American Journal of Nursing and Health Sciences
2025, Vol. 6, No. 1, pp. 16-18
https://doi.org/10.11648/j.ajnhs.20250601.12

Research Article

Virulent and Multidrug-Resistant STEC Non-O157:H7 in Raw Milk in Khyber Pakhtunkhwa Pakistan: The Need for Proper Quality Surveillance and Assurance Plans

Safir Ullah[1, *], Sana Ullah[1], Muhammad Jamil Khan[2]

[1]Veterinary Research Diseases Investigation Center (VR&DIC) Chitral, Khyber Pakhtunkhwa, Pakistan

[2]Department of Allied Health Sciences, Iqra National University, Phase Two Hayatabad, Peshawar, Khyber Pakhtunkhwa, Pakistan

Abstract

Shiga toxin-producing *Escherichia coli* (STEC), particularly the non-O157:H7 strains, present a major and growing public health threat in Khyber Pakhtunkhwa, Pakistan. This region, like many others in the country, has a high rate of raw milk consumption, which is often unpasteurized. Raw milk serves as a potential vehicle for STEC transmission due to its susceptibility to contamination at various stages of production, handling, and distribution. These strains of *E. coli* are highly virulent, and their ability to produce Shiga toxins makes them particularly unsafe. Infections caused by STEC can result in severe foodborne illnesses, such as hemolytic uremic syndrome (HUS), which primarily affects young children and the elderly. A key concern adjoining STEC is their increasing resistance to multiple antibiotics. Multidrug resistance complicates the treatment process, and increasing the possibility of complications. Moreover, these pathogens often go undetected due to inadequate testing facilities and limited public awareness, especially in rural and semi-urban areas. Given these risks, there is an urgent need to implement effective quality surveillance and assurance strategies in the dairy sector. Regular monitoring and microbial testing of milk at both the farm and market levels are essential to detect contamination early. In addition, promoting better hygiene practices among dairy workers and ensuring the cleanliness of equipment can significantly reduce the risk of contamination. Pasteurization of milk should be strongly encouraged to reduce pathogenic microorganisms before consumption. In addition, antibiotic stewardship must be emphasized in dairy farming to prevent the misuse of antibiotics, which contributes to the rise of resistant bacterial strains. By adopting these preventative measures and strengthening regulatory oversight, the health risks associated with STEC in raw milk can be significantly reduced, ultimately safeguarding public health in the region.

Keywords

STEC, Raw Milk, HUS, KPK

[*]Corresponding author: drsafirvri@gmail.com (Safir Ullah)

Received: 27 March 2025; **Accepted:** 16 April 2025; **Published:** 9 May 2025

1. Introduction

Shiga toxin-producing *Escherichia coli* (STEC) is a major pathogen of concern in food safety due to its ability to cause severe foodborne illnesses. Among the different strains of STEC, non-O157:H7 serogroups have been recognized as emerging threats, particularly in developing countries like Khyber Pakhtunkhwa province, Pakistan. This non-O157:H7 strains are known to be highly virulent and display resistance to multiple antibiotics, making them a significant challenge for public health. Raw milk, a commonly consumed product in Pakistan, can serve as a vehicle for the transmission of these pathogens if not properly handled and processed. In this circumstance, this report explores the scientific background of virulent and multidrug-resistant STEC non-O157:H7 in raw milk in Khyber Pakhtunkhwa Pakistan, focusing on the need for effective quality surveillance and assurance plans to mitigate the public health risks associated with these pathogens.

2. Shiga Toxin-Producing *E. coli* (STEC) and Its Impact on Public Health

E. coli is a diverse group of bacteria, but specific strains like STEC are capable of producing toxins called Shiga toxins (Stx), which can cause severe gastrointestinal diseases in humans, such as bloody diarrhea, hemolytic uremic syndrome (HUS), and kidney failure [1] While *E. coli* O157:H7 is the most well-known and widely studied strain of STEC, non-O157:H7 serogroups, including *E. coli* O26, O111, O145, and others, have been increasingly associated with human infections in recent years [2]. These strains share many of the pathogenic characteristics of *O157:H7*, including the ability to produce Shiga toxins (stx) genes, but they are often more difficult to detect and may be more widespread in foodborne outbreaks [3].

3. The Role of Raw Milk in STEC Transmission

Raw milk, due to its least processing, is considered a high-risk food product for microbial contamination, including *E. coli*. In Khyber Pakhtunkhwa, the consumption of raw milk is common, particularly in rural areas, due to cultural preferences and limited access to pasteurized milk. The presence of pathogens like STEC in raw milk is largely attributed to contamination during the milking process, handling, and storage. Dairy animal can become infected with STEC through fecal contamination in the environment, and once contaminated, milk can harbor the pathogen if not properly refrigerated or pasteurized [4]. In addition to *E. coli*, other pathogens such as *Salmonella* and *Listeria monocytogenes* can also be present in raw milk, contributing to a higher risk of foodborne diseases. However, the role of non-O157:H7 strains in milk contamination have received less attention than O157:H7, although evidence suggesting that non-O157:H7 strains may be equally, if not more, virulent in some cases [5].

4. Virulence Factors of STEC Non-O157:H7

The virulence of *E. coli* strains is primarily associated with their ability to produce Shiga toxins. These toxins target the endothelial cells in blood vessels, causing damage to the intestinal lining and potentially leading to HUS. Non-O157:H7 strains, despite their genetic diversity, possess similar virulence factors to *O157:H7*, including the *stx1* and *stx2* genes that encode for Shiga toxins [6]. Additionally, these strains can carry other virulence factors such as intimin, *(eae*) gene a protein that facilitates the attachment of the bacteria to host cells, and enterohemolysin (*ehx*A) gene, which contributes to cell damage [7]. The virulence potential of non-O157:H7 strains in raw milk is particularly concerning because these strains can be present without immediate signs of contamination, making detection challenging. Studies have indicated that non-O157:H7 strains may be more prevalent in certain geographic areas, including parts of India, where surveillance systems are less robust [8].

5. Multidrug Resistance in Non-O157:H7 Strains

In calculation to their virulence, many non-O157:H7 strains of *E. coli* are becoming increasingly resistant to multiple antibiotics, a trend that poses a significant threat to public health [9]. Antibiotic resistance in *E. coli* is often acquired through horizontal gene transfer, which can occur within animal populations or between different bacterial species. The use of antibiotics in livestock, including dairy cows and buffalo, is one factor contributing to the development of resistance in foodborne pathogens [10]. The multidrug resistance in non-O157: H7 strain complicates treatment options for infections in humans. Infections caused by resistant strains can lead to prolonged illness, increased healthcare costs, and a higher risk of complications. The development of such resistance is particularly concerning in the context of foodborne pathogens like STEC, as antibiotics are typically not recommended for treatment due to concerns over increasing the risk of HUS [5]. Furthermore, the presence of multidrug-resistant STEC in raw milk means that consumers are at risk of exposure to these resistant pathogens, which could potentially lead to public health crises if not addressed.

6. Need for Proper Quality Surveillance and Assurance Plans in Khyber Pakhtunkhwa Pakistan

Particular the growing concern over virulent and multi-drug-resistant STEC non-O157:H7 strains in raw milk, there is an urgent need for effective quality surveillance and assurance plans in Pakistan. Several key strategies can be implemented to mitigate the public health risks associated with these pathogens.

1) *Surveillance Systems:* Surveillance programs should be established to monitor the prevalence of STEC, including non-O157:H7 strains, in milk production and distribution chains. This should include routine screening of raw milk for *E. coli* contamination, as well as specific tests for Shiga toxins [4]. Implementing a national surveillance system would help identify outbreaks early and prevent the spread of infection.
2) *Hygiene and Sanitation:* Proper hygiene and sanitation practices during milking, handling, and storage are crucial in preventing contamination of raw milk with pathogens like STEC. Educational programs should be introduced for dairy farmers and milk handlers to ensure proper sanitation and handling techniques. Additionally, enforcing regulations regarding the cleanliness of dairy farms and milk processing facilities could further reduce contamination risks.
3) *Pasteurization:* One of the most effective ways to eliminate STEC from milk is pasteurization. Despite the preference for raw milk in some areas, promoting the benefits of pasteurization can significantly reduce the risk of foodborne illness. Government initiatives that encourage or mandate pasteurization, particularly in urban areas and larger dairies, could help mitigate the risk of STEC transmission.
4) *Antibiotic Stewardship:* Implementing antibiotic stewardship programs in the dairy industry is essential to limit the use of antibiotics in livestock and reduce the spread of multidrug-resistant bacteria. In addition to reducing the risk of resistant pathogens, such programs can help preserve the efficacy of antibiotics in treating human infections [10].
5) *Public Awareness and Education:* Raising awareness among the general public about the risks associated with consuming raw milk and the importance of food safety practices can help reduce the incidence of foodborne diseases. Educating consumers on proper milk handling and storage techniques can also contribute to minimizing the risk of contamination.

Abbreviations

STEC	Shiga Toxin-Producing *E. coli*
KPK	Khyber Pakhtunkhwa
HUS	Hemolytic Uremic Syndrome
AMR	Antimicrobial Resistance

Author Contributions

Safir Ullah: Conceptualization, Funding acquisition, Methodology, Project administration, Supervision, Writing – original draft

Sana Ullah: Data curation, Formal Analysis, Project administration, Software, Visualization

Muhammad Jamil Khan: Formal Analysis, Methodology, Software, Supervision, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Kaper, J. B., et al. (2004). Enterohemorrhagic Escherichia coli: An emerging foodborne pathogen. Infectious Disease Clinics of North America, 18(3), 1-35.

[2] Nataro, J. P., &Kaper, J. B. (1998). Diarrheagenic Escherichia coli. Clinical Microbiology Reviews, 11(1), 142-201.

[3] Scallan, E., et al. (2011). Foodborne illness acquired in the United States—major pathogens. Emerging Infectious Diseases, 17(1), 7-15.

[4] Jayarao, B. M., et al. (2006). Prevalence of Escherichia coli O157:H7 in milk and milk products. Journal of Dairy Science, 89(3), 787-795.

[5] Bielaszewska, M., et al. (2012). Shiga toxin-producing Escherichia coli in foodborne outbreaks. Emerging Infectious Diseases, 18(6), 918-926.

[6] Munoz, M. A., et al. (2010). Shiga toxin-producing E. coli in raw milk and its public health implications. Journal of Dairy Science, 93(3), 1020-1030.

[7] Eppinger, M., et al. (2011). Genome sequences of the O26 and O111 Shiga toxin-producing Escherichia coli strains. PLoS One, 6(4), e19348.

[8] Chakraborty, S., et al. (2011). Prevalence of non-O157 Shiga toxin-producing Escherichia coli in cattle in India. Journal of Food Protection, 74(10), 1725-1730.

[9] He, D., et al. (2017). Antibiotic resistance in Shiga toxin-producing Escherichia coli. Microorganisms, 5(1), 4.

[10] Marshall, B. M., & Levy, S. B. (2011). Food animals and antimicrobial resistance. Veterinary Research, 42(1), 1-14.