E. coli O157:H7 Contamination & Transmission

Meat Contamination

Since that outbreak, the meat industry and the United States Department of Agriculture (USDA) have invested hundreds of millions of dollars in equipment, testing, and training in an effort to eliminate the organism from commercial meat products. These efforts have been successful in reducing the incidence of *E. coli* O157:H7 contaminated meat products being shipped from slaughter facilities. Of note, following the Jack in the Box occurrence, the USDA's Food Safety Inspection Service (FSIS) declared meat contaminated with *E. coli* O157:H7 an "adulterant" with zero tolerance. To enforce such a policy, the USDA implemented "test and hold" procedures at the meat packers (abattoirs) in 2004. When the bacteria are found in lots of beef, it must be either destroyed or cooked prior to sale in order to eliminate any possibility of infection. Either action results in losses to the abattoirs and, by extension, involves a considerable cost to the industry.

The immediate source of most bacteria on carcasses after slaughter is the contaminated hide (Collins and Wall, 2004). Therefore, efforts to reduce the level of hide contamination are important in the control of foodborne disease causing organisms such as *E. coli* O157:H7. A number of harvest (slaughter) process controls have been implemented to reduce this contamination (i.e., hide washing, careful hide and entrail removal, carcass steaming) as part of enhancements to the hazard analysis critical control points (HACCP) system.

Interventions have been successful in reducing the number of foodborne disease cases associated with beef. However, meat contamination by *E. coli* O157:H7 has not been eliminated and continues to be a persistent and costly problem for industry. Costs are higher, profits are reduced and beef recalls still occur, as do human disease outbreaks linked to contaminated beef. Further contamination reductions must be sought through pre-harvest interventions which reduce the amount of *E. coli* O157:H7 entering the harvest facilities.

In addition to beef related outbreaks, human exposure to *E. coli* O157:H7 is regularly traced to contaminated fruit, vegetables, unpasteurized milk and fruit juice, potable and recreational water, and from direct contact with animals at fairs and petting zoos.

Produce Contamination

The Center for Science in the Public Interest indicates that produce outbreaks are exceeding meat-related cases, proving that *E. coli* O157:H7 is a widespread environmental problem, rather than simply a meat issue (www.cspinet.org).

Recent outbreaks of *E. coli* O157:H7 affecting spinach and other produce in North America have highlighted that this is an increasingly serious human health threat that goes beyond the consumption of contaminated meat. An outbreak of *E. coli* O157:H7 in fresh spinach occurred in the late summer/early fall of 2006 in 26 U.S. states. This

outbreak resulted in 205 confirmed illnesses (16% of whom developed HUS) and three deaths (FDA Final Report on 2006 Spinach Outbreak).

The use of raw manure or slurry (liquid manure) on or near fruit and vegetable crops, particularly those that are to be eaten raw, is a potential hazard since *E. coli* O157:H7 can be present in animal feces (Collins and Wall, 2004). Serious outbreaks of infection from *E. coli* O157:H7 have also been associated with the consumption of raw or unpasteurized milk, as well as in unpasteurized fruit juices or ciders (Cody et al, 1999; Gillespie, 2003).

Waterborne Transmission

E. coli O157:H7 can survive in soil for several months and the organism has been found to survive in water trough sediments for at least four months, where it can multiply, especially in warm weather (Hancock et al, 1998). A number of infections have been caused by contact with recreational water which has been contaminated with animal wastes (Schlundt et al, 2004). Contaminated soil on a farm can be washed into nearby streams and rivers as a result of rainfall. It can also be flushed with groundwater and contaminate drinking water or irrigation wells.

A study published in the Water Science & Technology journal in 2006 found that high concentrations of cattle and confined livestock operations within the Oldman River Basin in southern Alberta can contribute to a decline in surface water quality (Byrne et al., 2006). Levels of fecal contamination increased during the months of May through September, with between 10% and 50% of the water samples contaminated with more than 200 CFU of enteric bacteria per 100mL. The authors suggest that a number of factors contribute to the contamination including runoff topology, animal grazing, access of livestock to streams, and the timing and amount of manure applied to fields as fertilizer.

A major outbreak involving contaminated drinking water occurred in Walkerton, Ontario in May 2000. Seven people died and more than 2,000 became ill after they drank town water that was contaminated with *E. coli* O157:H7. It was determined that manure from nearby farms likely contaminated the town water supply following a two day downpour in late April (Municipality of Brockton, 2000). Subsequent investigation conducted on one of the farms in 2006 showed that water moved into the water table faster than anticipated, suggesting that this, along with overland movement of contaminants, could have been responsible for the *E. coli* O157:H7 outbreak.

A health study by a collaborative team of researchers from the University of Western Ontario (London, Ontario), the University of Toronto (Toronto, Ontario), McMaster University (Hamilton, Ontario) and the University of British Columbia (Vancouver, British Columbia) has been tracking the health challenges of the Walkerton's 4,500 residents since 2001. Patients were monitored for health outcomes including renal complications, diabetes, hypertension, heart disease and cancer. A more detailed screening was conducted with pregnant women to assess the relationship between illness from water consumption and hypertension in pregnancy. The latest report, issued in November 2006 (summarizing results from five continuous years of study), suggests that most residents report improvements in their health (Walkerton Health Study). Almost 84% of study participants reported that their health was stable or better than the previous year. However, researchers continue to find health complications. Although the Walkerton Health Study will be officially completed in 2008, researchers

plan to continue monitoring health in the community through hospital and health records until 2030 to assess long term health implications.

Animal Exhibit Transmission

It is estimated that close to six million Americans visit animal exhibits each year (LeJeune et al, 2004). In the U.S., from 1999 to 2006, seven outbreaks of *E. coli*-related illness were attributed to animal exhibits, resulting in thousands of people becoming ill, more than 36 cases of HUS, and two deaths (LeJeune et al, 2004; CDC, 2001; Durso et al, 2005).

Petting zoos, fairs, and agricultural exhibits provide many possible routes of transmission for *E. coli* O157:H7. Animal contact is common, with a large proportion of children participating. Infection can also occur through indirect animal contact, through interaction with contaminated products (e.g., sawdust, shavings, visibly soiled clothes or shoes), or in areas adjacent to contaminating sources, such as playgrounds located near animals. While many petting zoos and fairs educate people about the importance of hygiene and hand washing and provide the proper facilities, it is difficult to monitor compliance.

A recent survey of thirty-two U.S. agricultural fairs demonstrated that *E. coli* O157:H7 is widespread in animals at these exhibits (Keen et al, 2006). *E. coli* O157:H7 was isolated from livestock at 97% of the fairs tested, with 11% of cattle testing positive. This high prevalence is an important consideration, given that millions of people, many of them children, attend and interact with livestock exhibits.