On Farm Food Safety Strategies

INTERVENTION SUMMARY	
Status	Some currently available and some emerging technologies
Location	Farm and feedlot
Intervention type	Diet manipulation or vaccination
Treatment time	Can take up to months
Regulations	Manipulation of feed ingredients approved Use of vaccines, supplements, additives and probiotics require approval
Effectiveness	Variable
Likely cost	Variable
Value for money	Difficult to ascertain at present
Plant or process changes	Any changes would occur on farm or at feedlot Animal handling facilities would be required to administer treatments
Environmental impact	Few alterations envisaged
OH&S	Handling of animals involves a certain amount of risk Animal treatments and feed additives may have specific handling and storage requirements
Advantages	May be possible to prevent or reduce excretion of *E. coli* O157:H7 in animal faeces.
Disadvantages or limitations	No consensus in literature Supplements and vaccines not yet available May leave residuals in the meat

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The farm or feedlot is the origin of microorganisms introduced onto carcasses during slaughter and dressing. During rearing, numerous factors interact to affect the visual cleanliness and pathogen shedding characteristics of livestock. Adam and Brülisauer (2010) suggest that there are four key aspects for control of pathogens on the farm: animal husbandry, cleanliness of animals, feeding and transport to slaughter. Good standards of hygiene are the essential starting point for minimising the levels of pathogens in livestock. These include the provision of clean and dry bedding, rodent control, cleaning of water troughs every 2-3 weeks, minimising young stock contact between herds and leaving a down time period after the spreading of manure on, or close to, grazing fields. Water troughs have been shown to support *E. coli* O157, and be a source of colonisation of previously 'clean' animals, so control of pathogen populations in the water could be a possible means of reducing the incidence. Chlorine would appear to be the treatment of choice, but some strains of *E. coli* are particularly resistant to chlorine, and animal water troughs often contain large amounts of organic material, which would inactivate the chlorine.

A number of research groups have considered the effects of different feed ingredients and diet manipulation on the shedding of pathogens by livestock, but the results are often conflicting. It appears that changes in diet and management practices could precipitate increased shedding of pathogens, perhaps as an outcome of the 'stress' caused by the changes *per se* or as a result of a change in gut pH. A review by Pointon *et al.* (2012) concluded that animals should be fasted before loading for ≤24 hours to help minimise hide/fleece soiling during transport. This is because greater than 48 hours off feed before slaughter can lead to increased pathogen load in faeces. An extract from the brown seaweed *Ascophyllum nodosum* has been used as a feed additive to promote stress tolerance, and researchers found that feeding this brown seaweed supplement to feedlot cattle 14 days prior to slaughter was associated with decreased prevalence of *E. coli* in faeces and on hides, but more research would be necessary to confirm these results (Barham *et al.* 2001). In addition, Jeong *et al.* (2011) found that cattle feed supplemented with chitosan microparticles decreased *E. coli* O157:H7 shedding.

There is a significant amount of research into the feeding of probiotics, or 'good bacteria', to livestock to competitively exclude the pathogens. In the poultry industry, a product containing a cocktail of 29 organisms (Preempt™) has been approved by the US FDA for its use to reduce *Salmonella* incidence in flocks. Some organisms have also shown promise in reducing the incidence of *E. coli* O157:H7 in calves (Zhao *et al*., 1998), while natural products from some non-pathogenic *E. coli*, 'colicins', seem to have some inhibitory effects on *E. coli* O157:H7 (Murinda *et al.*, 1996, Etcheverria *et al.*, 2006). However, Cull *et al.* (2012) studied the use of a *Lactobacillus acidophilus*-based direct-fed microbial (DFM). They found that there was no reduction in either the levels of cattle carrying *E. coli* O157:H7 nor the number of high shedding cattle. On the other hand, sodium chlorate, given by mouth to cattle, sheep and pigs has been shown to reduce *S.* Typhimurium and *E. coli* O157:H7 in the intestinal content (Anderson *et al.*, 2001; Edrington *et al.*, 2003; Loneragan and Brashears, 2005), and work is underway to see if this can be used in the field. No regulatory approvals have been granted to date for sodium chlorate in the US, EU or Australia.

Vaccination of poultry against *S.* Enteritidis PT4 has been very effective in reducing the incidence of this organism in poultry flocks and eggs. It also has a substantial impact on the incidence of salmonellosis in humans in the UK (Adak *et al.*, 2002). Furthermore, there is substantial research into the production of a vaccine against *E. coli* O157:H7 for cattle. Preliminary trials in Canada have shown promise (Huffman, 2002). A two-dose vaccination regime effectively reduced *E. coli* O157:H7 faecal shedding and hide contamination (Smith *et al*., 2009*)*. The USDA granted approval in 2009 for a conditional licence to Epitopix to sell a vaccine. Cull *et al.* (2012) examined the efficacy of an *E coli* O157:H7 vaccine. They found that the level of *E coli* O157:H7 positive cattle decreased (from 31.7% down to 17.4 ± 3.95%) as did the incidence of high shedding cattle (from 3.5% down to 0.95 ± 0.26%)

Use of vaccines, supplements, additives and probiotics require approval by the Australian Pesticides and Veterinary Medicines Authority (APVMA).

On-farm intervention strategies for *E. coli* O157:H7 in cattle (adapted from Brashears *et al*., 2005)

Intervention strategy	USDA approved	Cattle type	Effective?	Estimated Cost (A$)
Diet formulation				
Forage-based diets	Yes	Mature dairy	Yes	Unknown
Grain-based diets	Yes	Sheep model, dairy, steers	Yes	Unknown
Whole cottonseed	Yes	Finishing beef	No	Variable based on season & geographic location
Diet supplements				
Probiotic bacteria	Yes	Finishing beef, weaned calves	Yes	~2-3¢ per animal per day in feedlot
Brown seaweed	Yes	Finishing beef	Yes	~$5-$6 per animal
Vaccination	No	Finishing beef	Yes	~$1.50-$3.00/animal
Sodium chlorate	No	Mature dairy	Yes	Unknown
Antibiotics				
Neomycin	No	Finishing beef	Yes	~$2/animal

Proponent/Supplier Information

Epitopix manufacture a vaccine for cattle to reduce the prevalence of *E. coli* O157:H7 and one for *Salmonella* Newport to be distributed in the US by Pfizer Animal Health and Agrilabs respectively.

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References

Adak, G. K., Long, S. M., O'Brien, S. J. (2002) Trends in indigenous foodborne disease and deaths. Gut **51**: 832-841.

Adam, K., Brülisauer, F. (2010) The application of food safety interventions in the primary production of beef and lamb: A review. International Journal of Food Microbiology **141**: S43-S52

Anderson, R. C., Buckley, S. A., Callaway, T. R., Genovese, K. J., Kubena, l. F., Harvey, R. B., Nisbet, D. J. (2001) Effect of sodium chlorate on *Salmoenlla typhimurium* concentrations in the weaned pig gut. Journal of Food Protection **64**: 255-258.

Barham, A. R., Barham, B. L., Blanton, Jr, J. R., Allen, V. G., Pond, K. R., Miller, M. F. (2001) Effects of Tasco 14 on prevalence levels of enterohemorragic *Escherichia coli* and *Salmonella* spp. in feedlot steers. Journal of Animal Science **79**: 257.

Brashears, M., Loneragan, G., Younts-Dahl, S. (2005) Controlling microbial contamination on the farm: an overview. In: Improving the Safety of Fresh Meat (Ed. Sofos, J. N.). Woodhead Publishing in Food Science and Technology, CRC Press, New York. Pp 156-174.

Cull, C. A., Paddock, Z. D., Nagaraja, T. G., Bello, N. M., Babcock, A. H., Renter, D. G. (2012) Efficacy of a vaccine and a direct-fed microbial against faecal shedding of *Escherichia coli* O157:H7 in a randomized pen-level field trial of commercial feedlot cattle. Vaccine **30**: 6210-6215Davies, M. H., Hadley, P. H., Stosic, P. J., Webster, S. D. (2000) Production factors that influence the hygienic condition of finished beef cattle. The Veterinary Record **146**: 179-183.

Edrington, T. S., Callaway, T. R., Anderson, R. C., Genovese, K. J., Jung, Y. S., McReynolds, J. L., Bischoff, K. M., Nisbet, D. J. (2003) Reduction of *E. coli* O157:H7 populations in sheep by supplementation of an experimental sodium chlorate product. Small Ruminant Research **49**: 173-181.

Etcheverria, A. I., Arroyo, G. H., Perdigón, G., Parma, A. E. (2006) *Escherichia coli* with anti-O157:H7 activity isolated from bovine colon. Journal of Applied Microbiology **100**: 384-389.

Huffman, R. D. (2002) Current and future technologies for the decontamination of carcasses and fresh meat. Meat Science **62**: 285-294.

Jeong, K. C., Kang, M. Y., Kang, J., Baumler, D. J., Kaspar, C. W. (2011) Reduction of *Escherichia coli* O157:H7 shedding in cattle by the addition of chitosan microparticles to feed. Applied and Environmental Microbiology **77**: 2611-2616

Loneragan, G. H., Brashears, M. M. (2005) Pre-harvest interventions to reduce carriage of *E. coli* O157 by harvest-ready feedlot cattle. Meat Science **71**: 72-78.

Murinda, S. E., Roberts, R. F., Wilson, R. A. (1996) Evaluation of colicins for inhibitory activity against diarrheagenic *Escherichia coli* O157 strains, including serotype O157:H7. Applied and Environmental Microbiology **62**: 3169-3202.

Pointon, A., Kiermeier, A., Fegan, N. (2012) Review of the impact of pre-slaughter feed curfews of cattle, sheep and goats on food safety and carcase hygiene in Australia. Food Control **26**: 313-321.

Smith, D.R., Moxley, R.A., Klopfenstein, T.J., Erickson, G.E. (2009) A randomized longitudinal trial to test the effect of regional vaccination within a cattle feedyard on *Escherichia coli* O157:H7 rectal colonization, fecal shedding and hide contamination. Foodborne Pathogens and Disease **6**: 885-892.

Zhao, T., Doyle, M. P.,Harmon, B. G., Brown, C. A., Mueller, P. O. E., Parks, A. H. (1998) Reduction of carriage of enterohemorrhagic *Escherichia coli* O157:H7 in cattle by inoculation with probiotic bacteria. Journal of Clinical Microbiology **36**: 641-647.