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# Antimicrobial Resistance of *E. coli* Isolated from Broiler Flocks and Slaughterhouses in Batna District, Algeria

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## ABSTRACT

In the last few years, the poultry sector in Batna has faced the emergence of atypical diseases. Many professionals suspect unusual viral infections like Newcastle disease, infectious bronchitis, and avian influenza. These diseases are often associated with colibacillosis and salmonellosis, both of which have developed atypical, multi-drug resistance. combat *Escherichia* (E.) *coli* superinfections, a study targeted broiler chickens from 80 flocks and two slaughterhouses in the Batna region. Researchers collected organ samples, including neck skin, from both sick animals and those intended for slaughter, isolating 100 *E. coli* strains—50 from flocks and 50 from slaughterhouses. antibiotic resistance profiles of *E. coli* isolated from livestock were 62.5% (50/80), revealing moderate resistance rates to several antibiotics. Specifically, resistance was noted for tetracycline (62%), doxycycline (56%), enrofloxacin (44%), ampicillin (46%), amoxicillin (40%), and sulfamethoxazole-trimethoprim (34%). Resistance to colistin showed a lower rate of 20%; amoxicillin-clavulanate and ticarcillin-clavulanate had a resistance of 12% and 8%, respectively. While gentamicin and chloramphenicol had even lower rates at 8% and 6%. Notably, 94% of strains were sensitive to chloramphenicol, and 92% were sensitive to gentamicin. Additionally, 28% of strains were resistant to three antibiotics, and 18% were resistant to four. *Escherichia coli* isolated from the slaughterhouse was 83.3% (50 / 60) demonstrated higher antibiotic resistance than those from herds. These isolates were resistant to tetracycline, ampicillin, enrofloxacin, and doxycycline, at 82%, 80%, 78%, and 74%, respectively, and had moderate resistance to nalidixic acid, chloramphenicol, sulfamethoxazole-trimethoprim (SXT), and amoxicillin; resistance rates for colistin, gentamicin, and TTC were lower. In terms of multidrug resistance, 42% of the slaughterhouse strains were resistant to five antibiotics, 18% to four, and 14% to two. Nevertheless, these strains remained highly sensitive to colistin and gentamicin.

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## INTRODUCTION

Algeria's poultry industry has recently modernized to meet global standards and WTO requirements. This modernization necessitates robust biosecurity measures to mitigate infectious disease risks. Despite these efforts, viral diseases like infectious bronchitis (IB), Newcastle disease (ND), and avian influenza virus (AIV), coupled with a lack of advanced diagnostics (like RT-PCR and PGFE), have facilitated bacterial infections such as colibacillosis, salmonellosis, and mycoplasmosis. (**Khathayet *et al.*, 2021).**

In 2021, Algeria produced 430,846.2 tons of white meat and 6.08 billion eggs. However, white meat production declined by 20.4% compared to 2019. This decrease was attributed to rising feed costs, supply shortages, the COVID-19 pandemic, and outbreaks of H5N8 avian influenza, as reported by the Algerian Ministry of Agriculture and Rural Development (MARD) **(Akkari *et al.* 2024).** Colibacillosis remains the most common condition found in bacteriological analyses of both sick and healthy broiler chickens. It is consistently linked to poor farming practices, including overcrowding, inadequate bedding, poor ventilation, and lapses in biosecurity, such as pest infestations **(Awawdeh *et al.*, 2022).**

The lack of qualified sanitary labor further worsens the issue. Clinical signs of colibacillosis often overlap with atypical subacute viral infections and other conditions like coccidiosis, necrotic enteritis, and mycoplasmosis. This situation leads to various lesions, including enteritis, colisepticemia, respiratory syndrome, airsacculitis, and salpingitis. At slaughterhouses, cross-contamination between batches of broiler chickens from different sources is a major concern. Poor hygiene among staff, machinery, and facilities increases the risk of pathogen spread. Additionally, biofilms on work surfaces hinder effective disinfection. *Escherichia coli* isolated from livestock or slaughterhouses often appear on media for enterobacteria alongside other coliforms, both lactose-positive and lactose-negative.

Unfortunately, antibiotic susceptibility testing is rarely requested by veterinarians, who often prescribe inappropriate antibiotics at suboptimal doses. This practice contributes to the emergence of multi-drug-resistant strains, worsening an already limited antibiotic arsenal in veterinary medicine. The rise of multi-antibiotic-resistant *E. coli* poses a significant challenge for veterinary practitioners **(Ibrahim *et al*., 2019).** As a result, alternative treatment options are increasingly necessary, including prebiotics, probiotics, phytobiotics, vaccines, and remedies based on traditional medicine **(Abd El-Hack *et al.*, 2022).**

This study aims to identify the primary multi-resistance profiles of *E. coli* isolated from poultry flocks and slaughterhouses. It also seeks to compare the colibacillosis in infected birds with *E. coli* strains from the organs of healthy broiler chickens intended for human consumption.

## MATERIALS AND METHODS

This study was conducted in Batna, Algeria, located in the northeastern part of the country, characterized by its varied climatic conditions due to the surrounding Aurès Mountains. Temperatures range between 0 and 8°C in winter and can reach 50°C in summer. The region is known for its rich agricultural landscape and diverse livestock, including sheep, goats, cows, and poultry, particularly in areas with fertile pastures. Agriculture is a key economic activity, and animal products make up a significant portion of agricultural production in the region.

### Ethical approval

This study was conducted in accordance with the guidelines set by the Institutional Committee for the Protection of Animals of the National Administration of Higher Education and Scientific Research of Algeria (98-11, Act of August 22, 1998).

### Sampling procedure

### From poultry buildings

From August 2023 to April 2024, a study was conducted in the Wilaya of Batna, where 150 broiler chickens (60 deceased and 90 alive) were sampled from 80 poultry buildings housing 5,000 to 10,000 birds each, predominantly of the COB 500 and ARBOR ACRES breeds, aged 30 to 56 days. Mortality rates in these flocks ranged from 10 to 200 birds per day.

For chicken necropsy, five birds were selected from each flock (two sick, two recently dead, and one healthy). These chickens were examined at a private veterinary clinic, where blood samples were taken from the wing vein of living birds for serum analysis, and necropsies were performed on the deceased. Notable lesions that were found during autopsies included hepatic hypertrophy, airsacculitis, pulmonary congestion, and pericarditis. Vital organs such as the liver, heart, and spleen were collected for further analysis **(Lowenstine, 1986).**

### From slaughterhouses

For the samples collected at the abattoirs, two local facilities in the Batna district were selected and characterized by their outdated infrastructure and an average daily production of 5,000 chickens.

Over a span of 8.5 weeks in February and March 2024, we gathered 50 samples from these abattoirs, collecting one sample each week. Each sample consisted of four components: liver, heart, neck skin, and rinse liquid, sourced from the carcasses of five apparently healthy, freshly slaughtered chickens without visible lesions and collected following the cooling phase of the slaughtering process **(Coura *et al.*, 2017).**

### Bacteriological analysis

The samples were examined using a previously up-cited described method with slight modifications. The spleen, heart, and liver samples from the poultry buildings were carefully excised using a sterile blade and. 25 g of sample (internal organs) were mixed with 225 ml of buffered peptone water (Pasteur Institute of Algeria), vortexed, and incubated overnight at 35°C for 16 hours. To isolate *E. coli*, 100 µl of broth was inoculated with a platinum loop on Hektoen and MacConkey agars and incubated at 35°C for 24 hours. Colonies with an *E. coli* profile were confirmed using the IMVIC test and then subjected to antibiotic susceptibility testing (**Quinn *et al.*, 2002).**

For abattoir samples, organs from five subjects were pooled and macerated in a sterile compress. A portion (100 µl) of the maceration fluid was inoculated into Brain Heart Infusion Broth (BHIB) and incubated at 35°C for 24 hours, forming a single sample. A similar pooled sample was prepared from the rinse liquid. Portions of the BHIB cultures (from the liver, heart, neck scrapings, and rinse liquid) were then streaked onto Hektoen and MacConkey agar plates. Suspected *E. coli* colonies were confirmed with the IMVIC test and tested for antibiotic susceptibility **(Logue *et al.*, 2003).**

### Serology

To detect Mycoplasma, sera from both healthy and diseased broiler chickens from the same flock were pooled and tested using the slide agglutination method to identify the Mycoplasma serotype (*Mycoplasma gallisepticum* or *Mycoplasma synoviae*). The same slide agglutination test was also used to serotype *Salmonella* isolates, utilizing Salmonella antisera SGP (*Salmonella Gallinarum* and *Salmonella Pullorum*) from Bio-Rad Laboratories Inc., California, USA.

### Antimicrobial sensitivity test

**Table 1:** Used antibiotics and their concentrations

| Antibiotics | Abbreviation | Concentration |
|---|---|---|
| Amoxicillin | AMX | (20 µg) |
| Amoxicillin-clavulanate | AMC | (20/10 µg) |
| Ampicillin | AMP | (10 µg) |
| Doxycycline | DO | (30 µg) |
| Chloramphenicol | C | (30 µg) |
| Tetracycline | TE | (30 µg) |
| Gentamycine | CN | (10µg) |
| Nalidixic Acid | NA | (30 µg) |
| Colistin | CT | (10 µg) |
| Sulfamethoxazole-trimethoprim | SXT | (25 µg) |
| Ticarcillin – Clavulanic Acid | TTC | (20/10 µg) |
| Enrofloxacin | OFX | (5 µg) |

AMX=Amoxicillin, AMC=Amoxicillin-clavulanic acid, AMP=Ampicillin, DOX=Doxycycline, C=Chloramphenicol, TE=Tetracycline, CN=Gentamycin, NA=Nalidixic acid, CT=Colistin, SXT=Trimethoprim/Sulfamethoxazole, TC :Ticarcillin –Clavulanic Acid, OFX=Enrofloxacin.

All *E. coli* isolates were tested for antimicrobial susceptibility to eleven or twelve antimicrobials (Table 1) using the disk diffusion method on Mueller-Hinton agar (MHA; Liofilchem), following the Clinical and Laboratory Standards Institute (CLSI) guidelines (Wayne, PA, 2016). The antibiotics tested included amoxicillin (AMX; 20 µg), amoxicillin-clavulanate (AMC; 20/10 µg), ticarcillin-clavulanate (TTC; 20/10 µg), ampicillin (AMP; 10 µg), doxycycline (DO; 30 µg), tetracycline (TE; 30 µg), chloramphenicol (C; 30 µg), gentamicin (CN; 10 µg), nalidixic acid (NA; 30 µg), enrofloxacin (OFX; 5 µg), colistin (CT; 10 µg), and sulfamethoxazole-trimethoprim (SXT; 25 µg). The disks were obtained from Liofilchem and HiMedia (India), with *E. coli* ATCC 25922 serving as the reference strain. The results were analyzed according to CLSI guidelines **(Table 1).**

### Statistical analysis

The contingency tables and the Chi-square test were applied to determine the association between the frequency of resistance/sensibility to each antibiotic and the different broiler chicken production samples. The level of statistical significance was set at $p<0.05$ to compare co-resistances in different isolates.

## RESULTS

### Poultry Building Study Results

### Prevalence of bacterial isolates

Among the 80 broiler farms, colibacillosis was found in 50, resulting in a prevalence rate of 62.5%. Salmonellosis was detected in three of the 80 broiler buildings, resulting in a prevalence of 3.75%. Pseudomonosis was identified in one strain, yielding a prevalence rate of 1.25%.

### Prevalence of Detected Serotypes

Within the live chickens, *Mycoplasma synoviae* serotype was identified in 7 out of 80 samples (8.75%). No agglutination was observed with the anti-SGP antisera, confirming the absence of *Salmonella Gallinarum* and *Salmonella Pullorum*.

### Sensitivity of *E. coli* isolates to antibiotics

*Escherichia coli* isolates from broiler flocks exhibited a moderate resistance to tested antibiotics. The highest resistance rates were observed for tetracycline (62%) and doxycycline (58%). In addition, 44% of bacterial strains were resistant to enrofloxacin and ampicillin, compared to 40% and 32% for amoxicillin and SXT, respectively. Colistin and AMC showed lower resistance at 22% and 12%. Finally, **(Table 2)** shows that the resistance rates to gentamicin and chloramphenicol were the lowest, at 8% and 10%, respectively.

**Table 2:** Antibiogram of *Escherichia coli* isolates (50APEC)

| Antibiotics | Sensitivity (S) | Intermediate(I) | Resistance (R) |
|---|---|---|---|
| TE | 19/50 38% | 0 | 31/50 62 % |
| DOX | 21/50 42% | 0 | 29/50 58% |
| OFX | 21/50 42% | 8 /16% | 21/50 42% |
| AMP | 28/50 56% | 0 | 22/50 44 % |
| AMX | 33/50 66% | 1/2% | 16/50 32 % |
| SXT | 37/50 74% | 0 | 13/50 26% |
| CT | 37/50 74% | 2/4% | 11/50 22% |
| AMC | 44/50 88% | 0 | 6/50 12% |
| C | 45/50 90% | 0 | 5/50 10% |
| TTC | 46/50 92% | 0 | 4/50 8% |
| CN | 46/50 92% | 0 | 4/50 8% |

APEC=Avian pathogenic *Escherichia coli*

The most prevalent level of multidrug resistance among *E. coli* strains was observed against three antibiotics, occurring at 28%. This is followed by resistance to two, four antibiotics (20%) and five antibiotics (18%). The highest observed resistance is to six antibiotics, at 8%. Only 4% of strains exhibited resistance to a single antibiotic **(Table.3).**

**Table 3:** Strains of *Escherichia coli* showing multi-drug resistance from Broiler flocks

| Antibiotic Number | Strain number | Percentage |
|---|---|---|
| 1 | 2/50 | 4% |
| 2 | 10/50 | 20% |
| 3 | 14/50 | 28% |
| 4 | 10/50 | 20% |
| 5 | 9/50 | 18% |
| 6 | 4/50 | 8 % |

The most common antibiotype profile is TE-AMP (resistance to two antibiotics), which is found in 12% of the strains. Another profile with five antibiotics—TE-DOX-AMX-CT-OFX—also occurs at 12%. A different five-antibiotic profile, TE-DOX-AMX-SXT-OFX, appears in 6% of cases. Additionally, the four-antibiotic profiles DOX-AMP-SXT-OFX and DOX-AMX-C-OFX each have a prevalence of 4%. Finally, threeantibiotic profiles (TE-AMP-AMC, DOX-TTC-SXT) each represent 6% of the strains **(Table.4).**

Table.4: Multidrug resistance Pattern of *Escherichia coli* from broiler flocks (50 strains)

| Antibiotic Number | Profiles Number | Most frequent Profiles | Rate | percentage |
|---|---|---|---|---|
| 1 | 2 | CT | 1/50 | 2% |
| | | AMP | 1/50 | 2% |
| 2 | 6 | TE AMP | 6/50 | 12% |
| | 2 | DOX SXT | 2/50 | 4% |
| | 3 | TE AMP AMC | 3/50 | 6% |
| | 3 | DOX TTC SXT | 3/50 | 6% |
| | 2 | DOX AMP OFX | 2/50 | 4% |
| 4 | 7 | DOX AMP SXT OFX | 2/50 | 4% |
| | | DOX AMX C 0FX | 2/50 | 4% |
| 5 | 2 | TE DOX AMX CT OFX | 6/50 | 12% |
| | 3 | TE DOX AMX SXT OFX | 3/50 | 6% |
| 6 | 3 | TE DOX AMP NA C OFX | 1/50 | 2% |
| | | TE DOX AMX CT CN OFX | 1/50 | 2% |
| | | TE DOX AMX CT SXT OFX | 1/50 | 2% |

## Slaughterhouses results

### Prevalence for APEC Strains in Slaughterhouses

Overall, *E. coli* was isolated from 50 out of 60 samples, resulting in an incidence rate of 83.3% over the 60 days. No strains of *Salmonella spp.* or *Pseudomonas spp*. were found alongside the *E. coli* strains.

### Antimicrobial sensitivity test for APEC Strains

The antibiotic resistance observed in *E. coli* from slaughterhouses was as follows: Tetracycline: 82%, Ampicillin: 80%, Enrofloxacin: 78%, Doxycycline: 76%, Nalidixic acid: 32%, Chloramphenicol: 22%, SXT: 20%, Amoxicillin: 16%. Resistance to TTC, colistin, and gentamicin was the lowest **(Table 5).**

**Table 5:** Antibiogram of isolated *Escherichia coli* from healthy carcasses in slaughterhouses

| Antibiotics | Sensitivity (S) | Intermediate(I) | | Resistance (R) | |
|---|---|---|---|---|---|
| TE | 09/50<br>18% | 0 | 0 | 41/50 | 82% |
| AMP | 10/50<br>20% | 0 | 0 | 40/50 | 80% |
| OFX | 06/50<br>12% | 5/50 | 10% | 39/50 | 78 % |
| DOX | 09/50<br>18% | 3/50 | 6% | 38/50 | 76% |
| NA | 31/50<br>68% | 3/50 | 6% | 16/50 | 32 % |
| C | 38/50<br>76% | 1/50 | 2% | 11/50 | 22 % |
| SXT | 40/50<br>80% | 0 | 0 | 10/50 | 20 % |
| AMX | 42/50<br>84% | 0 | 0 | 8/50 | 16 % |
| CT | 43/50<br>86% | 6/50 | 12% | 1/50 | 2 % |
| CN | 49 /50<br>98% | 3/50 | 6% | 1/50 | 2 % |
| AMC | 48/50<br>96% | 1/50 | 2% | 1/50 | 2 % |

The rates of multidrug resistance patterns among *Escherichia coli* strains included: resistance to five antibiotics in 42% of cases (21 out of 50), four antibiotics in 18%, two antibiotics in 14%, six antibiotics in 10%, and one antibiotic in 2% **(Table 6).**

**Table 6:** Strains of *Escherichia coli* showing multi-drug resistance from slaughterhouses

| Antibiotic Number | Number of strains | Percentage |
|---|---|---|
| 1 | 1/50 | 2% |
| 2 | 7/50 | 14% |
| 3 | 6/50 | 12% |
| 4 | 9/50 | 18% |
| 5 | 21/50 | 42% |
| 6 | 5/50 | 10% |

The most common resistance profiles were as follows: five antibiotics (TE-AMP-DOX-OFX-NA) showed a resistance rate of 20% (10/50), while TE-AMP-DOX-OFX-Chad a resistance rate of 14% (7/50). Profiles with four antibiotics (TE-AMP-DOX-OFX) had a resistance rate of 10% (5/50), and those with two antibiotics (TE-AMP) also showed a resistance rate of 10%. Resistance rates for profiles with six, three, and one antibiotic were lower, at 6%, 4%, and 2%, respectively. Overall, the multidrug-resistant profiles for six, five, and three antibiotics amounted to 54% (27/50), calculated as follows: 10 + 7 + 5 + 3 + 2 = 27 **(Table 7).**

**Table 7:** Multidrug resistance Pattern of *E.coli* from slaughterhouses (50 strains)

| Antibiotic Number | Profile Number | Most frequent Profiles | Number and rate of resistant strains | |
|---|---|---|---|---|
| 1 | 1 | TE | 1/50 | 2% |
| 2 | 5 | TE AMP | 5/50 | 10% |
| 3 | 2 | AMP OFX SXT | 2/50 | 4% |
| 4 | 5 | TE AMP DOX OFX | 5/50 | 10% |
| 5 | 17 | TE AMP DOX OFX NA<br>TE AMP DOX OFX C | 10/50<br>07/50 | 20%<br>14% |
| 6 | 3 | TE AMP DOX OFX NA C | 3/50 | 6% |

The Chi-square test indicated significant differences in resistance levels for doxycycline, ampicillin, AMC, and colistin between poultry flocks and slaughterhouses with $p < 0.05$ (**Fig. 1).**

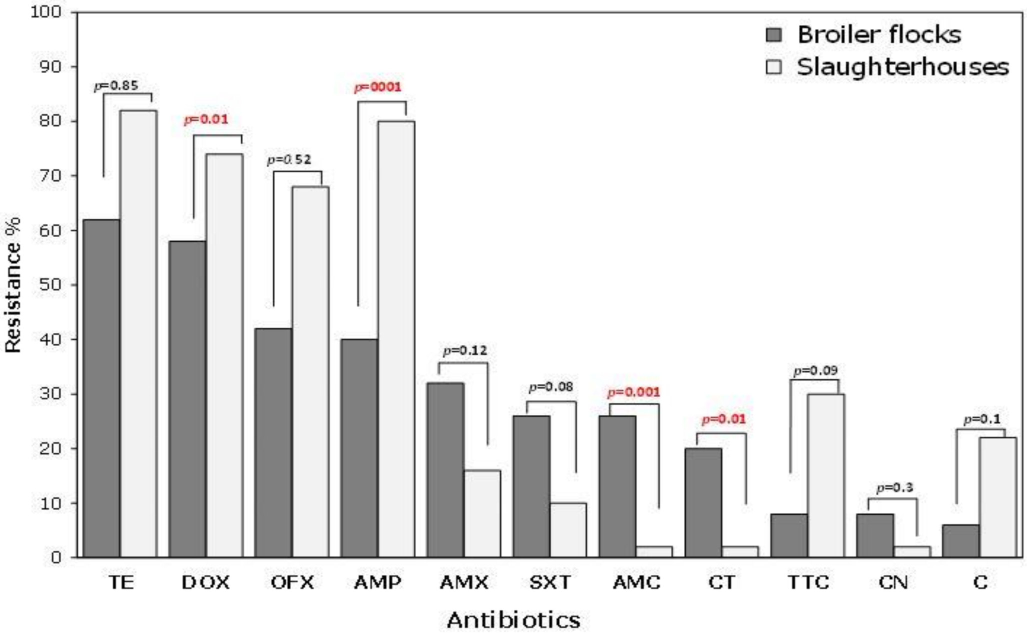


**Fig.1:** Resistance of *Escherichia coli* isolates from slaughterhouses (n=50) and poultry flocks (n=50), (Chi-2 test).

## DISCUSSION

The study confirmed that colibacillosis is prevalent among poultry flocks, affecting 62.5% of the examined population. We isolated 50 strains of *E. coli* from 80 samples taken from various organs, including the liver, heart, and spleen of infected chickens. This moderate incidence helps explain why septicemia is a leading cause of mortality, with daily death rates ranging from 10 to 200 birds. Colibacillosis often complicates viral diseases, such as Newcastle disease and infectious bronchitis, contributing to the overall high mortality rate. Notably, it was found to be associated with SGP pathology in 3.75% of cases **(Jahantigh and Dizaji, 2015; Djeghout *et al.*, 2017).**

Colibacillosis is commonly diagnosed in bacteriological analyses of deceased, sick, and even healthy birds. However, in flocks experiencing moderate mortality and receiving treatment, *Escherichia coli* isolation is often null due to effective infection control. Similarly, bacterial isolation is rare in cases of acute viral infections. This explains the moderate incidence of colibacillosis in broiler houses and the relatively low recovery rates of *E. coli* from the organs of deceased, sick, or apparently healthy birds, with previous studies reporting recovery rates of 65.33% **(Kim *et al.*, 2020) and 58% (Pilati *et al.*, 2024)** compared to our rate of 62.5%.

The antibiotic resistance rates of *E. coli isolates* from broiler flocks are moderate, with the highest observed for tetracycline resistance in our study (62%) aligning with previous reports by **Ejeh *et al.*,** (57.1%), **Khanal *et al.*,** (62.5%), **Moawad *et al.*,** (57.14%), and **Meguenni *et al.*,** (57.1%) in 35 strains. The high resistance to doxycycline, similar to tetracycline, likely results from cross-resistance due to shared mechanisms.

Enrofloxacin, a second-generation quinolone, has a broader spectrum against Gram-negative bacteria compared to nalidixic acid and effectively penetrates infection sites, making it a preferred treatment for colibacillosis. However, it has a resistance rate of 42%, aligning with findings from **Aggad *et al.*, (2010),** who reported 45% resistance in 100 isolates; **Khanal *et al.*, (2017)** with 37.4% in 40 cases; and **Pilati *et al.*, (2024)**, with 30.16% in 63 isolates. We did not include first-generation quinolones like nalidixic acid, flumequine, and oxolinic acid, as regional studies indicated a shift in resistance towards fluoroquinolones **(Agabou *et al.*, 2016; Ahmed Ammar *et al.*, 2017).**

Ampicillin resistance was 44% in our study, which is similar to the 45.8% reported by **Barka *et al*., (2021).** Amoxicillin and SXT had resistance rates of 40% and 34%, slightly lower than the 54.04% and 37.4% found by **Boudjerda *et al*., (2022)** for amoxicillin and SXT. Of the 16 studies conducted on *E. coli* antibiotic resistance in Algeria's poultry sector, high resistance was found to ampicillin and possibly to amoxicillin, followed by resistance to tetracyclines, including doxycycline. The evolution of resistance to tetracyclines and beta-lactams in avian colibacillosis over the last two decades is mainly linked to the continuous and sometimes excessive use of antibiotics in livestock farming. This selective pressure has favored the spread of resistant strains, some of which produce extended-spectrum beta-lactamases (ESBL), making treatments more complex and less effective**.**

Our results on the resistance of *E. coli* to tetracyclines and ampicillin in poultry buildings revealed moderate resistance compared to the rest of the studies carried out in Algeria due to the limited number of isolated strains. Among the antibiotics studied, colistin and AMC had the lowest resistance rates at 22% and 12%, respectively, consistent with **Ahmed Ammar *et al.*, (2017)** who reported 21% and 17% resistance for colistin and AMC. Colistin is considered a critically important antibiotic and is used as a last resort for treating multidrug-resistant infections.

*Escherichia coli* strains isolated from poultry flocks show high sensitivity to gentamicin (92%), chloramphenicol (90%), and colistin (74%). These results are consistent with **Benameur *et al.*, (2014)** which reported sensitivities of 98%, 89.5%, and 68.4%, respectively. The overall sensitivity pattern indicates full sensitivity to colistin, followed by gentamicin and chloramphenicol. This aligns with findings from **Benklaouze *et al.*, (2020)** and **Aberkane *et al.*, (2023).** The moderate resistance to gentamicin may be due to its illicit use, as this antibiotic is prohibited in veterinary medicine in Algeria.

In our study, six antibiotics were tested, revealing a significant multidrug resistance rate of 74% (37 out of 50 strains). Specifically, 28% (14/50) were resistant to three antibiotics, 20% (10/50) to four, and 18% (9/50) to five. These findings align with those of **Merati *et al.*, (2020).** In contrast, **Aggad *et al.*, (2010)** reported resistance rates of 36%, 27%, and 17% for three, two, and one antibiotic, respectively. **Meguenni *et al.*, (2019)** found resistance rates of 70.12%, 53.5%, and 2.7% for two, three, and one antibiotic, respectively. **Benklaouze *et al.*, (2020)** and **Barka *et al.*, (2021)** reported even higher rates of 95.3% and 87% for three antibiotics. **Benameur *et al.*, (2014)** found an 18% resistance rate to four antibiotics, similar to our finding of 20%. Additionally, we found that 16% (8/50) of strains were resistant to five antibiotics. The most common resistance profiles among broiler chicken farms, each at 12%, include TE-DOX-AMX-CT-OFX and TE-AMP. These findings are consistent with **Hammoudi *et al.*, (2008)** and **Cige *et al.*, (2023)** regarding tetracycline and ampicillin.

The rate of isolated *E. coli* from broiler chickens in the two slaughterhouses was 83.3%, significantly higher than the 62.5% observed in broiler flocks. This aligns with **Wibawati *et al.*, (2023)** who only in the slaughterhouses reported a resistance rate of 24.1% for chloramphenicol, compared to our 22%. *Escherichia coli* isolated from abattoirs showed high resistance rates to the four most common antibiotics: TE (82%), AMP (80%), OFX (78%), and DOX (76%). These rates are significantly higher than those found in poultry flocks, particularly for the TE-DOX-AMP-OFX combination (62%, 58%, 42%, and 40%, respectively). Similarly, **Nonechat *et al*., (2024)** reported comparable resistance rates for TE, AMP, and CT at 78.2%, 78.2%, and 3.12%, respectively. In contrast, strains from the abattoir exhibited low resistance to CT, CN, and AMC (2%, 2%, and 18%). These findings align with **Amancha *et al.*, (2023)** which reported resistance rates of 3%, 12%, and 5% for CT, CN, and AMC.

The Chi-square test revealed statistically significant differences ($p < 0.05$) in resistance levels for doxycycline, ampicillin, AMC, and colistin between broiler flocks and slaughterhouses. This indicates that slaughterhouses may be more prone to harboring resistant strains, likely due to poor hygiene practices during processing.

Tetracycline and ampicillin resistance results are similar to findings in several previous studies conducted on abattoir isolates **(Scieberas *et al.*, 2019; Phiri *et al.*, 2020; Mgaya *et al.*, 2021).** No resistance was observed against gentamicin in any sample studied by **Tegegne *et al.*, (2023).** In terms of multidrug resistance, *E. coli* isolates from abattoirs showed a maximum rate of 42% for five antibiotics and 18% for four antibiotics. In comparison, **Hossain *et al.*, (2023)** reported 32% resistance for three antibiotics and 16% for four. **Gharib *et al.*, (2023)** found even higher resistance rates of 40%, 50%, and 60% for four, five, and six antibiotics, respectively.

Among the 60 samples, *E. coli* strains isolated from slaughterhouses had a prevalence rate for multidrug resistance profiles of 54% (27/50), which is close to the 54% (65/120) reported by **Javed *et al.*, (2024)** in chicken points of sale. Notably, 69.3% of these strains were multidrug-resistant (MDR), defined as resistant to at least three antibiotics. This rate is lower than the 74% (37/50) observed in strains from our broiler chicken facilities.The multidrug resistance profiles in our study, particularly for the TE-AMP-DOX-OFX combination, align with findings of **Noenchat *et al.*, (2024).** Similarly, our 10% resistance rate for the TE-AMP profile is close to the 20% reported by **Gharib *et al.*, (2023).**

A comparison of antibiotic resistance in *E. coli* strains from poultry farms versus those from slaughterhouses reveals that the latter exhibit higher resistance rates. This finding is consistent with **Phiri *et al.*, (2020)** and may be attributed to the continuous processing and dispersion of germs during evisceration. Factors such as air circulation carrying contaminated dust and the presence of insects also contribute to germ spread among animals. Additionally, samples taken from the skin of the neck and carcass rinse fluid are more likely to yield a higher number of *E. coli* strains, which are known indicators of fecal contamination in water **(Yulistiani *et al.*, 2019; Noenchat *et al.*, 2024).**

In developing countries, the application of HACCP to the slaughter process is virtually nonexistent due to poor compliance with hygiene standards, lack of Good Manufacturing Practices (GMP), and inadequate facilities. As a result, ensuring the production of safe food is nearly impossible **(Ahmed *et al.*, 2023).** The most prevalent antibiotype profile of *E. coli* in poultry farms, accounting for 12%, is similar to that found in slaughterhouses, which ranges from 12% to 14%. Both profiles share the same sequence: TE-DOX-AMX/AMP-OFX-NA/CT. This profile has also been observed in studies by **Benklaouze *et al.*, (2020); Aberkane *et al.*, (2023); Gharib *et al.*, (2023)** and **Jaseem *et al.*, (2023)** across 12 antibiotype categories. The antibiotics AMX and AMP, which are beta-lactams, exhibit cross-resistance.

## CONCLUSIONS

In summary, our study reveals significant antibiotic resistance among *E. coli* strains in broiler flocks and slaughterhouses in Batna. The high rates of resistance to commonly used antibiotics like tetracycline and doxycycline underscore the need for better antibiotic stewardship in poultry farming. Additionally, the higher prevalence of multidrug-resistant strains in slaughterhouses highlights the importance of improving hygiene and biosecurity practices. Future research should focus on developing alternative treatment strategies, such as vaccines or probiotics, to reduce reliance on antibiotics and combat the rise of resistant bacterial strains.

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### Conflict of interest

The authors declare that no conflict of interest.

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