



Escherichia coli and STEC:
An overview

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1 Executive Summary

Escherichia coli (*E. coli*) is a normal inhabitant of the intestines and is necessary for nutrition and intestinal health. It is the most common facultative anaerobic bacterium in the faeces of warm-blooded animals and humans.

While most strains of *E. coli* are harmless, some can cause illness in humans; the most commonly notified in New Zealand being certain strains of shiga toxin-producing *E. coli* (STEC), in particular *E. coli* O157:H7.

Vegetables, undercooked meat and raw dairy products are internationally recognised as sources of foodborne STEC infection of humans. Other recognized routes for human infection include exposure to manure compost, animal contact, farm/zoo environments and contaminated waterways.

Notwithstanding the association internationally with foods, outbreaks or notified cases of STEC illness in New Zealand have never been identified as being caused by processed food. Furthermore, a recent study by Massey University was unable to attribute STEC illness in New Zealand to food.

The greatest risk of STEC infection in New Zealand comes from contact with the farm environment, animal contact, untreated water supplies, and consumption of raw milk.

Nevertheless, MPI is maintaining a watching brief to identify and evaluate any new data that might identify a potential foodborne route for human STEC infection in New Zealand.

2 Background

2.1 WHAT IS *ESCHERICHIA COLI*?

The bacterium *Escherichia coli* (*E. coli*) is a normal inhabitant of the intestines of warm-blooded animals and humans. As part of a normal gut microflora, *E. coli* plays a vital role in the synthesis of essential nutrients from food, such as Vitamin K, essential for blood clotting; and the metabolism of bile acids and other sterols. Furthermore, *E. coli* has two additional roles in: stimulating the secretion of mucins which form a protective barrier maintaining the health of intestinal cells allowing maximal absorption of nutrients, and in the healthy development of the human immune system which protects us from getting sick. As one of the most common facultative anaerobic bacteria in the faeces of humans and animals and, because *E. coli* is easily cultured, it is often used as an indicator organism when testing for the presence of faecal contamination in water and food.

While many of the strains of *E. coli* are harmless, some are harmful (pathogenic) causing gastroenteritis, urinary tract infections, meningitis, and other more severe secondary illnesses in humans. *E. coli* that cause diarrhoea are classified primarily by their pathogenicity and virulence properties, and/or the pattern of adherence in cell culture. They can be further classified into serotypes according to specific markers or antigens on their cell surface and hair-like structures (O-antigens and H-antigens, respectively).



The routes for infection may be foodborne, waterborne (drinking, processing or recreational), person-to-person contact or through farm environments and animal contact.

Notwithstanding the separation between harmless and pathogenic strains, *E. coli* has the ability to acquire new or modify existing genetic material resulting in new pathogenicity and virulence characteristics. This was seen recently in Europe (2011) with an outbreak (2 or more people getting ill) caused by *E. coli* O104:H4 associated with the consumption of fenugreek sprouts. This particular *E. coli*, typically associated with travellers' diarrhoea, had

acquired a number of different virulence-associated genes including those for production of shiga toxins (see Section 2.3).

2.2 WHAT ARE PATHOGENIC *E. coli*?

There are six pathogenic groups of *E. coli* that are well characterized: enteropathogenic *E. coli* (EPEC), enterotoxigenic *E. coli* (ETEC), enterohaemorrhagic *E. coli* (EHEC), enteroinvasive *E. coli* (EIEC), enteroaggregative *E. coli* (EaggEC), and diffusely adherent *E. coli* (DAEC). Most of these strains, except for EHEC, are common in developing countries and are usually waterborne.

Pathogenic *E. coli* are most likely to cause illness in susceptible groups of people such as children, elderly people and immuno-compromised individuals.

The most commonly reported group of *E. coli* that causes illness in New Zealand is the shiga toxin-producing *E. coli* (STEC), which belong to the enterohaemorrhagic *E. coli* group.

2.3 WHAT IS AN STEC?

Shiga toxin-producing *Escherichia coli* (STEC) are a group of approximately 200 different strains that cause illness by producing a toxin called “shiga toxin” (encoded by the *stx* gene). In addition to the toxin gene, they also need to adhere to the gastrointestinal tract which they do through a protein called intimin (encoded by the *eae* gene) or more rarely by a process called auto-agglutination (encoded by the *aggC/aggR* gene). The process of attachment results in a change to the intestinal wall that causes a reduction in the absorption of fluid and nutrients from the intestinal tract. This results in diarrhoea, sometimes bloody. The severity of illness is likely to be determined by the presence of additional proteins, e.g. non-LEE effectors (NLE) for other virulence traits (e.g. subtilase).

Clinical symptoms of STEC infection in humans range from mild diarrhoea to severe stomach cramps, bloody diarrhoea and vomiting. STEC infection can also result in the

development of haemolytic uraemic syndrome (HUS), which can lead to kidney failure and may be life-threatening, particularly in infants and in elderly people.

E. coli O157:H7 is universally the most common STEC associated with human illness, with a number of other serotypes (e.g, O-antigen serotypes - O26, O45, O91, O103, O111, O113, O121 and O145) also identified as important causes of human STEC infection, but less frequently.

The virulence of STECs is variable and defined into five sero-pathotype groups (A-E).

Group A: O157 alone. Causes bloody diarrhoea and frequently HUS

Group B: Less frequently causes bloody diarrhoea and HUS (includes O26, O103, O111, O121, O145 and O45)

Group C: Even less frequently causes bloody diarrhoea and HUS (includes O104, O113, O91)

Group D: Causes only diarrhoea

Group E: Never been associated with human illness

2.4 FOOD SAFETY

Internationally, foods associated with cattle (e.g. undercooked ground meat, raw dairy products) and produce (vegetables and fruit) contaminated with cattle manure compost/fertiliser or contaminated irrigation water are recognised as sources of STEC human illness.

While there have been several severe STEC outbreaks overseas associated with leafy green vegetables and sprouts, especially organically cultivated, there is little evidence to suggest that produce presents a similar risk in New Zealand.

Red meat, in particular ground beef where mincing distributes any surface contamination throughout the product, has been confirmed as a pathway for outbreaks of *E. coli* O157:H7 and the other serotypes of STEC in a number of countries. Sheep meat has only been identified in two outbreaks (Germany 2007 and Norway 2008), both involving minced meat sausages. Insufficient cooking of these types of product leaves residual live pathogens and a

risk of human illness. Intact cuts of sheep or beef meat (e.g. steaks, lamb racks, roasts) have never been associated with any notified outbreaks.

Notwithstanding the association internationally with foods, outbreaks or notified cases of STEC illness in New Zealand have never been associated with processed food. Furthermore, a recent study by Massey University was unable to attribute STEC illness in New Zealand to food.

Instead, the greatest risk of STEC infection in New Zealand comes from contact with the farm environment, animal contact, untreated water supplies, and consumption of raw milk.

E. coli is killed by exposure to heat. Heating to above 71°C for a few seconds will kill *E. coli* contaminating a food product.

Rare steak or other intact cuts of meat are safe to eat if the outside of the meat is seared. Minced, rolled (e.g. rolled roasts, rolled lamb cutlets) and blade tenderized meat should be thoroughly cooked to its centre. Raw milk should be heat treated (e.g. pasteurised or scolded) prior to consumption.

2.5 GLOSSARY OF TERMS

Antigen –a foreign protein which induces an immune response in the body, particularly the production of antibodies; in this case proteins present on the surface of a bacterium.

Facultative anaerobic bacterium - is a bacterium which normally grows in the presence of oxygen (aerobically) but can, when necessary, also grow in the absence of oxygen (anaerobically).

Serotype - a group of bacteria with common surface antigens.

2.6 ADDITIONAL READING

MPI Food Safety Handling Tips: Clean, Cook, Chill

<http://www.foodsmart.govt.nz/food-safety/tips/>

MPI FoodSmart Foodborne Illnesses: General Information - *E. coli*

<http://www.foodsmart.govt.nz/food-safety/foodborne-illnesses/e-coli-0157/>

<http://www.foodsmart.govt.nz/food-safety/foodborne-illnesses/e-coli-0157/questions-answers.htm>

Ministry of Health: *Escherichia coli* (*E. coli*)

<http://www.health.govt.nz/your-health/conditions-and-treatments/diseases-and-illnesses/food-and-water-borne-diseases/escherichia-coli-ecoli>