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Review Article

Detection of *Salmonella* and *E. coli* in Street-Vended Shawarma in Iraq: A Mini Review

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Abstract: ***Background***: Shawarma is one of the most popular street foods in Iraq and the Middle East. However, its preparation and sale in open-air environments with poor hygienic practices pose a significant risk for microbial contamination. This study investigates the presence of *Salmonella* spp. and *Escherichia coli* in shawarma, analyzes contributing factors to contamination, and assesses the associated public health implications. ***Methods***: A literature-based review approach was used, drawing on recent regional studies and reports from global health agencies. Emphasis was placed on contamination rates, hygiene practices among vendors, antibiotic resistance patterns, and risk factors linked to meat handling and storage. ***Results***: Studies from Iraq and neighboring countries report *Salmonella* contamination rates in shawarma ranging from 7–15%, while *E. coli*, particularly O157:H7, has been detected in up to 20% of samples. Major contributing factors include inadequate cooking, cross-contamination, poor personal hygiene, and environmental exposure. Alarmingly, many of the isolated strains exhibit multidrug resistance. ***Conclusion***: The consumption of shawarma from unregulated street vendors in Iraq presents a serious public health concern due to microbial and antibiotic-resistant contamination. The lack of food safety monitoring and regulatory enforcement further exacerbates this issue. ***Recommendations***: Regulatory authorities must implement hygiene standards, establish routine microbial testing, conduct awareness and training campaigns for vendors, and monitor antibiotic resistance patterns to ensure food safety and protect public health.

Keywords: Shawarma, *Salmonella*, *E. coli*, street food, Iraq, foodborne pathogens, antibiotic resistance, public health.

1. INTRODUCTION

Shawarma is one of the most widely consumed meat-based fast foods in Iraq and across the Middle East, appreciated for its taste, affordability, and availability. Typically prepared from seasoned meat such as beef, lamb, or chicken, it is cooked on a vertical rotisserie and shaved off in layers for immediate serving. However, despite its popularity, shawarma sold by street vendors is frequently prepared under substandard hygienic conditions, exposing it to microbial contamination and posing significant food safety risks (WHO, 2023; FAO, 2022).

The nature of shawarma preparation—especially the continuous slicing of partially cooked meat, the use of unrefrigerated ingredients, and the reuse of cooking surfaces—creates an ideal environment for the growth and transmission of foodborne pathogens. The absence of standardized sanitation practices, particularly in informal markets, further exacerbates this issue in developing countries like Iraq, where regulatory oversight is limited (Jumaa *et al*., 2021).

Salmonella spp. and *Escherichia coli* (*E. coli*) are among the most frequently isolated bacteria in contaminated meat products, including shawarma. These microorganisms are well-documented causes of foodborne illnesses, leading to symptoms that range from mild gastrointestinal distress to severe systemic complications such as hemolytic uremic syndrome (HUS) (CDC, 2023). Studies from various Iraqi cities have reported alarmingly high rates of bacterial contamination in ready-to-eat meat, often linked to poor

vendor hygiene, lack of refrigeration, and improper meat storage (Hussein *et al*., 2022; Al-Janabi *et al*., 2020).

The public health implications are especially serious for vulnerable populations, such as children, the elderly, and immunocompromised individuals. Moreover, the emergence of antibiotic-resistant strains of *Salmonella* and *E. coli* in street food raises further concern, as it complicates treatment and increases the risk of outbreaks with limited therapeutic options (WHO, 2023; EFSA, 2022).

Therefore, understanding the microbial risks associated with shawarma and other popular street foods is crucial for developing effective food safety policies, surveillance programs, and public health interventions in Iraq and similar contexts.

2. *Salmonella* Contamination in Shawarma

Salmonella spp. are among the leading bacterial causes of foodborne illnesses worldwide, often linked to the consumption of undercooked or improperly handled meat. Several studies from the Middle East have reported notable prevalence rates of *Salmonella* in shawarma meat. For example, studies from Lebanon and Saudi Arabia found contamination rates ranging from 10% to 15% in shawarma samples (Araj *et al*., 2016; Alzahrani *et al*., 2018). In Iraq, a study conducted in Erbil reported the presence of *Salmonella* in 7.1% of grilled chicken samples, underscoring a comparable public health risk (Yousif *et al*., 2019).

Contamination may occur at multiple stages including slaughter, storage, marination, or due to cross-contamination from unclean surfaces and utensils. According to the World Health Organization (WHO, 2023), insufficient cooking and prolonged exposure of meat to ambient temperatures are among the key factors that allow *Salmonella* to proliferate.

3. *Escherichia coli* Contamination in Shawarma

Escherichia coli (E. coli), particularly the pathogenic strain O157:H7, is another major concern in street-vended meat products like shawarma. It can cause severe gastrointestinal illness and, in extreme cases, life-threatening complications such as hemolytic uremic syndrome (HUS). A study in Egypt found *E. coli* contamination in 20% of shawarma samples, many of which showed multidrug-resistant profiles (Fahim *et al*., 2022). In Iraq, *E. coli* O157:H7 was detected in 7.9% of meat samples collected from Kirkuk (Mohammed *et al*., 2021), indicating widespread contamination and resistance trends.

These bacteria are usually introduced through fecal contamination during slaughter or meat handling, especially when hygiene practices are inadequate. Improper hand hygiene among vendors, along with unsafe meat storage and undercooked products, contributes significantly to the risk of infection (CDC, 2023; WHO, 2023).

4. Factors Contributing to Bacterial Presence in Street Shawarma

Several environmental, behavioral, and procedural factors contribute to the microbial contamination of shawarma in street food settings:

- Lack of temperature control: Shawarma is typically cooked on vertical rotisseries and may be left exposed for long hours. If the internal temperature of the meat is not consistently high, bacterial growth may occur (Taha & Abdullah, 2020; FAO, 2022).
- Cross-contamination: Shared knives, cutting boards, and serving surfaces between raw and cooked meat are major vectors for bacterial transmission (FAO, 2019).
- Poor personal hygiene: Many street vendors do not wear gloves or wash their hands regularly, increasing the risk of contaminating the meat during preparation and serving (Hussein *et al*., 2022).
- Environmental exposure: Open-air environments expose food to dust, flies, and other contaminants, which significantly increase the likelihood of microbial contamination.

5. Public Health Implications

Foodborne illnesses caused by *Salmonella* and *E. coli* pose significant health threats, particularly in countries where street food is widely consumed and poorly regulated. In Iraq, the lack of strict enforcement of food safety standards raises the potential for outbreaks, especially in densely populated urban areas.

Moreover, the increasing prevalence of antibiotic-resistant bacterial strains complicates treatment and containment efforts (EFSA, 2022; Mohammed *et al*., 2021). These infections not only lead to morbidity and mortality but also burden the healthcare system with increased costs and reduced productivity. Public health strategies, including awareness campaigns, routine microbial testing, and vendor training programs, are essential to mitigate these risks and protect consumer health (WHO, 2023; FAO & WHO, 2022).

6. CONCLUSION

This study highlights the significant risk of bacterial contamination in shawarma, particularly with *Salmonella* spp. and *Escherichia coli*, both of which are major foodborne pathogens. The findings from Iraq and neighboring countries consistently demonstrate that improper food handling, lack of hygiene among vendors, inadequate temperature control, and environmental exposure are key contributors to contamination. The detection of multidrug-resistant strains further complicates the public health burden, making treatment less effective and more costly.

In Iraq, where street food plays an essential role in daily nutrition for many people, the absence of strict regulatory frameworks exacerbates these risks. It is imperative to recognize shawarma and similar ready-to-eat street foods as potential sources of foodborne outbreaks, especially among vulnerable populations such as children, the elderly, and immunocompromised individuals.

7. RECOMMENDATIONS

To minimize the risk of bacterial contamination and improve public health safety, the following recommendations are proposed:

1. Implementation of strict hygiene regulations: Local authorities should establish and enforce food safety standards for street vendors, particularly for meat-based foods like shawarma.
2. Regular microbiological surveillance: Routine testing of shawarma samples for pathogens such as *Salmonella* and *E. coli* should be conducted by food safety agencies and public health departments.
3. Vendor training programs: Food handlers and street vendors should receive training in personal hygiene, proper food storage, safe cooking temperatures, and cross-contamination prevention techniques.
4. Public awareness campaigns: Educational initiatives should target consumers and vendors alike to increase awareness about the dangers of foodborne pathogens and the importance of food safety practices.
5. Monitoring antibiotic resistance: Continuous monitoring of antimicrobial resistance in foodborne bacteria is crucial to guide treatment options and develop effective control strategies.
6. Promotion of safe food environments: Infrastructure improvements, such as clean cooking stations, access to clean water, and waste disposal systems, should be promoted in areas with dense street food activity.

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