

Antibiotic Resistance Profile of Escherichia Coli Isolated from Apparently Healthy Domestic Poultry

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Abstract

Keywords	<i>Poultry, despite being a primary source of meat for many residents in Bauchi Metropolis, the quality of poultry remains a significant concern due to potential contamination with Escherichia coli, Escherichia coli and other pathogens. While previous studies have addressed antibiotic resistance, microbial load and multidrug resistance profiles in domestic poultry in Bauchi, there is a lack of recent, comprehensive research focusing specifically on the antibiotic resistance profile of E. coli strains isolated from apparently healthy domestic poultry. This study was conducted to determine the antibiotic resistance profile of Escherichia coli [BP1.1] isolated from apparently healthy domestic poultry in Bauchi, Bauchi State, Nigeria. E. coli was isolated using MacConkey agar and identified by conventional microbiology technique. The isolates were tested against 13 antibiotics using the disc diffusion method. A total of 13 different antibiotic resistance profiles were observed, with each isolate showing resistance to at least four or more drugs tested. Generally, the E. coli isolates showed resistance rates of 95% to Ampicillin, 20.5% to Chloramphenicol, 21.8% to gentamicin, 60.9% to Penicillin, 19.3% to Streptomycin, 76.9% to Eftazidime, 25.6% to Cefuroxime, 43.6% to Cefixime, 21.9% to Ofloxacin, 33.3% to Augmentin, 66.2% to Nitrofurantoin, 25.3% to Ciprofloxacin, and 30.9% to Tetracycline. This study showed that the average number of resistance phenotypes per isolate was significantly higher for Ampicillin. A significant public health concern observed in this study is that antibiotic resistance commonly found in E. coli strains may constitute a potential reservoir of resistance genes that could be transferred to pathogenic bacteria.</i>
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1. Introduction

Escherichia coli belongs to the Enterobacteriaceae family, which cause infection that poses or constitutes great hazard to the poultry industry, causing loss of weight, reduction of egg production and high mortality (Abd El Tawab et al., 2021). All over the world, E. coli infection is one of the serious problems that cause great threat to the profitability of avian enterprises. E. coli in the poultry intestine is a member of the normal microbiota. Still, the colonization of the respiratory tract by pathogenic E. coli strains is associated with extraintestinal disease, which results in morbidity and mortality of poultry by causing septicemia (Coura et al., 2017). However, E. coli is a normal flora inhabiting the intestinal tract of birds; under the influence of predisposing factors such as inadequate and faulty ventilation, overcrowding, hunger, thirst, extremes of temperatures and low vitality, high mortality during rearing, reduced weight gain and condemnation of birds at the time of slaughter occur (Abd El Tawab et al., 2021).

Avian colibacillosis is a complex syndrome characterized by multiple organ lesions with air sacculates and associated pericarditis, perihepatitis and peritonitis being most typical (Abd El Tawab et al., 2021). Naturally, E. coli-infected chicks present with clinical signs such as loss of appetite, cyanosis, tendency to huddle, respiratory distress, depression, reduction of weight gain, dropped wings, closed eyes, and labored breathing (Abd El Tawab et al., 2021). Certain strains of E. coli have virulence properties associated with host tissue colonization,

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production of toxins, iron uptake systems, defensins and serum resistance. However, the pathogenesis of colibacillosis is not completely understood (Coura et al., 2017).

Local chickens are free-range birds which may serve as a reservoir or carrier of pathogenic *E. coli* to the environment, poultry and households. Due to increasing demand for egg and meat products in the poultry sector, which is among the fastest-growing agro-based industries worldwide, disease burden has, however, remained a great challenge in poultry production (Abdu & Ibrahim, 2021). Most of these bacteria do not cause disease because they are environmentally friendly and are part of the normal flora. However, with the estimated number of bacterial species reaching about 1030 worldwide, it is important to identify and differentiate those species that are pathogenic, particularly from a medical and public health perspective (Spitzer, 2015). However, contamination of food with pathogenic *E. coli* species can cause serious foodborne illness in humans (Spitzer, 2015).

Antibiotic resistance is a growing global health concern with the huge societal risk of reverting to the pre-antibiotic era if not addressed. By 2050, it is estimated that death from an antibiotic-resistant infection will occur every three seconds (Sanchez, 2020). Between the rise in antibiotic-resistant infections and the 90 billion tons of chicken meat that are produced worldwide annually, there is a well-documented connection. Due to this connection, the World Health Organization (WHO) adopted the 'One Health' approach in 2017, which states that the health of people, animals, and the environment are inextricably related to one another. According to WHO, it is relevant to refer to the 'One Health' approach when discussing antibiotic resistance, food safety, and the control of zoonoses (Sanchez et al., 2020).

Infections caused by antibiotic-resistant bacteria have resulted in increased hospitalization rates and longer hospital stays for infected individuals (Sanchez et al., 2020). The use of antibiotics for growth promotion has increased and has been linked to the development of antibiotic resistance among bacterial strains (Spitzer, 2015). The practice of administering sub-therapeutic doses of antibiotics to poultry in preventing disease not only increases resistance to bacteria found in animals, but also in humans. As a result of farming practices, workers and consumers may be exposed to antibiotic-resistant bacteria. Poultry farm workers and families living on farms using antibiotics in the feed, including neighboring families, have an elevated risk of exposure to antibiotic-resistant *E. coli*. Consumers who purchase poultry products which utilize antibiotics in production may also be exposed through cross-contamination from raw meat on surfaces and consumption of undercooked meat. Antibiotic resistance genes can move horizontally, especially through conjugative gene transfer, to other bacteria (McInnes, 2020). It has been suggested in several studies that *E. coli*, specifically, to human health has relevance because it is able to transmit from retail meat to people and ultimately be a source of urinary tract infections (Johnson et al., 2017). The emergence of resistance has the potential to impact the treatment and management of infectious diseases in both animals and humans. This increasing resistance has received considerable national and international attention (Abd El Tawab et al., 2015).

2. Material and Method

2.1 Study Area

The study area was Bauchi Local Government Area, Bauchi State, Nigeria. The study area was carefully selected based on Geographical location, Population Density, Well characteristics and Historical Data.[BP1.1] Bauchi LGA experiences a tropical savanna climate (Aw) characterized by distinct wet (May–October) and dry (November–April) seasons. The mean annual temperature ranges from 22°C to 38°C, accompanied by average annual rainfall between 900mm and 1,000 mm, and relative humidity levels reaching up to 80% during peak rainfall months. These ambient temperatures and high humidity levels during the wet season create favorable micro-climatic conditions for microbial growth and proliferation in surface and groundwater sources. Furthermore, seasonal surface runoff, shallow water table depth, improper waste disposal, and proximity of wells to pit latrines in densely populated areas significantly contribute to microbial contamination and bio-burden accumulation in local water supplies.

2.2 Sample Collection

All domestic poultry included in this study were, at the time of specimen collection, not showing any signs of ill health. The sampling sites were Fadaman Mada Poultry Farm, Nabordo Poultry, and Pacific Farm All located in Bauchi State, Nigeria and were all commercial farms where the animals are reared for food. Fresh faecal dropping was randomly collected from domestic poultry; care was taken to avoid collecting more than one

faecal sample per animal. Faeces were packed in a sterile plastic container and were tightly covered to avoid contamination from air droplet. These were carefully taken to the microbiological laboratory in Abubakar Tafawa Balewa University, Bauchi, for analysis.

2.3 Antibiotic Susceptibility Test

Bacterial inoculum was prepared and adjusted to match the 0.5 McFarland standard. Mueller-Hinton agar plates were used (usually poured to a thickness of 4 mm). A sterile cotton swab was dipped into the inoculum and spread the bacteria evenly across the surface of the agar plate to create a lawn culture. The plate was allowed to dry for about 5 minutes for the inoculum to absorb. Antibiotic discs were placed on the agar surface at specified distances (usually 24 mm apart) using sterile forceps. The plate was incubated upside down at 37°C for 16-24 hours. After incubation, the diameter of the inhibition zones was measured (clear areas with no bacterial growth around discs), including the disc diameter, with a ruler or calliper. Interpret results as Susceptible (S) or Resistant (R) by comparing zone sizes with CLSI (Clinical and Laboratory Standards Institute) guidelines.

3. Results

Table 1: Identification of *E. Coli* by biochemical test

Morphology	Reaction
Gram Stain	negative
Shape	Very Short rod
Biochemical Test	
Indole	positive
Methyl red	positive
Methyl red	positive
Citrate	negative
Lactose	positive

Preference: Bergey's manuals

The identification of *E. coli* was confirmed through both morphological and biochemical characteristics. Microscopic examination showed that the isolates appeared as very short rods, which is consistent with the typical morphology of *E. coli*, a Gram-negative bacillus. The negative result further supports its classification within the Enterobacteriaceae family.

The biochemical tests provided additional confirmation. The isolates tested positive for indole production, methyl red, and lactose fermentation, but were negative for citrate utilization. These results align with the characteristic profile of *E. coli*. The ability to produce indoles indicates the organism's possession of the enzyme tryptophanase, which breaks down tryptophan to form indole. A positive methyl red test suggests stable acid production from glucose fermentation, a common feature in *E. coli*. Furthermore, the fermentation of lactose is a well-known trait of *E. coli*, which is often used in differentiating it from other Enterobacteriaceae members such as *Salmonella* and *Shigella*, which do not ferment lactose. The negative citrate test result shows that the isolates cannot use citrate as the sole carbon source, which further distinguishes *E. coli* from *Klebsiella* and *Enterobacter* species, which are citrate positive.

FARM	AMP	CHL	GEN	PEN	STR	TET	CAZ	CRX	CXM	OFL	AUG	NIT	CPR	100%
Fadaman Mada Farm	100	33.3	16.7	66.7	23.3	86.7	26.7	36.7	20	33.3	66.7	23.3	30	100
Nabordo Poultry	93.3	13.3	26.7	53	16.7	76	23	46.7	23.3	36.7	66.7	26.7	33.3	100
Pacific Farm	94.2	15	22	63.2	18	68	27	47.3	22.5	30	65.2	26	29.5	100
Average	95.8	20.5	21.8	60.9	19.3	76.9	25.6	43.6	21.9	33.3	66.2	25.3	30.9	100

Total number of each antibiotic profile of *Escherichia coli* divided by the total number of isolates and multiplied by 100%

Antibiotic Profile of *E. coli* X 100 percentage (%)

Total Number of Isolates

4. Discussion

The *E. coli* isolates showed a resistance rate of 95% to Ampicillin, 20.5% chloramphenicol, 21.8% Gentamicin, 60.9% to Penicillin, 19.3% to Streptomycin, 76.9% Cefazidime, 25.6% to Cefuroxime, 43.6% to Cefixime, 21.9% to Ofloxacin, 33.3% to Augmentin, 66.2% to Nitrofurantoin, 25.3% Ciprofloxacin, 30.9% to Tetracycline. Overall, 13 different antibiotic resistance profiles were observed, with all the isolates showing resistance to at least four or more of the drugs tested. The *E. coli* strains isolated exhibited high rates of resistance against the following antibiotics: Ampicillin, Penicillin, Cefazidime, Cefuroxime and Nitrofurantoin. This high resistance level, although the farms under study do not have histories of supplementing animal feed with antibiotics as growth promoters, nor are antibiotics used prophylactically extensively. It is therefore probable that other factors and pressure of resistance in the absence of antibiotic exposure.

Although the domestic poultry sampled in this study do not receive any modern veterinary attention, they may maintain close contact through a myriad of routes (such as water) with humans in their environment that had been previously exposed to various antibiotics. In many areas of Bauchi, it is common for people to defecate in and around surrounding compounds, bushes or to urinate just at the corner of the house. Such poor and unhygienic methods of human excrement expose these animals to normal human resistance organisms from animal hosts, because of selective use of antibiotics in human hosts in the same environment.

Taking resistance according to sources of samples, there is strong evidence that the use of antimicrobial agents in poultry production can lead to the emergence and dissemination of resistant *E. coli*, which can then be passed onto people via food or through direct contact with poultry. The identification of 13 distinct MDR profiles among *E. coli* isolates poses a direct infection risk to poultry handlers, slaughterhouses, and consumers. Close contact between free-roaming poultry and households facilitates bidirectional transmission of resistant pathogens via the fecal-oral route, contaminated soil, or shared water sources. The high resistance rates against critical first- and third-line therapeutics, namely Ampicillin, Cefazidime, and Nitrofurantoin, have serious clinical consequences. *E. coli* is a primary causative agent of urinary tract infections (UTIs), neonatal sepsis, and gastroenteritis in humans. The circulation of strains resistant to these frontline antibiotics leaves clinicians with limited, often expensive alternatives (e.g., Carbapenems), increasing treatment costs, hospital stays, and mortality rates in resource-constrained healthcare settings. *E. coli* acts as a major donor and recipient of resistance plasmids (carrying resistance determinants for β -lactams, aminoglycosides, and tetracyclines) within the gut microbiome. The dissemination of these MDR strains into local water bodies via unhygienic excrement disposal threatens broader ecosystem health, potentially transferring resistance traits to other hyper-virulent pathogens such as *Salmonella* spp. and *Klebsiella pneumoniae*.

These findings highlight the urgent need for a One Health approach in Bauchi State that addresses human sanitation alongside animal husbandry. Improving municipal waste disposal, stopping open defecation, and protecting shallow groundwater sources are as crucial to curbing environmental AMR as enforcing regulations on veterinary antibiotic sales.

5. Conclusion

The study investigated the occurrence and antibiotic resistance profiles of *Escherichia coli* isolated from apparently healthy domestic poultry in Bauchi Metropolis. *E. coli*, though a common member of poultry intestinal microbiota, can become pathogenic and pose health risks to both poultry and humans. This research highlighted that despite the absence of prophylactic or extensive antibiotic use in the surveyed farms, the *E. coli* isolates exhibited high levels of resistance to multiple commonly used antibiotics, including Ampicillin, Penicillin, ceftazidime, Cefuroxime, and Nitrofurantoin. The findings suggest that antibiotic resistance in *E. coli* from poultry may be influenced not only by direct antibiotic exposure but also by environmental factors and human interaction, as close contact with antibiotic-exposed human populations may facilitate the transfer of resistant bacteria. The presence of multidrug-resistant *E. coli* in domestic poultry underscores significant public health concerns, given the potential for transmission of these resistant strains to humans through direct contact, contaminated food products, or environmental pathways. This resistance complicates treatment options for bacterial infections and highlights the global challenge posed by antimicrobial resistance.

Considering these findings, the study stresses the urgency of continuous monitoring and stringent regulation of antibiotic use in poultry farming to mitigate the emergence and spread of resistant bacteria. Furthermore, improving hygiene and sanitation practices in farming environments and communities is essential to reduce

transmission risks. Overall, the research contributes valuable knowledge on the antibiotic resistance landscape in poultry-associated *E. coli* in Bauchi and underscores the interconnectedness of animal, human, and environmental health in addressing antimicrobial resistance challenges.

6. Recommendations

The study suggests the following recommendations:

1. Implement strict regulations on the use of antibiotics in poultry production, limiting their use to therapeutic purposes under veterinary supervision only.
2. Prohibit or strictly control the use of antibiotics as growth promoters or for prophylaxis to minimize the development of resistance.
3. Promote good farm management practices, including proper sanitation, waste management, and biosecurity measures to reduce environmental contamination and bacterial transmission.
4. Educate poultry farmers about hygienic practices to reduce the spread of resistant bacteria from humans to animals and vice versa.
5. Strengthen collaboration among veterinary, medical, and environmental sectors to develop integrated strategies addressing antimicrobial resistance.
6. Promote research on transmission pathways of resistant bacteria between animals, humans, and the environment.

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