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Original article

Comparison of Reported Antibiotic Treatment in Chicken Farming and Antibiotic-Resistant (*E. coli*) in Commercial Poultry Meat

Amir Gomaa[1], Sauad Abdulhadi[2], Najah Mohamad[2], Abdulsalam Saleh[1]*

[1]*Department of Health Food Hygiene, Faculty of Veterinary Medicine, University of Omar Al-Mukhtar, EL-Beida, Libya*
[2]*Department of Pharmaceuticals and Forensic, Faculty of Veterinary Medicine, University of Omar Al-Mukhtar, EL-Beida, Libya*
Corresponding Email. *abdulsalam.abdullah@omu.edu.ly*

Abstract
This study investigates the prevalence and antimicrobial resistance of Escherichia coli in poultry meat sold in Al Bayda, Libya. A total of 37 chicken meat samples were analyzed for resistance to 12 antibiotics, using the disk diffusion method. The results indicated high resistance rates, particularly to ampicillin, ampicillin-sulbactam, cefazolin, and tetracycline, with 48% of the isolates exhibiting multidrug resistance. Conventionally reared poultry showed significantly higher resistance to gentamicin, commonly used in egg vaccines. The study found no significant differences in resistance across production categories, but brand-specific factors were strongly associated with resistance levels. These findings suggest that antibiotic use in poultry production, particularly in conventional systems, contributes to increased resistance, emphasizing the need for improved regulations and monitoring of antibiotic use across all stages of production to ensure food safety and reduce the spread of resistance.
Keywords. Escherichia Coli, Antimicrobial Resistance, Antibiotics, Food Safety.

Introduction

The use of antibiotics in cattle production has important public health consequences. Regardless of its intended function, routine antibiotic treatment on farms encourages the development and maintenance of microorganisms resistant to antibiotics [1-3]. These resistant bacteria represent a danger to human health by either directly causing infections or transferring resistance genes to pathogens that affect humans [4,5]. The establishment of procedures at various manufacturing and post-slaughter phases may help determine the causes of antibiotic-resistant microorganisms found in commercially marketed chicken products. The findings show a direct correlation between elevated levels of *E. coli* resistance and the usage of antibiotics in chicken production [6].

Escherichia coli is a bacteria commonly present in the intestines of vertebrates and is often found in retail meat products [7]. Most clinical and food strains of (*E. coli*) have been showing an increase in antibiotic resistance, with livestock strains showing a faster increase in resistance than human clinical strains between 1950 and 2002, according to the U.S. Food and Drug Administration's National Antimicrobial Resistance Monitoring System (NARMS) [8]. The usage and distribution of antibiotics in animals produced for food increased annually between 2009 and 2015, despite mounting concerns about the hazards to public health posed by their use in livestock production.

Recently, (colistin-resistance) caused by plasmids has been found in cattle, meat products, and human patients. Colistin is used in some countries to promote the development of farm animals and prevent diseases. It is also essential for treating carbapenem-resistant infections [9]. The growing global spread of (colistin-resistance) seriously threatens the safety of the global the supply of food [10,11]. There are significant differences between the labeling of meat products and the use of antibiotics in cattle production. For instance, compared to animals raised in traditional agricultural methods, those bred for meat classified as "organic" or "raised without antibiotics" (RWA) are subject to stricter regulations regarding the use of antibiotics. However, RWA standards continue to allow the use of antibiotics for the whole of the animal's life, including immunizations and in-egg injections.

As consumers become more informed about the relationship between antibiotic use in food animals and the rise of antibiotic resistance, there has been an increase in demand for RWA and organic products. Poultry raised conventionally tends to have bacteria that show greater resistance to a wide variety of antibiotics and are more often resistant to multiple drugs compared to those from RWA or organic systems, although some exceptions have been noted [12,13]. This study employed a routine sample approach, collecting retail chicken items every two weeks for a whole year in order to determine whether the prevalence of antibiotic-resistant (*E. coli*) varied by source and manufacturing type. Because of its frequent sampling and emphasis on brand-specific variations in resistance levels, the study also looked at disparities in (*E. coli*) contamination levels among different brands of retail chicken products.

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Methods

Samples

A range of antibiotics, including ampicillin, cefazolin, trimethoprim-sulfamethoxazole, ampicillin-sulbactam, tetracycline, gentamicin, and ciprofloxacin, were used to assess each sample's antimicrobial susceptibility. The disk diffusion approach was used for the testing [13,14]. 'Intermediate' and 'resistant' samples were combined for statistical analysis after being gathered from retail marketplaces in Al-Bayda, Libya. Resistance to at least three distinct types of antibiotics was defined as multidrug resistance. With a significance threshold of $\alpha = 0.05$, the Chi-square test was used to evaluate the variations in resistance prevalence across different groups; no multiple comparison corrections were used. Version 3 of R software was used for all statistical analyses.

Sample Collection

In 2024, 37 chicken meat packages were bought from grocery stores in Al Bayda, Libya (Figure 1). The likelihood of *Escherichia coli* contamination in the chicken products was found to be 89.7% (P = 0.0575). There was no significant variation in the rates of (*E. coli*) contamination between different production categories for any of the meat types.

Figure 1. Poultry farms from which samples were collected.

Results and discussion

All 12 tested antibiotics showed resistance, with the exception of imipenem and amikacin, to which no isolates showed resistance. In four poultry isolates, extended-spectrum beta-lactamase (ESBL) synthesis was detected. Different varieties of meat have varying rates of resistance, with eight individual and combination antibiotics showing statistically significant variations. Over half of the isolates showed resistance to tetracycline (74%) and/or ampicillin (64%), ampicillin-sulbactam (55%), and/or cefazolin (48%). Additionally, 48% of Escherichia coli isolates were multidrug-resistant. Resistance was identified in the majority (9 of 12) of the antibiotics tested, with *E. coli* isolates from Libyan poultry exhibiting the highest levels of resistance, particularly to critical antibiotic classes used in human medicine. Since farmers in the US are exempt from reporting species-specific antibiotic usage, it is difficult to establish a clear link between increased resistance levels and at the farm antibiotic use. From the perspective of the consumer, the results show that over half of the chicken packages sold in stores included multidrug-in (*E. coli*).

Table 1. Number of packages and contamination test

Statement	Value
Number of chicken packages purchased	37 pack
Possibility of E. coli contamination	89.7 % (P = 0.0575)

Growing knowledge of risks of using antibiotics in cow raising has caused a shift in consumer opinions, which has also increased investment in this area [2]. According to our findings, E. coli -resistance to six antibiotics varied noticeably among chicken floor samples, with conventionally grown poultry exhibiting noticeably greater resistance. The resistance levels in Escherichia coli isolates from poultry, however, were not significantly affected by the production technique, indicating that, for the majority of antibiotics, selected pressures remained mostly constant throughout the three production methods.

Gentamicin resistance, which was most prevalent in isolates from chickens grown traditionally, was the lone exception. The greater gentamicin resistance shown in conventionally reared chicken may be explained by the fact that gentamicin is commonly used in egg vaccinations and that earlier research has connected the use of antibiotics in eggs to the emergence of resistant bacteria in poultry meat. It's interesting to note that isolates from poultry meat had the greatest levels of trimethoprim-sulfamethoxazole resistance, which was an unexpected discovery.

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Table 2. Number of antibiotics and resistance rate.

Statement	Value
Number of antibiotics tested	12 antibiotics
antibiotic resistance rate	Resistant to 9 out of 12 antibiotics

This might be linked to the increasing use of feed additives like copper and zinc, which are used to promote growth and ward against illness but may also increase resistance to antibiotics like soflunomide and tetracycline. Although tetracycline resistance was limited in organic or Raised Without Antibiotics (RWA) systems, it was present in all production methods. According to earlier studies, tetracycline resistance can persist for a long time after antibiotic usage has stopped.

Table 3. Antibiotic resistance rates

Antibiotic	Resistance ratio
Ampicillin	64%
Ampicillin-Sulbactam	55%
Cefazolin	48%
Tetracycline	74%

These results underscore the complexity of antibiotic resistance [15,16], Resistance can persist even when antibiotics are no longer used in some instances. (E. coli) resistance in chicken products was found to be significantly predicted by product, indicating that company manufacturing processes may have a greater impact on resistance levels than USDA regulations, which primarily address the period from hatching to slaughter. However, factors that take place both before and throughout the development period may also have an impact on how susceptible diseased chicken products are to E. coli.

Because the use of antibiotics in parent and broiler flocks is not regulated by organic or Raised Without Antibiotics (RWA) standards, antibiotic-resistant bacteria may migrate from grandmother flocks to parent flocks and subsequently to broiler flocks in chicken production. This may have an impact on the level of contamination in marketed goods. Additionally, previous studies have demonstrated that the use of antibiotics in egg injections can greatly boost the growth of antibiotic-resistant germs in chicken flesh, which can subsequently infect humans. The quality of the microbiome in various production systems may also be impacted by cross-contamination and post-slaughter processing [17,18]. Therefore, collecting detailed company-level information on antibiotic use during post-growing.

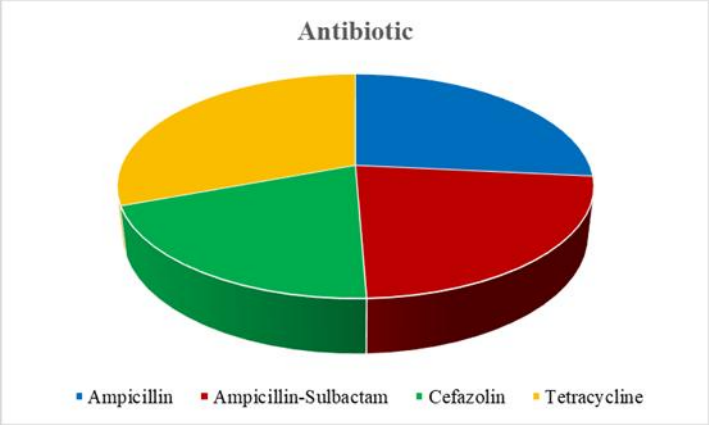

Figure 2. Antibiotic Resistance in Poultry: Resistance Ratios Across Different Antibiotics in Chicken Products.

Implementing protocols at various stages of production and post-slaughter processes could help identify the key factors that contribute to the presence of antibiotic-resistant bacteria in poultry products on the market. The results indicate a clear association between antibiotic use in poultry farming and increased levels of *E. coli* resistance.

The study showed that resistance was more common in conventionally produced poultry, indicating that antibiotics are more frequently used in these systems compared to dry farming systems. However, no significant differences in resistance were found between the various poultry production categories, suggesting that factors other than production methods may play a larger role in determining resistance levels. Importantly, resistance levels were more strongly linked to the brand of poultry products, suggesting that company-specific policies regarding production and processing could significantly influence resistance, including antibiotic use variations. This underscores the need to evaluate the internal practices of agricultural companies and their impact on product safety.

The study also revealed widespread tetracycline resistance across all production categories, implying that

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resistance may persist even after discontinuing the antibiotic, highlighting the complexity of addressing antibiotic resistance in agriculture. Given these results, it can be concluded that current regulations are insufficient in tackling antibiotic resistance effectively. There is a clear need for stronger monitoring and regulation of antibiotic practices at the company level. To improve antibiotic use management in the poultry industry, comprehensive and unified policies should be implemented throughout all production stages to reduce resistance development and safeguard food safety.

Conclusion

In conclusion, this study highlights the growing concern of antibiotic-resistant (*E. coli*) in poultry products, especially in conventional farming systems, where antibiotic use contributes to higher resistance rates. The findings underscore the urgent need for stricter regulations and more effective monitoring of antibiotic use at both the company and industry levels. Implementing comprehensive, standardized policies throughout all stages of production is essential to reduce resistance development and ensure the safety of poultry products.

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Conflicts of Interest

The authors declare no conflicts of interest.

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المستخلص

تبحث هذه الدراسة في انتشار مقاومة المضادات الحيوية لبكتيريا الإشريكية القولونية في لحوم الدواجن المباعة في البيضاء، ليبيا. تم تحليل إجمالي 37 عينة من لحوم الدجاج بحثًا عن مقاومة 12 مضادًا حيويًا، باستخدام طريقة الانتشار القرصي. أشارت النتائج إلى معدلات مقاومة عالية، وخاصة للأمبيسلين، والأمبيسلين-سولباكتام، والسيفازولين، والتتراسيكلين، حيث أظهرت 48٪ من العزلات مقاومة متعددة للأدوية. أظهرت الدواجن التي يتم تربيتها تقليديًا مقاومة أعلى بكثير للجنتاميسين، المستخدم عادة في لقاحات البيض. لم تجد الدراسة أي اختلافات كبيرة في المقاومة عبر فئات الإنتاج، لكن العوامل الخاصة بالعلامة التجارية كانت مرتبطة بقوة بمستويات المقاومة. تشير هذه النتائج إلى أن استخدام المضادات الحيوية في إنتاج الدواجن، وخاصة في الأنظمة التقليدية، يساهم في زيادة المقاومة، مما يؤكد على الحاجة إلى تحسين اللوائح ومراقبة استخدام المضادات الحيوية في جميع مراحل الإنتاج لضمان سلامة الغذاء والحد من انتشار المقاومة.

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