Original article

Prevalence and antimicrobial resistance of *Escherichia coli* O157 from mutton meat in Khartoum State, Sudan

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**Abstract**

*Escherichia coli* O157 is recognized as a major food-borne pathogen of great concern which can be transmitted by consumption of meat and meat products. **Aim:** This cross sectional study was conducted to determine the prevalence and antimicrobial resistance of *E. coli* O157 in mutton meat from butcher shops in Khartoum State, Sudan. **Methods:** A total of 500 mutton meat carcass swabs were collected in the period March-December 2021 and processed according to ISO16654:2001 methods. Six antibiotics were used to evaluate antimicrobial susceptibility by disc diffusion method according to the guidelines of CLSI. **Results:** The results showed that the prevalence of *E. coli* O157 was 1% (5/500) from mutton meat. All isolates were sensitive to amikacin 5 (100%), while all isolates were resistant to ampicillin 5 (100%). For other antimicrobials, the resistance was cotrimoxazole 4 (80%), cefuroxime and cefotaxime 3 (60%). Three out of five isolates (60%) showed multiple drug resistance (MDR). **Conclusions:** The findings of this study demonstrated that *E. coli* O157 was present in mutton meat and frequently exhibited multiple drug resistance. Proper manufacturing processes and regular antimicrobial resistance monitoring should be taken into account.

**Introduction**

*Escherichia coli* (E. coli) O157 is a common Shiga toxigenic *E. coli* (STEC). A significant zoonotic and foodborne pathogen in charge for the majority of serious cases of human enterohemorrhagic *E. coli* (EHEC) diseases in the world [1].

*Escherichia coli* O157 can cause several dangerous diseases for humans including hemolytic colitis (HC), hemolytic-uremic syndrome (HUS), and thrombotic thrombocytopenia purpura (TTP) [2,3].

The main virulence factors of STEC are Shiga toxins, which can be divided into two subfamilies, Stx1 and Stx2, encoded by *stx1* and *stx2* genes [4].

The global burden of Shiga toxin *E. coli* (STEC) revealed that STEC causes about 2.8 million acute illnesses with an incidence rate of 43.1 cases per 100,000 person/year, 3,890 cases of HUS, 270 cases of end-stage renal disease (ESRD) and 230 deaths annually of which 10% can be attributed to *E. coli* O157. The incidence rate of STEC infections was estimated to range from 0.6 STEC illnesses per...
100,000 person-years in the African sub-regions, to 136 per 100,000 person-years in the Eastern Mediterranean sub-regions [5].

Human infections of *E. coli* O157 are associated with consumption of contaminated beef meat, raw milk, dairy products, vegetables, unpasteurized fruit juices and water [2].

Antimicrobial resistance has become a major health concern as it can lead to treatment failure which in turn can lead to death [6]. The use of antibiotics in animal production is thought to be a major contributor to the spread of antimicrobial resistant bacteria from livestock to humans [7]. Additionally, there have been increasing reports on the development of antimicrobial resistance to *E. coli* O157 [8]. Occurrence of resistant *E. coli* O157 strains isolated from animals, foods, and humans has been reported worldwide [9,10].

The lack of appropriate farm management practices and/or strict sanitary condition during the production process, handling and marketing of meat can lead to the transfer of *E. coli* O157 to the meat and its related food products, particularly, mutton meat. To our knowledge, there has been no prior study on prevalence of *E. coli* O157 from mutton meat in Sudan. This study aimed to determine prevalence and antimicrobial resistance of *E. coli* O157 from mutton meat in Khartoum state.

**Material and methods**

**Sampling**

This descriptive cross-sectional study was conducted between March-December 2021. A total of 500 mutton carcass swabs were randomly collected from butcher shops in Khartoum State (Khartoum, Khartoum North and Omdurman). Sampling was done according to the methods of Cheesbrough [11]. The samples were kept in ice thermal box under hygienic condition and transported to the microbiology laboratory at Ahfad University for Women at the day of collection.

**Isolation and identification of *E. coli* O157**

*Escherichia coli* O157 was isolated according to the method described in ISO16654:2001 [12] with some modifications. Each swab was pre-enriched in 9 ml of modified tryptone soya broth (Oxoid, UK) and incubated at 37°C for 24 h. Enriched culture were streaked onto sorbitol MacConkey agar, supplemented with cefixime and potassium tellurite (Oxoid, UK). The plates were incubated at 37°C for 24 h and examined for typical *E. coli* O157 colonies. The suspected *E. coli* O157 (colorless, sorbitol negative colonies) were picked and sub-cultured onto nutrient agar slope and identified by indole test, growth in Kligler Iron agar and latex agglutination test (Oxoid, UK).

**Antimicrobial susceptibility testing:**

The isolated *E. coli* O157 strains were tested for antimicrobial susceptibility according to guidelines Clinical and Laboratory Standards Institute (CLSI) [13] by using disc diffusion method in Muller-Hinton agar against six antimicrobial agents: amikacin (30 µg), ampicillin (10 µg), cefuroxime (30 µg), cotrimoxazole (25 µg), cefotaxime (30 µg) and tetracycline (30 µg).

**Results**

In present study five isolates (1%) of *E. coli* O157 were recovered from 500 swab samples of mutton meat in Khartoum State.

Testing of the five *E. coli* O157 isolates against six different antimicrobial agents showed variable results. All isolates were sensitive to amikacin 5 (100%), while all isolates were resistant to ampicillin 5 (100%). For other antimicrobials, the resistance was cotrimoxazole 4 (80%), cefuroxime 3 (60%), cefotaxime 3 (60%), amikacin and tetracycline 0 (0%), respectively, while one isolate (20%) showed intermediate resistance to tetracycline (Table 1) and (Figure 1). Three isolates showed multiple drug resistance (60%), MDR is recorded whenever, the isolate is resistant to there or more antimicrobial groups, The MDR pattern was same for the three isolates which was ampicillin, cefuroxime, cefotaxime and co-trimoxazole. (AM, CXM, CTX, COT)
Figure 1. Histogram of the percentage % resistance of *E. coli* O157 isolates to different antimicrobial agents

![Histogram of resistance percentage](image)

Key: AM: Ampicillin, COT: Cotrimoxazol, CTX: Cefotaxime, CXM: Cefuroxime, TE: Tetracycline, AK: Amikacin

Table 1. Antibiotic sensitivity/resistance pattern of *E. coli* O157 isolates

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Resistant</th>
<th>Intermediate</th>
<th>Sensitive</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No (%)</td>
<td>No (%)</td>
<td>No (%)</td>
</tr>
<tr>
<td>Amikacin</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>5 (100%)</td>
</tr>
<tr>
<td>Ampicillin</td>
<td>5 (100%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Cefuroxime</td>
<td>3 (60%)</td>
<td>0 (0%)</td>
<td>2 (40%)</td>
</tr>
<tr>
<td>Cefotaxime</td>
<td>3 (60%)</td>
<td>0 (0%)</td>
<td>2 (40%)</td>
</tr>
<tr>
<td>Co-trimoxazole</td>
<td>4 (80%)</td>
<td>0 (0%)</td>
<td>1 (20%)</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>0 (0%)</td>
<td>1 (20%)</td>
<td>4 (80%)</td>
</tr>
</tbody>
</table>

Discussion

Food borne infections are major health problem in developing countries, including Sudan. This study established the prevalence of 1% (5/500) of *E. coli* O157 from mutton meat in Khartoum State. This is the first detailed report of the prevalence *E. coli* O157 from mutton meat in Sudan.

The findings suggest the presence of *E. coli* O157 on carcass might be due to cross contamination with abattoir environment so the carcass contamination might come from potable water that the abattoir used for washing the carcass parts. The association of some risk factors with carcass contamination has been linked to feces [14,15] and skin [16]. *E. coli* O157 has been reported to spread easily onto carcass surfaces from the hide or during evisceration [14,17,18]. Meat is frequently found to be contaminated due to poor sanitary environment during slaughter, transportation and handling [19].

The findings of this study are similar to the results of Duffy et al. [20] in Australia who obtained a prevalence of 1.3% *E. coli* O157 from sheep meat. While Battisti et al. [21] in Italy 0.7% prevalence, which is lower than our results. In contrast, the results obtained are less than 2.5% of Hiko et al. [22] in Ethiopia and less than 4.8% of Rahimi et al. [23], 3.92% of Shekarfroush et al. [24] and 6.8% of Jafaryan-Sedigh et al. [25] in Iran. Also lower than 3.2% of Messele et al. [26] in Ethiopia. The variation in prevalence may be attributed to hygienic conditions and methods of isolation.

Antimicrobial susceptibility testing in this study showed that all isolates are sensitive to amikacin 5 (100%) and tetracycline 4 (80%) which is similar to the results of Hiko et al. [22] in Ethiopia and all of the isolates were resistant to ampicillin 5 (100%), co-trimoxazole 4 (80%) which is higher than the results of Messele et al. [26] in Ethiopia. In this study the results showed multidrug resistances was found in 60% of the isolate *E. coli* O157. The
occurrence of MDR was recorded previously ranging from 22.6% to 100% [22,27,28].

The wide spread and imprudent use of antibiotics in food animals is thought to be accountable for the emergence and wider spreading of antimicrobial resistant (AMR) bacteria in humans [29,30]. In humans, positive selection for drug resistant bacteria has also been reported in the normal microflora of exposed individuals or populations. This indicates that antibiotic resistance can be developed in both commensal and pathogenic bacterial strains and can even be transferred to other bacterial strains, including other pathogenic and environmental bacteria [31].

Conclusion
This study showed that E. coli O157 is present in mutton meat; our results showed high multiple drug resistance which poses risk to public health. In general, this study provides a baseline of E. coli O157 prevalence and antimicrobial resistance in mutton meat. Food handlers should be trained to apply good hygiene practices and good manufacturing practice to produce safe food for final consumer.

Conflicts of interest : None.

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