Guidance on risk reduction during animal production

Introduction

The scientific community continues to work with animal agriculture to investigate methods to reduce food safety risks through the use of specific production practices. Although much has been learned about the ecology of biological, chemical and physical hazards during animal production, there are as yet no specific production practices addressing biological hazards that consistently and predictably lead to improvement in food safety. Results are promising in some cases and those avenues are still under investigation. A key point to recognize is that risk reduction interventions that may be expected in the future will necessarily arise from those areas currently under research, or new areas added to the research agenda. It is important, therefore, for producers to be aware of the practices being explored so that they can have input into the process and raise concerns about (1) areas that are not currently under investigation that should be, (2) the economic impact of implementing new practices on the farm, and (3) the impact of food safety hazards on the marketability of their products.

Management Practices Currently Under Research

Researchers approach the problem of food safety on the farm cognizant of the need for cost effective and practical methods that reduce hazards. Appropriate management practices are being explored to find cost-effective ways to prevent, reduce, or eliminate hazards during animal production. Of special interest are ways to reduce the risk of *E. coli* O157:H7 and *Salmonella spp*. Currently, no clear association has been found between management factors and the presence of *E. coli* or *Salmonella spp.* Research, however, shows promise in certain areas. The following highlights are not specific practices that can currently be recommended for implementation, but they show promise and may become recommendations in the future.

Management Practices

1. Housing	Separating calves from adults shows some effect in reducing prevalence/shedding of *E. coli* O157:H7 in calves.
2. Feed and water	Feed and water may serve as sources by which *E. coli* O157:H7 or *Salmonella spp.* can enter the production unit. Water trough design is an important factor in the potential effectiveness of using water chlorination. Cattle should be prevented from standing in or defecating in the troughs. **Hyperchlorination (2-5 PPM)** reduces total *Escherichia coli* concentrations 90% over non-chlorinated troughs as long as the troughs are not contaminated by organic material, such as manure. Hyperchlorination does not adversely affect the palatability of the water and had no detectable effect on performance (feed intake, feed efficiency, or rate of gain). Appropriate chlorine levels are

difficult to maintain and need to be adjusted at least daily. Providing chlorinated drinking water alone, however, is not enough to control shedding. There appear to be other unidentified factors at work that impact the prevalence of animals shedding *E. coli* O157:H7, because the percentage of animals shedding tends to peak at the same time in pens with or without chlorinated drinking water.

Electrolyzed oxidizing (EO) water was shown to kill *E. coli* O157:H7 cells in vitro It is produced by exposing deionized water containing 0.1% (w/v) sodium chloride to an electrolysing chamber containing an anode and a cathode separated by a diaphragm. Point source inactivation of potential waterborne pathogens by minimal concentrations of EO water solutions may be possible. This has not been tested under field conditions.

3. Antibiotic use

Although no specific recommendations can be made for individual antibiotics, preliminary research studies show that under the limited conditions tested: some antibiotics (tetracycline, spectinomycin) appeared to have little effect on shedding, other antibiotics appeared to reduce fecal shedding of *E. coli* O157:H7 (ceftiofur, bicozamycin, neomycin), while some antibiotics appeared to increase shedding (tilmicosin). Additional research is needed to determine if these observations are valid. Animals treated with antibiotics that increase shedding of *E. coli* O157:H7 should be separated from the herd. Antibiotics approved for use in cattle are under investigation as a pre-slaughter treatment to reduce (or eliminate) shedding of *E.* coli O157:H7 in cattle. Salmonella infections treated with antibiotics have been shown to prolong pathogen shedding.

4. Preslaughter treatments other than approved antibiotics

Pre-slaughter treatments are being investigated that may dramatically reduce the level of gram negative bacteria in the rumen and intestinal tract of cattle. They could be given to cattle/livestock shortly before slaughter and to livestock in antemortem pens. Examples include:

- sodium chlorate

In vitro studies and early experimental trials show that feeding sodium chlorate dramatically reduces the level of gram negative bacteria, including *Salmonella spp.* and *E. coli*. The Food and Drug Administration is currently considering whether sodium chlorate is generally recognized as safe (GRAS), or whether it should be regulated as a food additive, feed additive, or a drug. Pending FDA determination, sodium chlorate may not be used in cattle going to slaughter for human food. The tissues of sodium chlorate treated animals were approved to go into animal feed during the recent

field trial.

- Tasco — Tasco is an extract from the seaweed *Ascophyllum nodosum,* a known source of cytokinins with increased antioxidant activity, and is currently being fed in commercial feedlots. Field trials to demonstrate the efficacy of Tasco in reduce fecal carriage and shedding of *E. coli* O157:H7 are pending.

- Diet: hay/forage vs. grain — Using diet as a means to affect pathogen status continues to be controversial, and there are conflicting reports in the scientific literature. Feeding hay for a brief period immediately before slaughter may reduce the risk of food-borne *E. coli* infection; however, in one study, the feeding of 100% forage following a 48 hour fast resulted in a significant increase in the number of *E. coli* O157:H7 positive animals. Forage diets have not eliminated carriage or shedding of *E. coli* O157:H7, and forage diets have been associated with increased duration of shedding of *E. coli* O157:H7. Feeding of forage/roughage diets and feeding of specific grains continue to be investigated as management practices that may increase or decrease pathogens. There is no scientific support for making a recommendation on diet at this time.

5. Vaccines — Vaccines are being investigated that produce antibodies that would prevent adherence and colonization of *E. coli* O157:H7. This is important because the bacteria must attach to the intestinal tract in order to cause disease. Vaccines are being designed to prevent or minimize attachment and colonization by a variety of mechanisms. Vaccines to intimin (intimin$_{O157}$), which is an outer membrane protein adhesin that is necessary for intestinal colonization, would prevent infection. Intimin is also necessary for the attaching and effacing lesions observed in *E. coli* O157:H7 infections in piglets and neonatal calves.

6. Transgenic feeds — Research is being planned to construct a transgenic corn that expresses intimin$_{O157}$ in its seeds for testing in weaned calves

7. Competitive Exclusion — Several competitive exclusion (CE) products are under development. A pharmaceutical company has purchased a CE product designed to displace *E. coli* O157:H7 in the gastrointestinal tract, and they have received an investigational new animal drug (INAD) exemption from the Food and Drug Administration to use the product in cattle intended for use in human food. This CE product has a seven-day withdrawal time. A field trial has not been conducted yet.

   A competitive exclusion product has been developed for swine. It

is not yet commercially available.

- Probiotics — Supplementing cattle with certain probiotic cultures (two strains of *Lactobacillus acidophilus*) has been shown experimentally to decrease the incidence of *E. coli* O157:H7 in the feces of finishing beef cattle.

- Bacteriophages — Bacteriophages are viruses that have a predator-prey relationship with bacteria. Researchers have had some success killing *Salmonella spp.* on poultry carcasses. It should not be difficult to kill bacteria on beef by applying bacteriophages internally as well as to carcass surfaces. Bacteriophages are currently not approved for use on human food.

Conclusions

Progress continues to be made in the search for cost-effective strategies that can be implemented during animal production to reduce the risk of food safety hazards entering the farm-to-table continuum. Research depends upon the production community to provide access to farms in order to collect the samples needed to determine the ecology of pathogenic organisms. It is essential to determine the mechanisms used by pathogens to enter farms, to spread between animals and within the environment, and the specific conditions that affect pathogen survival. With this knowledge, interventions can be found to prevent, control, or eliminate pathogens on the farm.

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