
	S	0	0	21	20	15	18	0	0	26	24	20	20
ASFFS2	E	0	0	25	8	10	20	0	0	0	12	10	20
	S	7	0	21	23	15	19	11	0	26	25	22	18
ASFCS1	E	–	–	–	–	–	–	–	–	–	–	–	–
	S	0	0	24	16	11	19	0	0	25	18	15	19
ASFCS2	E	0	14	14	17	11	20	11	0	30	28	24	20
	S	–	–	–	–	–	–	–	–	–	–	–	–
ESFFS1	E	0	0	26	0	18	20	0	0	15	10	10	16
	S	7	0	26	13	0	20	0	0	18	19	20	20
ESFFS2	E	0	0	18	0	0	21	0	0	13	11	6	20
	S	0	0	25	17	20	20	0	0	14	23	22	20
ESFCS1	E	0	0	25	0	19	20	0	0	20	16	14	20
	S	0	0	22	21	20	19	0	18	30	26	18	20
ESFCS2	E	0	0	26	0	21	21	0	0	17	15	13	26
	S	–	–	–	–	–	–	–	–	–	–	–	
DFFS1	E	12	0	0	15	0	22	0	0	11	30	19	20
	S	10	0	0	14	0	15	0	0	16	17	14	14
DFFS2	E	0	0	27	12	24	20	0	0	11	24	19	21
	S	7	0	0	12	0	10	0	0	13	20	20	19
DFCS1	E	7	0	23	0	10	18	0	0	27	19	12	20
	S	0	0	26	0	15	22	0	0	30	15	13	22
DFCS2	E	0	0	25	20	20	21	0	12	30	28	24	20
	S	15	0	25	12	18	20	0	11	14	18	15	20

Note: ORG–organism, E–*E. coli*, S–*Salmonella*, TET–tetracycline, AMP–ampicillin, CTR–cefuroxime, CIP–ciprofloxacin, CTX–cefotaxime, AMK–amikacin, COT–cotrimoxazole, CXM–cefotaxime, CHL–chloramphenicol, LEV–levofloxacin, OF–ofloxacin, GEN–gentamicin.

TABLE III: Values from the CLSI Table that Indicate the Range for Susceptibility, Resistance and Intermediates

ORG	L	TET	AMP	CTR	CIP	CTX	AMP	COT	CXM	CHL	LEV	OF	GEN
E	R	<11	≤13	≤19	≤21	≤22	≤14	–	≤14	≤12	≤16	<12	≤12
E	I	12–14	14–16	20–22	22–25	23–25	15–16	–	15–17	13–17	17–20	13–15	13–14
E	S	≥15	≥17	≥23	≥26	≥26	≥17	–	≥18	≥18	≥21	≥16	≥15
SAL	R	–	–	–	≤20	–	–	–	–	≤12	–	–	≤12
SAL	I	–	–	–	21–30	–	–	–	–	13–17	–	–	13–14
SAL	S	–	–	–	≥31	–	–	–	–	≥18	–	–	≥15

Note: ORG–organism, E–*E. coli*, SAL–*Salmonella*, L–levels, TET–tetracycline, AMP–ampicillin, CTR–cefuroxime, CIP–ciprofloxacin, CTX–cefotaxime, AMK–amikacin, COT–cotrimoxazole, CXM–cefotaxime, CHL–chloramphenicol, LEV–levofloxacin, OF–ofloxacin, GEN–gentamicin, R–Resistivity, I–Intermediate, S–Susceptibility.

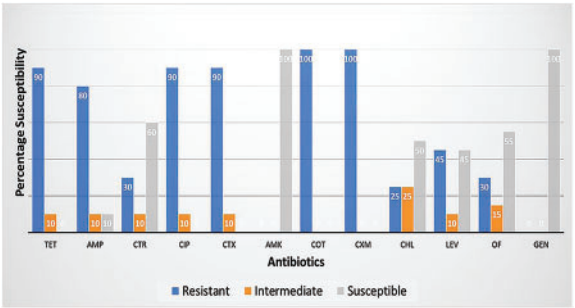

Fig. 7. Susceptibility of *E. coli* to standard antibiotics.

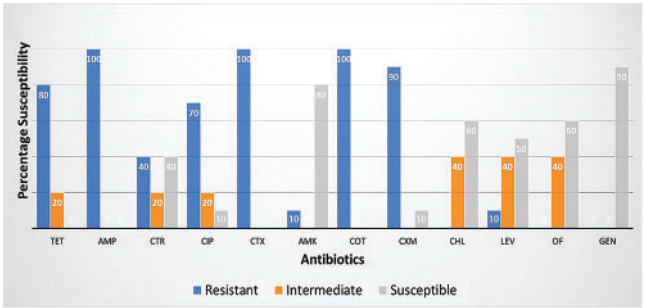

Fig. 8. Susceptibility of *Salmonella spp.* to standard antibiotics.

a shared responsibility that requires collective action to safeguard our future.

One striking finding of this study herein reported was the 100% prevalence and occurrence of both *E. coli* and *Salmonella spp.* in the cloaca of chickens from the selected farms, which has the same bearing as the findings of Cige *et al*. [17], who reported a prevalence of 19.5% and 8.9% for *E. coli* and *Salmonella*, respectively. The sample size difference between the current investigation (24 birds) and the previously stated study (384 birds) might be the cause of the lower prevalence indicated by these authors compared to this study.

Nevertheless, the results of both studies show that *E. coli* and *Salmonella spp*. have colonized poultry birds' cloacae. The high prevalence rate raises immediate concerns about the safety of poultry products entering the food

supply chain. It underscores the urgent need for comprehensive surveillance and control measures at the farm level to prevent the contamination of poultry products with these pathogens. The persistence of these bacteria in poultry populations also highlights the resilience of these pathogens in the farm environment.

Because the microorganisms that infect farm floors also affect chicken cloaca, there is a significant risk of cross-contamination. An environment that is conducive to the transmission of illnesses is produced when bird droppings come into contact with the floor. The results from the study of Djeffal *et al*. [18], who researched to ascertain the prevalence and risk factors connected to *Salmonella* contamination on poultry farms and slaughterhouses in Algeria, are consistent with the presence of *E. coli* and *Salmonella* in farm floors. It was discovered that 37% of the farms had flooring contaminated with *Salmonella*. The risk factor in their study, which showed significance, was the type of floor at the poultry farms, which further highlights the need for critically considering the floors of the farms in assessment studies, as was done in this study. Further evidence in support of this assertion was provided by Dagnew *et al*. [19], who carried out their study in Ethiopia and reported the isolation of *Salmonella* from droppings, floors, and cloaca of poultry birds with the droppings and floor presenting the majority of isolates. Cross-contamination has a significant impact on food safety and can occur at several stages of the chicken production process, ranging from the farm to the processing facilities. To reduce this risk, a focused effort will be required to improve biosecurity standards throughout the many poultry farms.

Furthermore, the pressing aspects of this study are the antibiotic resistance profiles for *Salmonella spp*. and *E. coli* found in the farms. Since the *E. coli* isolates were sensitive to amikacin and gentamicin but resistant to some significant medicines, including Ampicillin, Ciprofloxacin, Tetracycline, Cefotaxime, Co-Trimoxazole, and Cefuroxime, they were categorized as multidrug-resistant. Shecho *et al*. [20] reported that 92% of *E. coli* isolates from the cloaca of poultry birds were found to be multidrug-resistant, indicating they were resistant to two or more medications.

Ogunleye *et al*. [21], in different research in Nigeria, found similar results of multidrug-resistant *E. coli* strains from farms, connecting this to the farmers' improper use of antibiotics. The outcome of their study indicated that some farmers administered 3–7 different antibiotics to their birds for treatment, prophylaxis, or as growth promoters. Antibiotics are overused and build up in the bodies of birds over time. Furthermore, organisms exposed to leftovers for extended periods develop antibiotic resistance mechanisms, rendering them ineffective.

Salmonella spp. isolates are also categorized as multidrug-resistant *Salmonella* because they showed resistance to some antibiotics, including Ciprofloxacin, Tetracycline, Ampicillin, Cefotaxime, Co-Trimoxazole, and Cefuroxime, but exhibited susceptibility to others, including Amikacin, Gentamicin, Chloramphenicol, and Ofloxacin. The use of Enrofloxacin in broiler farms has been shown to reduce the incidence of *Salmonella spp.*, but it also causes Enrofloxacin resistance in isolates of *Salmonella spp.* and *E. coli* from the farm, according to Shang *et al*. [22]. In a comparable vein, Cige *et al*. [17] observed a higher percentage of *E. coli* and *Salmonella spp.* colonizing the cloaca of birds in Somalia, and several of the isolates were resistant to numerous antibiotics. Tetracycline and Co-trimoxazole had mild resistance in a Kenyan study on antimicrobial resistance in *Salmonella* and *E. coli* isolates from chicken wastes but with high resistance to Amoxicillin [23]. *E. coli* showed weak resistance to Meropenem (0.9%), Ceftazidime (6.2%), and Chloramphenicol (8.8%) but significant resistance to Tetracycline (54.6%) and Ampicillin (54%), according to Mudenda *et al*. [24]. These resistance patterns are concerning because they limit the effectiveness of antibiotics. Resistance to antibiotics like Cefotaxime is especially alarming, as it compromises the treatment options for severe infections in humans [25]. This research highlights the link between AMR in animals and people, as well as the need for a One Health policy to fully address the issue.

Furthermore, further study is needed to dive into the genetic pathways behind antibiotic resistance in these diseases. Understanding the specific resistance genes and how they propagate among poultry populations might help guide targeted therapies and the development of alternative treatments. Additionally, continual tracking of resistance patterns in both animals and humans is critical for the early detection of new dangers.

5. Conclusion

Antimicrobial resistance (AMR) is a developing worldwide health problem that jeopardizes public health, food security, and animal welfare. *E. coli* and *Salmonella spp*. were identified in the chicken cloaca and flooring of selected poultry farms, indicating potential cross-contamination. *Salmonella* was resistant to Tetracycline, Ampicillin, Ciprofloxacin, Cefotaxime, Co-Trimoxazole, and Cefuroxime but responsive to Amikacin and Gentamicin. Contamination levels in chicken products entering the food supply chain were high, raising concerns about their safety. The pollution of farm floors emphasizes the importance of improved biosecurity measures. The study highlights the need for strict hygiene practices, proper waste management, and continuous monitoring of farm conditions to mitigate this risk. Addressing AMR in poultry farming requires a holistic approach, including stringent biosecurity measures, responsible antibiotic use, education and training, surveillance, regulatory oversight, and exploring alternative methods. Collaborative efforts among government agencies, farmers, veterinarians, and the broader agricultural community are essential to effectively combat AMR and mitigate its global impact.

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Data Availability Statement

All data used is available and can be provided upon reasonable request.

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Conflict of Interest

The authors declare that there is no personal or professional conflict of interest.

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