# Avoiding the pitfalls in E. coli contamination containment

Ever since Escherichia coli O157:H7 was identified in the early 1980s, the bacterium has been a target for maintaining a clean supply chain for beef and other meats. But it has also been a persistent problem for meat processors.

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E. coli O157:H7 has been identified in as much as 60% of cattle hides and is most commonly found in the intestines of cattle. Infected cattle do not develop illness, which can result in frequent contamination during processing, and challenging to detect and prevent.

## Addressing pathogen hazards

In the US, the federal Agriculture Department has issued rules requiring meat processors to establish and implement food safety controls to properly address pathogen hazards.

This has been bolstered by the USDA's 'zero tolerance' policy for E. coli O157:H7, as well as for six additional shiga toxin-producing strains of E. coli (STEC); O26, O45, O103, O111, O121, and O145.

Of these STEC strains, E. coli O157:H7 is the most easily differentiated by biochemical methods, according to the World Health Organisation.

Nor is STEC limited to beef. Bacteria may still be found mostly in cattle intestines and hides, but has also been found in poultry, deer, sheep and pigs.

When these animals shed the organism through their faeces, food and water that has been in contact with the contaminated faecal matter are at risk.

One example of this is from a recent outbreak of STEC and E. coli O157:H7 in lettuce and leafy greens in the American Southwest, California, and the UK.

Current public health surveillance, however, points to irrigation water infected from nearby cattle ranches as a probable cause of these recent outbreaks.

Ingesting as few as 10 bacterial cells from contaminated food can result in illness. Signs of illness are bloody diarrhoea, severe cramps, nausea and vomiting.

In some cases, the infection may become life-threatening if it progresses to haemolytic uraemic syndrome (HUS), in which red blood cells are destroyed and kidneys are injured. In some cases, bloody diarrhoea can lead to thrombotic thrombocytopenic purpura (TTP), in which blood cells are leaked throughout the body.

Between 3-7% of illnesses progress to either HUS or TTP.

These STEC strains have not been limited to the United States. Recent public health reports have traced higher rates of E. coli O157:H7 in England, Wales, Scotland and Ireland. A 2005 outbreak in Wales from contaminated cooked meat resulted in 157 illnesses and one death, and a 2016 outbreak from mixed salad leaves in the UK resulted in 105 illnesses and two deaths.

Contamination events linked to producers and the resultant effect on their brands have forced processors to hold products until testing is completed, and possibly destroy those products if pathogens are detected. Test and hold procedures mandated by GMP and regulations make it imperative that test results be returned in the shortest time possible.

The USDA has warned that the agency expects an investigation of each positive test result, followed by corrective actions.

"Without reporting, a sampling and testing program is merely a 'test-and-divert' program," USDA warned, in which food samples that test positive for a possible pathogen are taken off, or diverted from, the supply line. This process does not identify the source of the contamination.

"Test and divert programs will not prevent, eliminate or reduce to a non-detectable level E. coli O157:H7 in raw beef."

The USDA warned processors that removing hides and intestines during processing can be technically difficult, and "even under good manufacturing practices, occasionally contamination of the carcase will occur."

## Stx and eae

Two virulence genes – stx and eae – are well-known indicators of the pathogenic ability of E. coli O157:H7. Past research has shown that both are usually necessary for STEC to cause illness.

Outbreaks of illness caused by E. coli O157:H7 in England and Wales have shown that a newly evolved subtype of stx, known as stx2b, was behind the severity of the illnesses reported, according to new findings from Public Health England.

The study marked the first time that this subtype was linked to illness.

The findings not only demonstrate how quickly certain bacteria can evolve but indicate the need for diligent care in processing beef and other meats in preventing contamination.

## Testing complexities

Pathogens, including STEC, can be found in a wide variety of sample types, which pose a number of challenges for both sampling and measurement. Obtaining a statistically representative sample is often very difficult and can reduce the probability of detection to a small percent even before the actual testing begins.

Taking a larger number of samples, composite sampling and/or increasing the test aliquot from 25g to 375g can increase the probability of detection.

These strategies can have significant practical implications on the enrichment phase of the test method such as handling and disposal, time and temperature, media formula and cost that also impact the outcome of the test for better or worse.

The sample matrix itself can affect the end detection system and a balanced optimised procedure is required.

There are several end detection systems, for example, immuno-assays and various nucleic acid amplification methods with differing sensitivities, specificities, limits of detection and measurement times.

Further attempts to improve the overall time to result, including pooling post-enrichment cultures prior to measurement, also have a high risk of generating false negative results.

Clearly, there are many inter-dependent factors involved in test methods for pathogens that need to be carefully assessed and controlled to provide reliable results.

Testing is only part of the overall management process and cannot be relied upon solely to guarantee quality and safety.

Testing for STEC has become more complex in recent years, as global agriculture regulators have required processors to look for multiple serogroups in addition to E. coli O157:H7. Not all strains have stx and eae, thus distinguishing pathogenic E. coli can be difficult during culture confirmation.

In addition, a recent report from the WHO and UN Food and Agriculture Organisation called for risk-based identification of STEC looking at as many as 12 subtypes of the stx gene alone, adding to the complexity of detection.

Therefore, processors should ensure that:

- Slaughter and dressing procedures are designed to minimise cross-contamination.
- Optimally, every production lot should be sampled and tested before leaving the supplier.
- Extra attention is paid to infection during summer months.
- Historical data is used to identify patterns in positive results.

Such diligence may not prevent every strain of STEC from entering a given supply chain, but these efforts can go a long way toward reducing the risk of outbreaks. ■