Scientific Contributions

Testing Beef for Pathogenic *Escherichia coli*

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Escherichia coli are bacteria that are normally present in the intestines of mammals, including humans and cattle. Most strains of the organism are benign, but some strains can produce toxins and cause disease in humans. The toxins are termed vero- or shigatoxins, and *E. coli* carrying them are termed verotoxigenic *E. coli* (VTEC) or shigatoxigenic *E. coli* (STEC). The genes that code for the toxins are associated with a virus that integrates into the bacterial chromosome. When the virus particles are released from cells they can sometimes carry toxin genes with them into cells that they infect. Thus, previously benign strains can be transformed into pathogens. *E. coli* are serotyped by determining the antigens that they carry on the body of the cells (O antigens) and the flagella (H antigens). Because toxin genes can be transmitted between strains of *E. coli*, there is no necessary relationship between serotype and pathogenicity. However, VTEC of some serotypes are more common than VTEC of other serotypes among *the VTEC that* are found as causes of enteric disease in humans.

VTEC of the O157:H7 or O157:H$^-$ serotypes have been recognized as human pathogens for some 30 years. Because of concerns about VTEC illness and carriage of the causative organisms by cattle, O157 VTEC have been deemed an adulterant by the USDA; and routine testing of beef for *E. coli* O157 is required by regulatory authorities in Canada and the USA. Testing for *E. coli* O157 in samples from human patients and from beef has been facilitated by the ease with which *E. coli* O157 can be distinguished from most *E. coli* of other serotypes which, unlike *E. coli* O157, can ferment sorbitol and produce glucuronidase. It has, however, become apparent that O157 VTEC are responsible for only about half the human VTEC disease in North America. Consequently, mandatory testing of beef for six other *E. coli* serotypes that together include the VTEC responsible for about 35 % of human VTEC disease is now being considered.

It is by no means clear that much, if anything would be gained by way of improvement of the microbiological safety of beef as a result of implementing the proposed testing, which will be difficult and expensive. A major problem with end product testing for acceptance or rejection of batches, which is the type of testing used and proposed for O157 and non O157 VTEC on beef, is that there is only a small probability of the

organisms being detected when their numbers in the product are low, as are the numbers of VTEC in beef. Consequently, a negative test give no real assurance that tested batch is in fact free of VTEC of the designated serotypes. It gives no assurance at all of a batch being free of VTEC of other serotypes. Thus, end product testing its self does little to improve the safety of beef provided to the consumer. The safety of the product is improved only if processors take effective actions for better control of contamination in response to test results. That has happened to some extent in response to the results of testing for O157 VTEC. However, the results of tests of end product are a poor guide as to where in a process efforts should be concentrated to obtain improvements. Requiring testing for VTEC of serotypes other than O157 will give no better direction to efforts to improve control over VTEC contamination of beef than does the current testing for O157 VTEC.

The continued emphasis on end product testing of beef for VTEC is curious, because it has for long been recognized that this cannot be an effective means of controlling hazardous microbiological contamination; and because the limited benefits from such testing are clearly shown by the ongoing problems with O157 VTEC in beef. The only known means by which these and related problems can be resolved is implementation at all beef plants of Hazard Analysis: Critical Control Point (HACCP) systems that are validated for the adequacy of control over enteric pathogens. Testing of product at appropriate stages of processing for enumeration of generic *E. coli* can facilitate the identification of actions that would be the most effective for improving control of hazardous contaminations. Such testing can also be used to monitor the maintenance of control over hazardous contamination, once adequate control is achieved. There is, of course, no necessary relationship between numbers of generic *E. coli* and numbers of VTEC; but all VTEC are *E. coli*. Thus, if the numbers of generic *E. coli* are reduced to very low levels, as they can be, then the possibility of VTEC being present will be small indeed. This type of approach is successful with water, and it could be equally so if applied to meat in an appropriate form. What is certain is that enhanced end product testing for VTEC will do little, if anything to improve beef safety; and it may well retard the implementation of better means of controlling VTEC in beef.