Effecting food safety in cattle-finishing systems—
the role of dietary components and other
management practices
Dave Smith, DVM, Ph.D., DVM, University of Nebraska,
Lincoln

Smith presented results from several studies examin-
ing the effect of dietary components and other man-
agement practices in cattle-finishing systems on food
safety. In introducing his topic, Smith cautioned the
audience that the media’s interpretation of scientific
studies should remind the research community that no
conclusions can be made from any single study.

Past research has demonstrated that feedlots differ in
E. coli O157:H7 carriage, suggesting that individual cat-
tle production systems may influence food safety out-
comes. It seems reasonable that feed rations may af-
fect the bacterial population in cattle, however it is not
ever clear how cattle rations affect E. coli O157:H7, or
how to use cattle rations as a preharvest intervention.

Smith presented research that demonstrated contra-
dictory results on the effect feedlot rations may have
on pathogen-shedding rates in cattle. He recom-
ended future research should focus on determining
what affects the probability for cattle to shed E. coli
O157:H7 and determine the most effective strategies
for intervention, by either limiting direct environ-
mental exposure or reducing the duration of infection.

Beef safety research

Tom Edrington, Ph.D., Food and Feed Safety Research
Unit, Agricultural Research Service, U.S. Department of
Agriculture

Previous research conducted by Edrington and his col-
leagues examined the prevalence of MDR Salmonella in
various classes of dairy cattle. The results suggested
that pasteurization of waste milk fed to calves may have
a significant effect on decreasing Salmonella
prevalence in the calves. The researchers hypothesized
that unpasteurized milk might serve as a vector for
Salmonella, as well as antibiotic resistance.

Samples were collected from several large dairy opera-
tions in the Southwest United States and compared
Salmonella prevalence differences between calves fed
pasteurized versus non-pasteurized milk. The examina-
tion of waste-milk pasteurization on incidence of MDR
Salmonella in dairy cattle did not produce expected
results. In fact, Salmonella prevalence was higher in all
classes of dairy cattle on a farm feeding pasteurized
waste milk versus a farm that was feeding unpasteur-
ized milk. The researchers noted other general man-
agement differences between the operations and will
consider analyzing those aspects in future research.

Researchers from Edrington’s group are also investi-
gating the incidence of multi drug-resistant generic E.
coli, which is common in young dairy calves and disap-
ppears with age. Results may provide information on
how to eliminate these bacteria from the gut popula-
tion at an earlier age in cattle.

Feedlot cattle research to determine whether acyl-
hydrasine-lactone autoinducer (AHL) is correlated with
E. coli O157:H7 populations was presented. AHL may
repress gene expression that is required for bac-
terial colonization in cattle. Preliminary results indicate
that a forage diet may possibly influence AHL.

Edrington presented research projects examin-
ing the role of stressors on acquisition of multi drug
resistance by Salmonella, as well as the role of bacte-
riophae in the acquisition of MDR by Salmonella.

Edrington’s group has also worked for some years on
validating chlorate as a preharvest intervention. Sup-
plementing cattle drinking water with chlorate has
been shown to be an effective intervention strategy at
the feedlot level and was awarded its first patent in
2002. However, chlorate’s use as a feed additive is still
under review by the Center for Veterinary Medicine,
Food and Drug Administration.

Conclusion

All of these research projects demonstrate the evolu-
tion that has taken place in the understanding of
beef’s safety challenges. By sponsoring this research,
the beef industry has demonstrated its commitment to
finding effective strategies for reducing, and poten-
tially eliminating, safety challenges to the U.S. beef
supply.

Research Update Session Summary

Introduction

The beef industry, through the Beef Checkoff Program, has devoted more than $25 million to beef
safety research. These studies have laid the groundwork for advancing the goal of creating
the safest beef supply possible. During the 2008 Beef Industry Safety Summit, leading research-
ers presented results from studies that will advance the industry’s understanding of beef safety
risks and aid in the development of solutions to existing challenges. The summit is funded by
the Beef Checkoff Program and coordinated by the Beef Industry Food Safety Council (BIFSCO) and
the National Cattlemen’s Beef Association (NCBA), and continues the tradition of industry driven
efforts to improve beef safety.

Overviews of the research projects and results are outlined in the executive summary for the
2008 Beef Industry Beef Safety Summit, which can be accessed at www.bifasco.org. This report
summarizes the research in more detail. More beef safety research information can also be ac-
cessed at www.beefresearch.org.

Beef safety research updates

Veterinary drug residue issues
Steven Lehotay, Ph.D., U.S. Department of Agriculture-Agricultural Research Service

Veterinary drug residues still present safety and regulatory issues for the beef industry, and con-
tinue to be monitored and addressed by regulatory agencies. Lehotay emphasized the need for
more rapid screening tests with wider monitoring scope and more reliable results. Research ef-
forts are focused on improving screening methods to make them more cost-effective and to en-
sure that they meet industry needs.

Chemical residue testing in beef harvest facilities is currently conducted in a two-tiered approach
with initial screenings performed by Food Safety Inspection Service (FSIS) inspectors in harvest
facilities. Presumptive positive samples are sent to the FSIS laboratory for quantitative and qual-
itative analysis. Total residue monitoring has decreased since 2001, but violations are increasing,
primarily because of flunixin. Cull dairy cows represent the largest percentage of violations.

One of the primary areas of focus is to evaluate the use of muscle tissue and fluid extracted from
muscles rather than kidney or liver samples, which are currently utilized in most testing pro-
grams. According to Lehotay, muscle tissue is more accessible for easier collection and much less
complex to extract and analyze. The lower residue tolerance levels in muscle tissue could poten-
tially reduce nonvolatile positives that occur in existing sampling programs. Testing muscle tis-
sue for drug residues would also be a more effective use of resources, as it would eliminate the
need for additional analyses of muscle tissue in the event of organ positives. In Lehotay’s opin-
ion, the condemnation of organs is a non-issue, when it is the muscle tissue that is ultimately the
end product for the majority of consumers. The agency is also working to speed up the testing
process to provide accurate residue results within 48 hours on held carcasses.

Nutritional factors influencing prevalence of foodborne pathogens in feedlot cattle
Jim Drouillard, Ph.D., Kansas State University

Ration components for feedlot cattle may have some association with the prevalence of food-
borne pathogens. However, further research is needed to accurately understand the causal rela-
tionship between diet and pathogen prevalence rates in cattle. Drouillard presented a compila-
tion of project results that examined the effect of various grain processing methods (dry-rolled
corn versus steam-flaked corn) and the replacement of ration components with dried distillers
grains (DDG) or wheat on pathogen shedding in cattle.
One of the projects tracked a group of cattle that were preselected for 100 percent prevalence rate. The researchers determined DGs consumption appeared to impact the prevalence of E. coli O157:H7; however, Drouillard cautioned the audience against foregone conclusions. “It is important to remember that a variety of factors including the removal of starch from the diet, the alteration of the rumen microbial environment and the number of bacteria present may also play roles in this phenomenon. When grain is removed from a ration and replaced with distillers grains, starch is being removed from the ration,” said Drouillard. “That dynamic may modify the environment to the point that it is more hospitable to pathogens or they are better able to proliferate.”

To examine that effect, Drouillard and his colleagues conducted a study that added starch back into the ration to potentially make the gastrointestinal environment friendlier to competitive bacteria. That study revealed no differences in pathogen prevalence between cattle on treatment and cattle on control diets. However, Drouillard said this result may be due to low prevalence rates in the study animals to the point that it was difficult to accurately determine differences in shedding rates. Future research efforts will continue to focus on altering the microbial environment so that competitive bacteria can displace the pathogenic species.

**Highlights of beef safety research from the U.S. Meat Animal Research Center (MARC)**

Mohammad Koohmaraie, Ph.D., MARC, Agricultural Research Service, U.S. Department of Agriculture

Highlights of research to control pathogens in the beef supply focused on work to improve hold and test procedures in beef processing facilities; attribution of antibiotic resistant Salmonella to cull cows; and projects examining the effect of feeding wet distillers grains (WDG) on E. coli O157:H7 shedding in feedlot cattle.

Previous research has indicated that cull cows may have a higher prevalence of multi drug-resistant (MDR) Salmonella than younger cattle processed in feedlots. The effect of irrigation had to be eliminated to accurately test the hypothesis. The researchers found that sampling feces from the distal colon after cull cows had been fed irrigation reflected Salmonella shedding rates at the production site and eliminated effects that irrigation contamination might have on study results. The study validating this sampling procedure has been submitted for publication in the *Journal of Food Protection.*

In the attribution study, researchers sampled hides at processing plants (cull cow/bull and fed) to determine *Salmonella* rates in hair samples. Feces from the distal colon were sampled to determine *Salmonella* rates in the production environment. *Salmonella* positive fecal samples were more prevalent in cull dairy animals (70.2 percent) versus beef market animals (37.9 percent) and fed cattle (7.0 percent).

### Prevalence of Salmonella

<table>
<thead>
<tr>
<th>Hides Salmonella</th>
<th>Fecal Salmonella</th>
<th># positive</th>
<th>%</th>
<th># positive</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dairy Cow</strong></td>
<td></td>
<td>716</td>
<td>83.0%</td>
<td>618</td>
<td>71.6%</td>
</tr>
<tr>
<td><strong>Dairy Bull</strong></td>
<td></td>
<td>41</td>
<td>93.2%</td>
<td>19</td>
<td>43.2%</td>
</tr>
<tr>
<td><strong>All Dairy</strong></td>
<td></td>
<td>757</td>
<td>83.5%</td>
<td>637</td>
<td>70.2%</td>
</tr>
<tr>
<td><strong>Beef Cow</strong></td>
<td></td>
<td>262</td>
<td>87.0%</td>
<td>118</td>
<td>39.2%</td>
</tr>
<tr>
<td><strong>Beef Bull</strong></td>
<td></td>
<td>38</td>
<td>97.4%</td>
<td>11</td>
<td>28.2%</td>
</tr>
<tr>
<td><strong>All Beef</strong></td>
<td></td>
<td>300</td>
<td>88.2%</td>
<td>129</td>
<td>37.9%</td>
</tr>
<tr>
<td><strong>Fed Cattle</strong></td>
<td></td>
<td>213</td>
<td>57.4%</td>
<td>26</td>
<td>7.0%</td>
</tr>
</tbody>
</table>

Fecal sample prevalence of multi drug-resistant (MDR) *Salmonella* followed similar trends—32.5 percent dairy market animals, 16.2 percent of beef market animals and 0.8 percent fed cattle, were positive respectively.

### Prevalence of MDR-Salmonella

A two-phase project examined the effect of varying *Salmonella* percentages of wet distillers grain (WDG) on cattle performance, and the effect of WDG (0 to 60 percent of ration, dry matter basis) on *E. coli O157:H7* shedding. In the second phase of the study, the researchers examined differences between a control diet and one that included 40 percent WDG on *E. coli O157:H7* shedding rates. Fecal samples were collected monthly from October until the cattle were harvested in June. Results revealed variations that could not be explained by treatment in shedding rates between pens and within pens throughout the trial.

<table>
<thead>
<tr>
<th>Hides Salmonella</th>
<th>Fecal Salmonella</th>
<th># positive</th>
<th>%</th>
<th># positive</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dairy Cow</strong></td>
<td></td>
<td>327</td>
<td>37.9%</td>
<td>288</td>
<td>33.4%</td>
</tr>
<tr>
<td><strong>Dairy Bull</strong></td>
<td></td>
<td>24</td>
<td>75.5%</td>
<td>7</td>
<td>17.5%</td>
</tr>
<tr>
<td><strong>All Dairy</strong></td>
<td></td>
<td>351</td>
<td>38.7%</td>
<td>295</td>
<td>32.5%</td>
</tr>
<tr>
<td><strong>Beef Cow</strong></td>
<td></td>
<td>82</td>
<td>27.2%</td>
<td>54</td>
<td>17.9%</td>
</tr>
<tr>
<td><strong>Beef Bull</strong></td>
<td></td>
<td>7</td>
<td>17.9%</td>
<td>1</td>
<td>2.6%</td>
</tr>
<tr>
<td><strong>All Beef</strong></td>
<td></td>
<td>89</td>
<td>26.2%</td>
<td>55</td>
<td>16.2%</td>
</tr>
<tr>
<td><strong>Fed Cattle</strong></td>
<td></td>
<td>29</td>
<td>7.8%</td>
<td>3</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

**All MDR data should be considered presumptive subject to confirmation.**

### Beef Safety Interventions

*Mindy Brashear,* Ph.D., International Center for Food Industry Excellence, Texas Tech University

Results from several studies addressing beef safety interventions, carcass sampling protocols and preharvest intervention practices were presented by Brashear.

A study that examined the timing of three safety interventions (lactic acid-producing bacteria; acidified sodium chloride; and 3 percent lactic acid spray) on enhanced beef strip loin determined that in general, all three treatments significantly reduced *E. coli O157:*H7 after 21 days of storage prior to enhancement. The effects of the three intervention treatments had an observable difference in the highest level of contamination across several plants.

Results from another study examining the susceptibility of both MDR and non MDR *Salmonella* to lactic acid treatments was presented. According to Brashear, lactic acid, an intervention strategy commonly used in industry, appears to deal effectively with MDR, as well as drug-susceptible Salmonella. Another study examining the necessary dose of lactic acid bacteria to effectively inhibit foodborne pathogens in meat found a lower dose (10^5 cfu/g) was as effective as a higher dose (10^7 cfu/g).

Texas Tech University researchers have conducted several research studies over the years focusing on preharvest safety interventions. The prevention of cross contamination through dust control was examined during load out of cattle at feedlot facilities. Controlling dust resulted in fewer pathogens being isolated from air samples. These results indicate that dust control may play an important role in reducing subsequent contamination of cattle hides and, consequently, carcasses.

Another preharvest research project analyzed the effectiveness of *Lactobacillus acidophilus* strain NP 51 (LAB) in reducing *E. coli O157:*H7 prevalence in fecal samples. The results indicate that LAB could be applied to manure via spraying to reduce pathogen levels and subsequent contamination of beef hides. The research may also have implications for manure used in fertilizer applications in ready-to-eat crops. LAB applications in a feedlot setting might also reduce environmental contamination of nearby water bodies or crops in the event of excessive storm run-off.

### Siderophore receptor and porin protein (SRP)-based vaccines for control of *E. coli O157*

Guy Loneragan, B.V.Sc., DVM, West Texas A&M University

Loneragan presented preharvest beef safety research examining the potential of a siderophore receptor and porin protein (SRP) based vaccine for control of *E. coli O157*. All bacteria require iron for survival, and in bacteria, iron is acquired via siderophore and porin proteins. A vaccine was developed that stimulates immunity against these cell-surface proteins, which would in turn reduce iron acquisition. A challenge study was initially conducted to validate the concept. Two subsequent field efficacy studies were performed. Trends to decrease pathogen populations were desirable, however prevalence in study animals was so low in the first field study that biological significance was questionable. The second field study demonstrated a vaccine efficacy of 86 percent with a 98 percent reduction in iron concentration in fecal samples. The vaccine did not negatively affect animal performance and demonstrated effectiveness in reducing the burden of *E. coli O157:*H7.