

What You Need to Know about Pre-harvest Safety Interventions

Background and Objectives

The National Cattlemen's Beef Association (NCBA), on behalf of the Cattlemen's Beef Board, conducted a research project evaluating the existing market for irradiated ground beef. Data was collected from the current purchasers of irradiated ground beef as well as those who do not purchase it in order to evaluate and identify barriers/issues for acceptance of irradiated ground beef in the food service and retail channels as well as evaluate the marketing efforts that exist regarding the sale of irradiated beef.

The immediate goal of researching and developing pre-harvest safety interventions is to reduce pathogen loads on cattle presented for slaughter, so in-plant safety systems are not overwhelmed. While 100 percent reduction in pathogen shedding would reap huge benefits, it's not realistic. In most instances, post-harvest interventions are extremely effective and the additive effect of pre-harvest interventions to decrease pathogen loads on hides would increase the efficacy of the entire safety system.

Most of the experiments evaluating pre-harvest safety interventions have been performed at the feedlot level as it is a production stage that is more intensely managed and is the stage in beef production immediately before harvest. Additionally, most research in pre-harvest beef safety has focused on *E. coli* O157:H7 as it is the pathogen that has had the greatest impact on beef safety. Research is expanding to include other pathogens such as *Salmonella*, *Listeria monocytogenes*, and *Campylobacter jejuni* as well as issues such as the development of antibiotic-resistant bacteria.

Production Best Practices

Many producers follow specific basic principles which are the foundation to good animal-health management. These best practices are the first step in addressing any foodborne pathogens in beef products that may impact human health. While no clear reduction in pathogen shedding has been demonstrated by research when applying these practices, they can still serve as a foundation for future efforts and align closely to principles outlined in the industry Beef Quality Assurance (BQA) program.

Basic principles of production best practices include:

- Clean feed
- Clean water
- Appropriately drained and maintained environment
- Biosecurity

Additionally, researchers have been exploring modifications to existing management practices to determine how they might reduce pathogen levels in cattle. The most notable area of research has been ration modification focusing on type of feed, frequency of feeding and feed quality, which has all been hypothesized to impact bacterial shedding rates in cattle.

Direct-Fed Microbials

This category includes probiotics, which contain bacteria or microorganisms that are beneficial to the host animal and reduce harmful pathogens through competitive exclusion. Most of the research in this area has focused on a specific *Lactobacillus*-based direct-fed microbial. This research has demonstrated a reduction in *E. coli* O157:H7 prevalence in cattle and a subsequent reduction of hide contamination.



Hundreds of strains of *Lactobacillus* exist and a comprehensive research project evaluating 650 strains found that only five show promise of reducing *E. coli* O157:H7. Of particular importance is the fact that some actually demonstrated the potential to increase pathogen shedding, versus decrease shedding.

- Zerby, 2006
- Brashears, 2004

Seaweed Extract

An extract has been identified from a specific variety of seaweed (*Ascophyllum nodosum*), which is a known source of cytokinin which is shown to have antioxidant effects. Research has evaluated the supplementation of this extract in feedlot rations prior to harvest. Efficacy in reducing *E. coli* O157:H7 shedding has been variable in research trials.

- Braden et al., 2004
- Bach et al., 2008

Orange Peel and Pulp

These by-products of the citrus juice industry are being utilized in some feedlot and dairy rations as a low-cost ingredient. Orange peel and pulp and other citrus fruits contain essential oils that are toxic to bacteria and exhibit an antioxidant effect in host animals. An experimental trial using sheep showed that feeding orange peel for seven days reduces *Salmonella* populations in the animals.

- Callaway et al, 2010
- Goodridge et al. 2010

Ractopamine

This is a beta-agonist commercially available as a medicated feed additive and is approved for use in feedlot cattle as a means of increasing lean-meat yield. Some experimental work has been conducted to determine its impact on decreasing *E. coli* O157:H7 and *Salmonella* but the mechanism for such a result is currently unknown.

- Edrington, et al., 2006

Antibiotic Feed Additives

Including commercially available additives such as ionophores, neomycin sulphate, tetracycline and oxytetracycline have been proposed as possible means of decreasing pathogen shedding; however, results have been inconclusive. Neomycin sulfate has shown significant promise in reducing *E. coli* O157 in multiple feedlot studies; however, a label change would be required before it could be sold to control *E. coli* O157 in cattle. Additionally, concerns about antibiotic use in livestock and antimicrobial resistance may hinder future research in this area. Potential benefits for human health would have to be balanced with concerns about antimicrobial resistance when evaluating antibiotic feed additives as a pre-harvest intervention.

- Brashears & Loneragan, 2005
- Ransom & Belk, 2003

Competitive Exclusions

Other strains of *E. coli* produce antimicrobial proteins that can inhibit *E. coli* O157:H7. By feeding these other strains to feedlot cattle, researchers have proposed it may lessen fecal shedding. This research is still very experimental in nature and its benefits have not been clearly defined.

Sodium Chlorate

This compound has been researched as an additive to feed and water and significant reductions in the shedding of *E. coli* O157 as well as *Salmonella* have been observed with its use. This product is awaiting FDA approval for this specific use and currently may not be used in cattle going to slaughter for human food.

- Edrington et al., 2009
- Anderson & Car, 2002

Cattle-Hide Washing

Washing cattle prior to harvest removes visible manure, and can potentially reduce the likelihood of contamination occurring at harvest when the hide is removed.

- Savell, 2001

***E. coli* O157 Vaccines**

Currently two vaccines are being investigated which are designed to reduce fecal shedding of *E. coli* O157:H7 in cattle. One of the vaccines defends against *E. coli* O157:H7 by disrupting the bacteria's iron transport system and is conditionally licensed in the United States. The other vaccine is a bacterial extract and is fully licensed in Canada. The vaccine manufacturers are seeking conditional licensing in the United States. While the vaccines employ different technology, both have been shown in experimental studies to reduce fecal shedding in commercial environments. The use of vaccines as intervention tools has significant potential because their use is a management practice producers are familiar with and can incorporate easily into existing management programs. As researchers determine the most effective dose and time of administration and these products work through the regulatory approval process, one important point to consider will be how to encourage adoption of these interventions as well as other promising technologies among farmers and ranchers when no discernible benefit to animal health is seen.

- Klopfenstein, 2005
 - Paterson, 2004
 - Paterson et al., 2004
- More recently the U.S. Department of Agriculture (USDA) Food Safety Inspection Service (FSIS) has allowed their use on cattle in holding pens immediately before slaughter with the goal of reducing hide contamination. While this method has shown promise, it also requires application equipment to apply the spray compound to the cattle.

Bacteriophages

Viruses that kill bacteria have been approved for use in post-harvest interventions. More recently the U.S. Department of Agriculture (USDA) Food Safety Inspection Service (FSIS) has allowed their use on cattle in holding pens immediately before slaughter with the goal of reducing hide contamination. While this method has shown promise, it also requires application equipment to apply the spray compound to the cattle.

- Callaway, 2005

Conclusion

Several pre-harvest interventions are currently being researched and are showing promise in reducing pathogen loads on cattle presented for slaughter. In addition to efficacy however, the feasibility of use in current production systems must be considered. This would include the time commitment to animal handling needed for



delivery/application of the intervention as well as the use of specialized equipment. While the majority of pre-harvest interventions examined to date have focused on the feedlot sector, as this field of research continues to expand, interventions may be introduced that could be applied at the cow-calf or dairy level.

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National Cattlemen's Beef Association | 9110 East Nichols Ave. | Centennial, CO 80112 | 303-694-0305

