



# Occurrence and Antimicrobial Susceptibility Profiles of *Escherichia coli* O157 Isolated from Beef and Poultry Meat in Khartoum State, Sudan

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

*Escherichia coli* O157 is a major food-borne pathogen transmitted by consuming contaminated food and water. This study was conducted between January and April 2021 on 400 samples of beef and poultry meat to determine the occurrence and antimicrobial susceptibility profiles of *E. coli* O157 in Khartoum State, according to the methods of ISO 16654 and Clinical and Laboratory Standards Institute (CLSI). The overall presence rate was found to be 1.7% (7/400). Two isolates were recovered from 200 beef meat samples (1%) and five isolates from 200 poultry meat samples (2.5%). All isolates were sensitive to ciprofloxacin and trimethoprim-sulfamethoxazole, but all were resistant to ampicillin (100%). Six isolates (85.7%) showed resistance to tetracycline, and five (71.4%) to gentamicin. Three isolates (42.8%) showed intermediate sensitivity to ceftazidime, and others (42.8%) were resistant to it. Six isolates (85.5%) showed multiple drug resistance (MDR). This study revealed the presence of resistant isolates in beef and poultry meat. To reduce the incidence of foodborne *E. coli* O157 species and antimicrobial resistance in Khartoum State, scientists and public health researchers need to know that *E. coli* O157 is present in beef and poultry meat in the region.

**Keywords:** *E. coli* O157; beef; poultry; antimicrobial resistance; MDR; Khartoum State; Sudan.

## 1. INTRODUCTION

“The enterohemorrhagic *E. coli* O157 is an emerging foodborne pathogen of public health concern and is one of the most common causes of foodborne infections in humans” [1]. “*E. coli* O157 infections have been linked to ground beef, raw milk, dairy products, vegetables, unpasteurized fruit juices, water, and direct contact with ruminant feces” [2].

“Lethal hemolytic uremic syndrome (HUS), bloody and non-bloody diarrhea, thrombotic thrombocytopenic purpura (TTP), and hemorrhagic colitis (HC) are all serious clinical syndromes caused by *E. coli* O157” [3]. The potent Shiga toxins *stx1* and *stx2* are the most important virulence factors in *E. coli* O157 infections [4].

Ingestion of contaminated food, water, and person-to-person transmission via the fecal-oral route have all been linked to human infection by *E. coli* O157 serotype. Ruminant and poultry meats are thought to be the main reservoirs of *E. coli* O157. The ease with which *E. coli* O157 can spread from one person to another indicates that the infectious dose is low. Furthermore, transmission by water, which would dilute the organisms, supports this theory. The infectious dose was estimated to be 10-100 CFU based on epidemic data [5].

“Antimicrobial resistance in *E. coli* O157 is a significant factor that can increase the bacterium's pathogenicity. High levels of resistance have been found in food samples, particularly meat. The resistance is mainly

against commonly used groups of antibiotics, including aminoglycosides, macrolides, cephalosporins, sulfonamides, fluoroquinolones, and tetracyclines” [6].

In Sudan, recent and detailed information on the occurrence and antimicrobial susceptibility profile of *E. coli* O157 is limited. Therefore, the present study was conducted to add more information regarding the occurrence and antibiotic susceptibility profiles of *E. coli* O157 in beef and poultry meat. This study aimed to determine the occurrence and antimicrobial resistance of *E. coli* O157 in beef and poultry meat in Khartoum State, Sudan.

## 2. MATERIALS AND METHODS

### 2.1 Study Design

This is a cross-sectional descriptive and laboratory-based study.

### 2.2 Study Population

The sample size required for the study was estimated to be 400 bacterial isolates with a power of 50% and a confidence level of 95% using the website [www.calculator.net](http://www.calculator.net).

### 2.3 Study Area and Sampling Technique

A total of 400 samples (200 beef and 200 poultry meat) were collected from the three cities of Khartoum State (Khartoum, Khartoum North, and Omdurman) between January and April 2021. Each collected beef and poultry cut was placed

in a sterile container and put into an ice bag, then transported to the laboratory on the day of collection for bacteriological investigation.

### 2.4 Isolation and Identification of *E. coli* O157

This was performed according to the methods of ISO 16654 [7]. Twenty-five grams of beef and poultry meat were transferred into a flask containing 225 ml of modified tryptone soya broth (Oxoid, Basingstoke, UK) and incubated at 37°C for 24 h. A loop-full of suspension was streaked onto cefixime tellurite-sorbitol MacConkey agar (Oxoid). The plates were incubated at 37°C for 24 h and checked for growth of typical *E. coli* O157, 1-2 mm colorless colonies. Presumptive *E. coli* O157 colonies were identified by Indole test and growth on Triple sugar iron agar (Oxoid) and Latex agglutination test (Oxoid, Basingstoke, UK).

## 3. RESULTS

### 3.1 Occurrence of *E. coli* O157

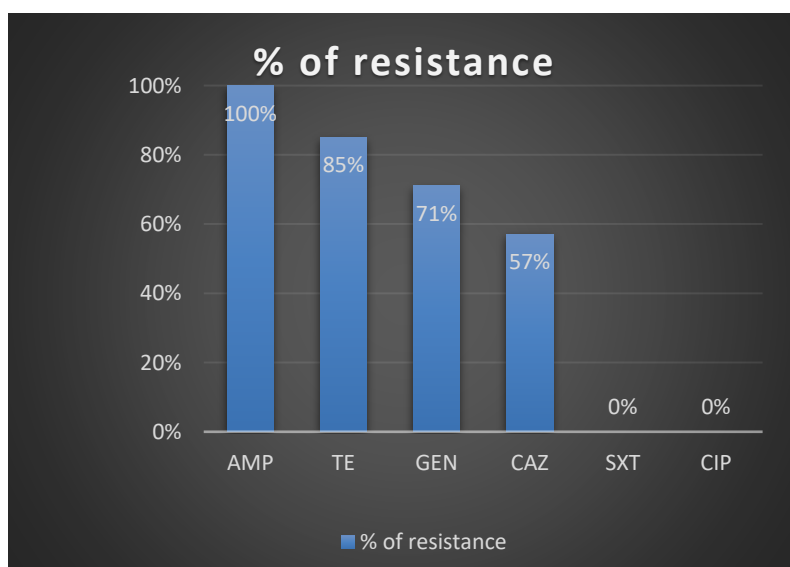
During this study, a total of 7 (1.7%) *E. coli* O157 isolates were recovered from 400 beef and poultry meat specimens. From the 200 beef meat samples, 2 isolates (1%) were obtained, and 5 (2.5%) isolates were recovered from the 200 poultry meat samples. After culturing on sorbitol MacConkey agar, the appearance of colorless colonies was presumptively considered and confirmed as the *E. coli* O157 latex agglutination test was used.

### 3.2 Antimicrobial Susceptibility Testing of *E. coli* O157 Isolates

The seven *E. coli* O157 isolates were subjected to antimicrobial susceptibility testing by using six different antimicrobial agents: ampicillin, trimethoprim-sulfamethoxazole, ciprofloxacin, tetracycline, gentamicin, and ceftazidime [8].

**Table 1. Antibiogram sensitivity/resistance pattern of *E. coli* O157 isolates to six agents**

Name	Class	Resistant No.(%)	Intermediate No.(%)	Sensitive No.(%)
Ciprofloxacin	Fluoroquinolones	0(0%)	0(0%)	7(100%)
Ceftazidime	Cephalosporins	4(57.1%)	3(42.9%)	0(0%)
Tetracycline	Tetracyclines	6(85.7%)	0(0%)	1(14.3%)
Gentamicin	Aminoglycosides	5(71.4%)	0(0%)	2(28.6%)
trimethoprim-sulfamethoxazole	Sulfonamides	0(0%)	0(0%)	7(100%)
Ampicillin	β-Lactam	7(100%)	0(0%)	0(0%)



**Fig. 1. The percentage (%) resistance of *E. coli* O157 isolates to six antimicrobial agents**

Key: AMP: Ampicillin, TE: Tetracycline, GEN: Gentamicin, CAZ: Ceftazidime, SXT: Trimethoprim-sulfamethoxazole, CIP: Ciprofloxacin

All isolates were sensitive to ciprofloxacin and trimethoprim-sulfamethoxazole; on the other hand, they were all resistant to ampicillin (100%). Six isolates (85%) showed resistance to tetracycline and five isolates were resistant to gentamicin (71%). Four isolates (57%) were resistant to ceftazidime, while three isolates showed intermediate sensitivity to it. Six isolates showed multi-drug resistance; multiple-drug resistance is the resistance of an isolate to at least one agent in three or more antimicrobial categories [9] (Table 1, Fig. 1).

#### 4. DISCUSSION

“Food of animal origin has been identified as the main vehicle for the transmission of food-borne pathogens to humans” [10]. The purpose of this study was to determine the presence of *E. coli* O157 in beef and poultry meat samples by using conventional culturing methods and Latex agglutination test. It revealed that the presence of *E. coli* O157 in raw beef and poultry meat was 1.7% (7/400).

The results show that the percentage of *E. coli* O157 contamination in beef meat is 1% (2/200); which is in line with a study conducted in Egypt [11]. *E. coli* O157 was detected in 1% of beef carcasses samples. The obtained results in this study were higher than the 0.8% [12] obtained from beef carcasses at retail shops in Ethiopia and less than the findings of [13], who isolated 8.5% *E. coli* O157 from raw beef samples from Iran.

Several studies conducted in different parts of Ethiopia showed that the presence of *E. coli* O157 in beef meat varies from 4.5% to 13.3% [14-17]. Moreover, the occurrence of *E. coli* O157 in beef meat was different in several studies performed worldwide, ranging from 1.1% in the UK [18] to 7.86% in Iran [19].

The findings of this study also show that the occurrence of *E. coli* O157 in poultry meat was 2.5% (5/200). This is in line with a study conducted by [20] in Riyadh, Saudi Arabia, in which *E. coli* O157 was detected in 2.5% of poultry meat samples. On the other hand, it disagreed with [21], who failed to isolate *E. coli* O157 from poultry meat samples in Iran. The obtained results of this study were higher than those of [11], who reported an isolation rate of 0.5% *E. coli* O157 from poultry meat samples in Egypt, and less than those of [22], who isolated

*E. coli* O157 from 7.3% poultry samples collected from Korea.

Generally, studies on the presence of *E. coli* O157 in poultry meat are limited. The occurrence of *E. coli* O157 in poultry meat was different than in several studies worldwide, ranging from 0.5% in Egypt (11) to 8% in Iran [23]. Improper meat handling and unhygienic practices during cutting and processing lead to cross-contamination of meat and can cause food-borne outbreaks.

In this study, all the isolates were sensitive to ciprofloxacin and trimethoprim-sulfamethoxazole, but on the other hand, they were all resistant to ampicillin. Six isolates (85%) showed resistance to tetracycline, while five (71%) to gentamicin and four (57%) to ceftazidime, while three isolates showed intermediate sensitivity to this latter drug.

The presence of high levels of *E. coli* O157 resistance in beef and poultry meat may be attributed to the uncontrolled use of antibiotics in veterinary medicine. This result is on track with a study conducted by [24], where all isolated strains of *E. coli* O157 exhibited resistance to ampicillin and were susceptible to ciprofloxacin and trimethoprim-sulfamethoxazole; tetracycline resistance was detected in (70%) of isolates.

Another study in Ethiopia demonstrated that 85.5% to 96.3% of *E. coli* O157 were susceptible to third-generation cephalosporin, ciprofloxacin, and gentamicin, and about 92.6% of *E. coli* O157 were resistant to ampicillin [25].

#### 5. CONCLUSION

To our knowledge, this is the first work on the occurrence of *E. coli* O157 from beef and poultry meat in Sudan. Despite the low occurrence, this is a public health issue and should not be underestimated, taking into consideration that proper meat inspection in Khartoum State is questionable; therefore, hygienic practices in slaughterhouses and butcher shops should receive particular attention. The presence of *E. coli* O157, even at low levels, maybe a warning signal for the possible occurrence of food-borne disease. This study indicated that multi-drug resistant *E. coli* O157 isolates were common, which requires preventative action at any point in the food production chain.

## DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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