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Food Processing:
*Understanding and
Controlling E. Coli
Contamination*

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Food Processing: *Understanding and Controlling E. Coli Contamination*

INTRODUCTION

Over the last few years, a number of outbreaks of foodborne illness were traced to an organism known as *E. coli*. A few examples are listed below:

- In 1993, an outbreak of illness caused by *E. coli* in the Pacific Northwest was traced to contaminated and undercooked hamburgers at a national fast food chain. The contamination caused 700 cases of *E. coli* poisoning, four of which resulted in child fatalities.
- In 1994, another outbreak linked to *E. coli* in the states of Washington and California which was traced to dry-cured delicatessen salami. The resulting 23 cases of *E. coli* poisoning led to the voluntary recall of 10,000 pounds of salami.
- In 1995, 12 cases of *E. coli* poisoning were traced to a swimming lake at an Illinois park.
- In 1996, 45 cases of *E. coli* poisoning were traced to a particular brand of unpasteurized apple juice.
- In 1997, in probably the most publicized case in recent years, 20 cases of *E. coli* poisoning in Colorado were traced to contaminated ground beef. This case prompted the recall of 25 million pounds of ground beef. Because of the enormous impact of this recall, including extensive negative publicity, the plant where the meat had been processed ceased operations and was sold.

As demonstrated by these events, *E. coli* presents a significant public health problem. Although *E. coli* is primarily a concern for food processors and food consumers, it presents risks for those who manage and use water systems and recreational water sources.

E. COLI

E. coli encompasses a number of strains of the bacterium known as *Escherichia coli*, which normally inhabits the intestines of all animals, including humans. Most strains of *E. coli* are harmless, and, in fact, are necessary for us to develop and function properly. *E. coli* and other bacteria provide us with many necessary vitamins. However, a few strains of *E. coli* are capable of causing illness in humans. Of particular concern is the strain known as *Escherichia coli* 0157:H7, which can cause severe illness. *E. coli* 0157:H7 produces large quantities of one or more related potent toxins that cause severe damage to the lining of the intestine. These toxins (verotoxin, or VT, and shingella-like toxin) are closely related (or identical to) the toxin produced by *shingella dysenteriae*.

Animals, such as dairy and beef cattle, chickens, pigs, and sheep are natural reservoirs for *E. coli* bacteria. However, *E. coli* also grows well *outside* the animal body, thriving, for example, in unclean food handling equipment. Direct human or animal fecal contamination is also often a source of this bacteria.

ILLNESS

E. coli 0157:H7 infection, or hemorrhagic colitis, often causes severe bloody diarrhea, abdominal cramps, and occasional vomiting. Fever is either absent or of low grade. The illness is self-limiting and lasts for an average of eight days.

In some persons, particularly the elderly and children under five years of age, the infection can also cause a complication called hemolytic uremic syndrome (HUS), in which the red blood cells are destroyed and the kidneys fail. About 2% to 7% of *E. coli* infections lead to this complication. In the United States, hemolytic uremic syndrome is the principle cause of acute kidney failure in children, and most cases of HUS are caused by *E. coli* 0157:H7.

RISK MANAGEMENT CONTROLS

Preventing food contamination and human infection from *E. coli* requires control measures at all stages of the food production continuum: from agricultural production, to processing, manufacturing, transporting, storing, and preparation of foods in both commercial establishments and the domestic environment.

Although contaminated ground beef has been the most common cause of *E. coli* poisoning, it certainly is not the only one. Human cross-contamination is probably at least as significant an exposure. Fruits, vegetables, and water are other common sources of contamination. Contamination can also occur at any number of points along the food production continuum.

Safe Agricultural Production

Certainly, the entire process of raising farm animals for food production is a source of this contaminant. There is insufficient data to recommend specific intervention methods on the farm in order to reduce the incidence of *E. coli* 0157:H7 in cattle. However, one new—and questionable—method of fattening cattle (and poultry) may be cause for investigation and concern. This method involves adding a variety of waste substances to livestock and poultry feed. Chicken manure, in particular, is increasingly used as feed for cattle. Cost seems to be the significant factor; chicken manure sells for \$15 to \$45 per ton, compared to alfalfa which sells for up to \$125 per ton.

As distasteful as it sounds, chicken and turkey droppings *can* be fed safely if they are handled properly. This includes correctly stacking the manure for four to eight weeks,

during which naturally-generated heat raises the temperature to 160°F -170°F, which is hot enough to destroy bacteria and toxins. The problem is that some farmers may not check the temperatures to ensure that adequate heat has been generated. From a risk management standpoint, a farm that uses waste products in animal feeds should follow proper procedures and keep adequate records to ensure that bacteria and toxins are eliminated.

Additional exposures to E. coli occur in cultivation and processing of fresh fruits and vegetables. Farmers must take care to avoid contaminating produce when manure, such as from cattle, is used as fertilizer. Contamination can occur when:

- Fertilizer which contains the E. coli bacteria comes in direct contact with the fruits or vegetables.
- Machinery or vehicles which are used to distribute the manure are also used to contain the harvest, but are not properly cleaned and sanitized before contact with harvested crops.
- Fruits and vegetables are not properly cleaned after harvest.
- Water which is used to irrigate or clean the product is contaminated with E. coli. (Recycled water is a particular concern, especially if it is used to irrigate fertilized fields, groves, etc.).
- Workers who pick, sort, package or otherwise handle the product can also be sources of contamination if they do not follow proper hygiene procedures.

Risk management programs should provide controls to reduce these exposures.

Safe Processing and Manufacturing

Food processing can include everything from picking or harvesting to slaughtering, sorting, packaging, and cooling or freezing. As indicated above, picking and harvesting of fresh fruits and vegetables can cause E. coli contamination, if proper sanitation procedures are not observed, especially with regard to cross-contamination, water quality, and individual cleanliness.

Good hygiene in slaughtering processes can reduce the possibility of contamination of carcasses, meat, and poultry. However, good hygiene alone will not guarantee the absence of E. coli from meat and poultry products; some processes themselves are inherently risky. For example, reworking ground beef can cause problems. Reworking was partly to blame for the very large recall of ground beef in 1997 (mentioned above). Reworking involves storing leftover product until the next day, and then incorporating the leftover into the next production run. In addition to the risks inherent in holding processed meats safely, reworking also makes it very difficult to specifically identify the source batch of any contaminated meat, should it be detected later. Although some processors have discontinued this practice, where it is still being done, the risk manager must be able to plan for recall contingencies.

Good hygienic practices in meat and poultry processing should also require that procedures be in place to reduce the possibility of meat coming in contact with viscera or fecal matter; these could provide a significant source of E. coli contamination.

Good hygiene includes ensuring that

- water sources are free from contaminants
- work surfaces and equipment are properly cleaned and sanitized
- workers practice proper hygiene procedures
- quality control testing is carried out properly to determine if contaminants are present prior to products being placed in the stream of commerce

Where practical, processors and manufacturers should employ laboratory tests for E. coli to determine if raw materials or finished products are contaminated. Maintain proper documentation of tests results for an appropriate length of time. New test procedures are under development that could make it easier to ensure product quality. One new process tests for the gene that marks E. coli; another uses an advanced thin-film biomaterial that functions as a litmus test for the bacteria.

The best way to control E. coli is to heat the product. E. coli cannot survive at temperatures above 155°F. Pasteurization, a cooking process that is used to kill bacteria, is a common process in milk and fruit juice production. However, it is often not practical or desirable to heat some food products before sale, such as fresh meat, poultry, or vegetables.

Another control method is irradiation; however, this process has many critics. Irradiation involves exposing the food products to low level ionizing radiation which kills bacteria and other pathogens. Although irradiation has been around for some time, with some exceptions, it is not currently popular in the U.S. Irradiation is currently approved by the FDA for use with chicken, produce, and spices. Although the practice is widely accepted in Europe and Japan, U.S. consumers have not embraced the process due to concerns that irradiation may cause long term health problems. Some consumer groups state that when food is irradiated, new potentially dangerous chemicals are formed, and vitamins and nutrients are seriously depleted. However, the FDA indicates that the levels of irradiation approved for use on food products don't alter the nutritional value of food. Because of this lack of consumer acceptance, irradiation has not become widely used, but every time there is a food contamination scare, the process is discussed again. Where irradiation is used, there are obvious risk management concerns with regard to personnel safety, monitoring, calibrating, and documenting.

Safe Transportation and Storage

Even if the processing and manufacturing procedures are extremely good, contamination can occur further along the food production continuum. If the means of transport (e.g.,

truck or rail car) was previously used to carry anything that could have been contaminated with E. Coli (such as fertilizer), it could cross-contaminate the new product. For example, if a truck that had been used to transport fertilizer were not properly cleaned and sanitized, fresh produce transported in the truck might be contaminated by any E. coli that remained in the unsanitized truck.

This hazard can also extend to storage operations. If a source of E. coli, such as fertilizer, were stored in a warehouse, and if the area were not properly cleaned and sanitized, cross-contamination could take place if fresh produce were then placed in the area. Additionally, equipment such as forklifts, conveyors, etc., that had been used to handle the fertilizer could also provide a source of cross-contamination if it were not properly cleaned and sanitized.

Although chilling or cooling foods, such as produce or meat, usually does not *kill* the E. coli bacteria, it does slow its rate of reproduction. However, once the food is brought out of refrigeration into a higher temperature, the bacteria will multiply. Chilling/cooling only lengthens the time before the food will spoil.

Packaging processes may also contribute to E. coli contamination. For example, packaging materials may come in contact with contaminated surfaces, thus transferring the contamination to the product. The person who does the packaging may also be a source for contamination; workers must not be permitted to handle foods if they are ill. Require workers to use hair nets, hats, proper clothing, and gloves. Formalize and enforce specific policies and procedures for proper hygiene for all food handling processes.

Safe Preparation Methods

Even when everything has been done correctly along the food production continuum, it can all be for naught if proper procedures and hygiene programs are not in place and followed. Whether it is in the commercial or domestic arena, proper food preparation can go a long way toward reducing the possibility of E. coli contamination. Basic procedures are described below. (Note: This list should not be considered to be all-inclusive.)

1. Employ proper hygiene procedures.
 - Make sure that work surfaces, equipment, and utensils are cleaned and sanitized.
 - Make sure that personnel wash hands frequently, and *always* after using the toilet or after coming in contact with raw meat, fish, poultry, or vegetables.

- Make sure that personnel employ proper hand washing procedures. They should use soap and warm running water, rub hands together to make a good lather, wash palms, backs of hands, wrists and arms up to the elbow, use a nail brush to clean fingernails, and rinse well.
2. When preparing foods, use proper methods to prevent cross-contamination:
 - When cutting boards have been used to prepare raw meat, fish, or poultry, do not use them again for other foods until they have been thoroughly cleaned and sanitized.
 - Never use the same plate that held raw meat or poultry for holding or serving the cooked product. Use a clean plate.
 - After using knives and other utensils on raw meat or poultry, wash them thoroughly in warm, soapy water before using them on other foods.
 3. Properly defrost or marinate foods in the refrigerator, *not* on the counter.
 4. Thoroughly wash all vegetables and fruits before preparing or serving to remove pesticides or bacteria. Use a vegetable brush.
 5. Keep hot foods hot and cold foods cold. Serve hot foods right away, and refrigerate all leftovers immediately. When foods are delivered or brought from the grocery, immediately put away all meats, dairy products, and other foods that require refrigeration.
 6. Cook foods properly to ensure that harmful pathogens are killed. Cook meat to an internal temperature of 155°F to 160°F. Chicken, other poultry, and hamburger should not be pink; all of their juices should run clear.
 7. Wrap leftovers and place them in the refrigerator right away.

SUMMARY

E. Coli bacteria, especially *Escherichia coli* 0157:H7, is a significant cause of food contamination and foodborne illness. A number of recent cases have highlighted how severe the hazard of E. coli can be.

Escherichia coli 0157:H7 is a particular strain of E. coli bacteria that can cause severe illness in humans, such as hemorrhagic colitis and the particularly severe hemolytic uremic syndrome (HUS).

Preventing food contamination from E. coli requires effective risk management controls at all stages of the food production continuum. Proper hygiene and controls must be incorporated into all processes, from agricultural production to final preparation and serving. Loss control and risk management professionals should become familiar with these controls to assist in evaluating and implementing appropriate programs to address this hazard.

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