Project Summary

Chlorate Supplementation in Feed and/or Water to Reduce Gut Concentrations of *Salmonella* and *E. coli* 0157:H7 in Beef Cattle

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Study Completed
May 2002

Prepared by the National Cattlemen’s Beef Association Center for Research & Knowledge Management

*Funded by The Beef Checkoff*
Background

Highly publicized outbreaks of food-borne illness since 1993, primarily caused by bacteria such as *E. coli O157:H7*, *Salmonella* and *Listeria monocytogenes*, elicited intense consumer concern about meat safety. In response, regulatory authorities, researchers and the beef industry initiated efforts to implement food safety management systems that would improve microbiological quality. The USDA Food Safety and Inspection Service (FSIS) began initiating new regulatory requirements during the mid-1990s. Packers were required to knife-trim carcasses to remove all visible contaminants, comply with written sanitation standard operating procedures (SSOP), implement Hazard Analysis Critical Control Point (HACCP) systems, and meet microbiological performance criteria and standards for *E. coli* and *Salmonella* as a means to verify HACCP effectiveness and pathogen reduction.

Researchers and beef packers/processors have addressed consumer food safety concerns by developing a variety of methods that are now implemented, or are being further developed, to reduce numbers of bacteria on beef and beef products and improve microbiological safety. These microbiological decontamination technologies include: (1) Animal cleaning; (2) Chemical dehairing at slaughter; (3) Spot-cleaning of carcasses by knife-trimming or steam/hot water vacuuming; and (4) Spraying/washing/rinsing of carcasses before evisceration and/or before chilling, with water, chemical solutions and/or steam or hot water.

The bovine gut is considered a reservoir for *E. coli O157:H7* and *Salmonella*. The main objectives of this study are to: (1) measure the extent to which chlorate supplementation in feed and/or water reduces concentrations of *E. coli O157:H7* and *Salmonella* in the stomachs and intestines of beef cattle; (2) determine the optimum concentrations and feeding regimes for chlorate supplementation; and (3) determine the effects of this supplementation on carcass quality.

Methodology

Sixty-four (64) feedlot cattle were randomly assigned to one of eight different treatments where amounts of the experimental chlorate preparations ranging from 0 to 500 mg/kg of body weight were given over a 1 to 5 day period as follows:

<table>
<thead>
<tr>
<th>Group</th>
<th>Chlorate Dosage/Total</th>
<th>Timing/Frequency of Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>None</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water 1</td>
<td>30mM/30mM</td>
<td>1 time/18 hours or less before slaughter</td>
</tr>
<tr>
<td>Feed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feed 1</td>
<td>100 mg/100mg</td>
<td>1 time/last day on feed</td>
</tr>
<tr>
<td>Feed 2</td>
<td>100mg/500mg</td>
<td>1 time per day/last 5 days on feed</td>
</tr>
<tr>
<td>Feed 3</td>
<td>100mg/500mg</td>
<td>5 times/last day on feed</td>
</tr>
</tbody>
</table>

The eight treatment groups were: Control (1 group); chlorate administered via water only (1 group); chlorate administered by feed only (3 groups); and chlorate administered by water and one of the
three feed treatments (3 groups). Each of these eight treatment options were replicated 4 times at
two-week intervals.

Significant water and feed treatment interactions were not observed for any of the variables
measured. An effect of experimental replicate on recovery of E. coli from ruminal (stomach) and
fecal contents was also not observed thus indicating no confounding effect of conducting the four
replicates over the entire two month period. Consequently, data were pooled across replicates and
analyzed for treatment effects.

Findings
Overall, the data show that water treatments had more of an effect on ruminal (stomach) E. coli
counts and feed treatment had more of an effect on fecal E. coli counts. The fact that the water
treatment resulted in reductions of ruminal but not fecal E. coli suggests that there may not have
been enough time between initiation of water treatment and slaughter (< 18 hours) for any of the
chlorate consumed in water to reach the lower gastrointestinal tract. Similarly, the fact that an effect
of feed treatment on fecal but not ruminal E. coli concentrations suggests that effective
concentrations of the experimental chlorate product consumed 26 hours earlier had passed through
the rumen and reached the lower gastrointestinal tract by time of slaughter as intended. These
findings support the concept that a dual route (water and feed) administration protocol may be most
effective in achieving total tract reductions in E. coli concentrations when administering the chlorate
preparations.

A feed treatment effect (P < 0.05) was observed on concentrations of generic E. coli recovered from
swabs of the left rump area and a trend (P = 0.08) for an effect of water treatment on
concentrations recovered from the carcass area. Chlorate supplementation had no effect (P > 0.10)
on concentrations of generic E. coli recovered from swabs collected from the back midline area.

As expected, the recovery of E. coli O157:H7 was highly variable which, with the limited number of
animals available within each treatment group (necessitated due to the costly expense of disposing of
these experimental animals), made it difficult to draw conclusions as to the effectiveness of the
chlorate treatments on the incidence of this particular bacterium. Comparison of genotypic
characteristics of E. coli O157:H7 isolates recovered from feces prior to chlorate treatment, in feces
after chlorate treatment but before shipping and from gut contents and swabs collected at slaughter
may, however, present an opportunity to determine whether the major contribution of carcass
contamination came from the animals themselves or from extraneous sources at the plant. While all
of the animals were cultured for Salmonella, the recovery rate (less than 20% culture positive upon
enrichment of fecal specimens) was too low to assess any potential effects of chlorate
supplementation on this pathogen.

No adverse effects due to chlorate administration on feed intake, water consumption, carcass weight
or percent of animals grading USDA Choice were found. However, feed intake was much lower
than expected regardless of treatment (including the animals receiving the control diet) and as a
result the cattle lost on average 7.0 kilograms of live body weight during their two weeks at the
feeding facilities. This most likely occurred because the cattle had not adjusted sufficiently to the
facilities or diet during the acclimation period.
Implications
The Centers for Disease Control (CDC) estimates that there are 76 million cases of food-borne illness in the United States annually, with 14 million cases attributed to known pathogens. *E. coli* alone is estimated to account for 76,000 cases of food-borne illness and 76 deaths annually. Multiple intervention strategies to inhibit or eliminate *E. coli* in the beef production process are extremely important to the industry. This research provides useful and important information pertaining to the safe use of chlorate as a feed and/or water supplement for reducing *E. coli* O157:H7 concentrations in cattle and provides a basis for further pharmacological studies that may ultimately be needed for FDA consideration.

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