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Beef Science Cluster

E-beam Treatment to Improve Beef Safety

Project Title:

Use of Low Dose e-Beam Irradiation to Reduce E. coli 0157:H7, Non-0157 (VTEC) E. coli and Salmonella Viability on Meat Surfaces

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Background

Irradiation has been used to pasteurize food for astronauts to prevent foodborne illness during space travel since 1966, and is approved for food treatment in over 50 countries. In Canada, irradiation is approved for spices, seasonings, flour, onions and potatoes, but not meat or poultry. Irradiation is the most studied of all technologies used for processing food over the past 60 years and:

- is safe for human food use at absorbed doses (60 kilo Gray, kGy) far higher than those approved for meat in the United States (7kGy),
- does not cause the meat to become radioactive, and
- has insignificant effects on food nutrients.

Verotoxigenic *Escherichia coli* (VTEC), also known as Shiga toxin-producing *E. coli* (STEC), are bacteria that can cause illness in humans. *E. coli* O157:H7 is one of about 200 serotypes of VTEC that cause illness in humans. More than a third of VTEC-related illnesses in humans are caused by these non-O157 serotypes (such as the "top 6": *E. coli* O26, O45, O103, O113, O111, O121 and O145).

Irradiation can destroy *E. coli*, but can have undesirable effects on flavour or colour under some conditions. This project examined whether a low dose (1 kGy) electron-beam (non-radioactive, ionizing) can eliminate *E. coli* O157:H7 and non-O157 VTEC from beef trim for ground beef fabrication. *Salmonella* were used as reference points for comparison to other research.

Low-dose e-beam treatment of beef trim to formulate ground beef appears to be viable pathogen mitigation process that does not affect product quality.

Objectives

1. Evaluate the sensitivity of different strains of *E. coli* O157:H7, non-O157 VTEC *E. coli* and serovars of *Salmonella* to a low dose (1 kGy) e-beam in fresh and frozen beef and determine whether lactic acid treatment might change their susceptibility.
2. Determine if exposure to the 1 kGy e-beam had detectable effects on the color, aroma, texture, juiciness or flavour of beef patties containing different levels of fat and differing amounts of e-beam treated ground beef.

What they did

A collection of 32 VTEC *E. coli* (including *E. coli* O157:H7 and the "top 6" non-O157 VTECs, plus six different *Salmonella* serovars) were screened for resistance to the 1 kGy e-beam. Twelve of these bacteria were then pooled in four groups to test for survivors on beef. Fresh muscle pieces (outside flat, inside round, brisket, and sirloin) were separately inoculated with either 1,000 bacteria/gram or 10 million/g of each of the four bacterial mixtures. These numbers are up to a million times higher than would normally be found in beef. The inoculated beef was exposed to a 1kGy e-beam. Surviving bacteria were recovered and counted during storage at 4°C for up to five days. Inoculated muscle pieces were also pre-treated with 5% lactic acid before being frozen and exposed to the e-beam.

For sensory tests, the same types of fresh muscle pieces (but not inoculated with bacteria) were treated with the 1 kGy e-beam. Fresh ground beef patties (10, 20 or 30% fat) were separately formulated with 0, 10, 20, 50 or 100% lean beef treated with the 1kGy e-beam, cooked and evaluated by a similar panel for colour, aroma, texture, juiciness and flavour.

What they learned

The beef used in this study was experimentally inoculated with up to a million times more bacteria than would normally be found in beef. In spite of this artificially high level of experimental contamination, treating fresh beef with the 1 kGy e-beam eliminated more than 99.99% of the VTEC *E. coli* and 99% of the *Salmonella.* The e-beam had less effect on *Salmonella* when used on frozen beef, but this could be overcome if the beef was dipped in 5% lactic acid before freezing.

The trained panel observed no effects of irradiation on the colour, aroma, texture, juiciness or flavour of beef patties, even when they were made entirely with beef that had been e-beam treated.

What it means

Under normal processing conditions, a 1 kGy e-beam would be expected to eliminate the hazard represented by all types of VTEC *E. co* *E. coli.* Low dose (1 kGy) e-beam treatment can effectively control *E. coli* O157:H7, non-O157 VTEC *E. coli* and *Salmonella* in fresh beef trim.

Lactic acid treatment by itself did not control contamination by these bacteria, but did make the e-beam more effective against *Salmonella* in frozen beef.

The e-beam did not have a significant effect ($P > 0.05$) on any of the sensory attributes of the beef patties, regardless of the amount of e-beam treated beef they contained.

Low-dose e-beam treatment of beef trim to formulate ground beef appears to be viable pathogen mitigation process that does not affect product quality.

See an interview with Dr. Rick Holley about this research at http://youtu.be/QvJfOsYQe8w

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