Results for today; Ideas for tomorrow

Meat Technology Update

Newsletter 6/03 December 2003

E. coli, *E. coli* O157 and *Salmonella*

E. coli are part of the normal intestinal flora of many animals, including humans. Most strains of *E. coli* have no detrimental effects on the animal host; however, some strains can cause serious human illness.

E. coli O157 (H7 or H-) is a particular type of *E. coli* that can cause gastroenteritis, which in some cases progresses to life threatening complications such as haemolytic uraemic syndrome (HUS). They do this by attaching to the wall of the human gut and producing toxins.

Salmonella and *E. coli* are mostly carried by healthy animals and can be shed in their faeces. Outbreaks of *E. coli* O157 have occurred from direct contact with cattle, and often, also, because of contamination of:

Figure 1. Cattle being fattened in a feedlot.

- dairy products (with yoghurt, cheese, milk—from raw milk or when pasteurisation has failed, or post-pasteurisation contamination);
- meat and meat products (fermented meats, ground beef such as in undercooked hamburger patties, cooked cold meats, jerky);
- horticultural products which have become contaminated directly with animal manure (e.g. apple juice and cider);
- water—either directly through consumption of contaminated ice or drinking water, or swimming in contaminated waters.

There are some of the key questions in learning more about *E. coli* and *Salmonella* in cattle.

1. How many cattle excrete these pathogens in their faeces and what is the number of microorganisms excreted by each animal?
2. What is the ecology of these organisms i.e. where are they found and how are they transmitted between animals?
3. What controls can we use for managing these bacteria in cattle?

Although the emphasis of this newsletter is on *E. coli* O157 in cattle, it also occurs in sheep and goats.

Salmonella and *E. coli* in cattle before slaughter

Food Science Australia conducted a national survey to determine if cattle from different production systems differed in the prevalence and numbers of *E. coli* O157 and *Salmonella*. A total of 310 faecal samples were collected from abattoirs throughout Australia; 155 samples were from grass-fed cattle and 155 from grain-fed cattle. The researchers found 13% of faeces were positive for *E. coli* O157:H7 and 7% were positive for *Salmonella*. The number of positive faeces did not differ between the two groups of cattle.

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The counts of *E. coli* O157 and *Salmonella* in cattle faeces were mostly very low, with the majority of animals shedding less than 10 colony-forming units/g. In contrast the counts of generic *E. coli* in the surveyed cattle were mostly between 10,000 and 1 million colony-forming units/g faeces. There was no significant difference between the two groups (Figure 2). These data cannot be compared with other studies because very little work has been done to obtain counts in faeces by accurate and sensitive methods.

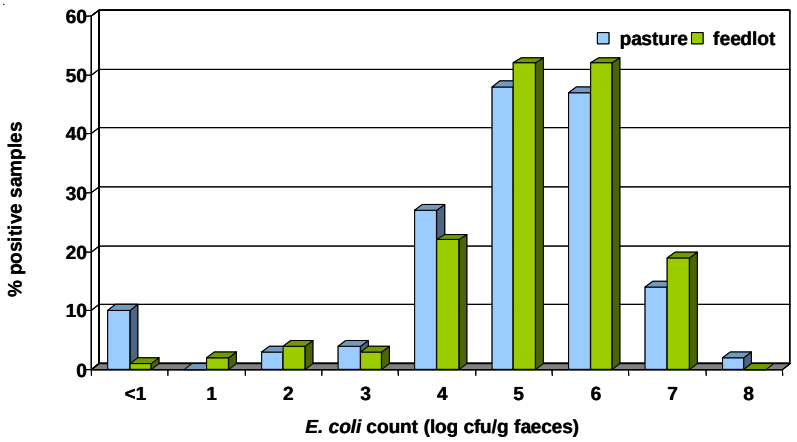

Figure 2. Total *E. coli* counts in cattle faeces from different production systems.

The prevalence of *Salmonella* and *E. coli* O157 in cattle varies within groups of animals and also between different groups of animals. Sporadic outbreaks of *E. coli* O157 have been observed both in Australia and overseas in cattle herds and in other animal groups. A study of animals on a dairy farm over a year showed continuous low prevalence of *E. coli* O157 in faeces, which increased during an outbreak that occurred during September (Figure 3). Had cattle from this farm been slaughtered during this outbreak there would have been a higher chance of contamination on the carcases, at least up until the chilling phase. It is important to realise that the prevalence of *E. coli* O157 within a herd can change greatly within a short period and sampling on different occasions can give very different results.

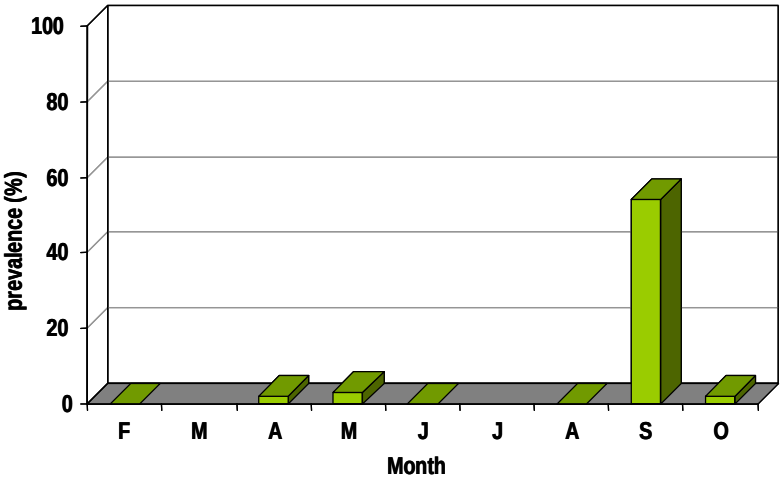

Figure 3. The prevalence of *E. coli* O157 in faeces from cattle on a Queensland dairy farm.

E. coli O157 and *Salmonella* may be introduced into a herd when cattle are moved to a contaminated area, or when new animals are added to the herd, or through contact with other animals such as cats, rodents and birds. Once introduced, these microorganisms can circulate among animals via direct contact (licking etc.), via feed and water troughs and the general environment. *E. coli* O157 and *Salmonella* can survive in soil and on pasture for several weeks (depending on the conditions) and animals grazing these fields may become contaminated. It is important to note that contamination may occur more than once with different *E. coli* O157 strains entering the same herd on several occasions.

There are indications that the season and animal husbandry practices play a role. Some generalisations that can be made from published research on *E. coli* O157 and *Salmonella* include:

- younger animals generally have a higher prevalence than adults;
- the prevalence of *E. coli* O157 is generally higher in the warmer months in some countries, particularly in the USA and UK; but, currently, it is not known if this is the case in Australia;
- there is also thought to be a higher prevalence of *Salmonella* with intensively reared animals;
- fasting and re-feeding can increase the number and prevalence of *Salmonella* shed in faeces;
- the prevalence of *Salmonella* on hides can increase during transport but the prevalence of *E. coli* O157 appears to be less affected by transport.

Furthermore, there are likely to be other factors that we don't know about, which may affect the prevalence of these bacteria in cattle.

Livestock Interventions

A number of interventions are being considered to reduce the risk of *E. coli* O157 on livestock at the time of slaughter. For example the method of feeding may influence *E. coli* O157. Diet can alter rumen pH and produce volatile fatty acids, which may reduce or enhance the risk of intestinal colonisation of certain organisms. There are reports that feeding hay rather than grain before slaughter can reduce the risk of cattle carrying *E. coli* O157 but these reports are not confirmed by Australian studies.

Vaccines to prevent *E. coli* O157 are under development. Results appear to have been variable and the optimum time to administer the vaccine and costs have not been determined. Feed additives such as sodium chlorate, neomycin and probiotics are also being investigated. Apart from the efficacy of these treatment there are also questions about the implication for animal welfare, possible environmental contamination and potential build-up of resistance.

There is some evidence that *E. coli* O157 may colonise the anal/rectal part of the intestine. If this is the case, treatments that largely affect

the rumen or small intestine may have very little effect on *E. coli* O157. Any treatment to reduce the risk of *E. coli* O157 in livestock must be used with caution. It is possible that if conditions are manipulated to reduce the risk of colonisation by *E. coli* O157, the conditions may become favourable for colonisation by another organism such as *Salmonella*.

E. coli and *Salmonella* in the abattoir

A study conducted by Food Science Australia followed the contamination in an abattoir by testing for, and counting, *E. coli* O157, *Salmonella* and total *E. coli* in four groups of cattle from different origins—some reared in feedlots and some fed on pasture.

Samples were collected from consecutively slaughtered animals from oral cavities, hides, paunches (rumen), faeces taken post-evisceration direct from the colon, and carcases both pre- and post-chill. The samples were all carefully identified so that test results could be related to specific animals. In addition, faecal samples were collected from the abattoir holding pen before the animals were slaughtered.

The results showed that *E. coli*, *E. coli* O157 and *Salmonella* were present in the cattle faeces, in oral cavities, on hides and on pre-chilled carcases, but were detected less frequently on post-chilled carcases. *Salmonella*, but not *E. coli* O157, was detected in the paunch, suggesting burst paunches may increase the risk of carcase contamination with *Salmonella* more than *E. coli* O157.

In three of the four groups of cattle the prevalence of *E. coli* O157 positive samples was low, but in one group, *E. coli* O157 was found on all hides, most oral cavities and in the faeces of many animals. One animal had high numbers of *E. coli* O157 in its faeces, and there were high counts on some of the hides. This was the only group of animals where a few pre-chilled carcases were found to be positive (but at low levels). The positive carcases were clustered around those animals that had high counts on the hides and in the faeces. No *E. coli* O157 were found on the carcases after chilling. It is suspected that this group of animals was being slaughtered during an outbreak of *E. coli* O157 shedding similar to that shown in Figure 3.

The number of *Salmonella* positive animals was higher in the first three groups, but was detected less often in the group that had high numbers of *E. coli* O157.

A lot of work is being done to find ways to control *E. coli* O157 and *Salmonella* at the abattoir. Some strategies include:

1. using good manufacturing practices (GMP) such as ensuring animals are clean, there are adequate and hygienic facilities, and that staff are trained in GMP;
2. reducing the microbial numbers on live animals prior to slaughter, for example, using washing and dehairing methods;
3. reducing the microbial numbers on carcases during processing by using decontamination methods;
4. using effective post-processing conditions such as chilling programs to prevent bacterial growth.

Some interventions are summarised in Meat Technology Update Newsletter 2/03. To determine which interventions are suitable for your establishment you should consider the:

- effectiveness of the intervention (that is, how much of a reduction in microorganisms can be expected);
- effect on product quality (colour, shelf life etc.);
- capital costs;
- running costs, including maintenance;
- environmental considerations such as water use and chemical and biological waste;
- customer's requirements and what are acceptable technologies for them.

Unfortunately, there is no 'magic bullet' intervention that will eliminate *E. coli* O157 and *Salmonella*.

USDA and AQIS policies

The US has recently introduced new rules based on the proposition that *E. coli* O157:H7 is a hazard likely to occur in beef production. Where this is the case, the hazard must be addressed in each processor's HACCP plan by implementing a critical control point (CCP) that has been validated in-plant, or by identifying an appropriate existing, validated CCP.

The good microbial quality of Australian meat is principally a result of careful attention to pre-slaughter and processing practices. In their response to FSIS, AQIS highlighted that there are fundamental differences between Australian and USA meat industries, and it is these differences that contribute to a greater level of microbial control, including:

- lower prevalence of faeces on Australian livestock presented for slaughter;
- the line speeds in abattoirs are paced to allow a standard of hygienic dressing that is consistently high;
- lower staff turnover rates;
- comprehensive training of operators;
- frozen distribution and storage of Australian product.

The incidence of *E. coli* O157:H7 in Australian meat shipped to the US for grinding is much less than the US incidence. We can't argue that *E. coli* O157 is a hazard not likely to occur in Australia because we know it is in livestock, but the methods used to process animals should be recognised as suitable for preventing carcase contamination.

Testing for *E. coli* O157:H7

The major reasons why processors need to test for *E. coli* O157:H7 are customer requirements.

The USA Food Safety and Inspection Service (FSIS) Directive 10,010.1 defines a positive sample as one which is 'positive for *E. coli* O157 and

(1) the H7 antigen test is positive OR (2) the H test is non-specific or the culture is non-motile and either toxin or one or more toxin genes are present'.

A comprehensive information sheet on 'Testing meat for *E. coli* O157:H7' is available from the Meat Update website: www.meatupdate.csiro.au

What if FSIS detects *E. coli* O157 in ground beef?

If the FSIS detects *E. coli* O157:H7 in ground beef produced from your boneless meat, but you found no *E. coli* O157:H7 in the same production lot, how would you explain the apparent difference in test results?

Clearly *E. coli* O157:H7, if present, is not spread uniformly throughout consignments of boneless meat and there are differences in sampling plans, sampling technique and testing methodology that affect the probability of detecting *E. coli* O157:H7. End product testing for acceptance of product is not considered to be a useful technique for control of pathogens.

Apart from questioning the FSIS sampling and testing techniques (not recommended), there are several things that can be done to provide assurance to customers that you have control over the risk of contamination of meat with *E. coli* O157:H7. These include:

- substantiating that your current sampling plan is valid and that changing it is not likely to give greater confidence of the absence of *E. coli* O157 because the pathogen occurs so infrequently;
- demonstrating that you have control of hygienic dressing and chilling by providing relevant supporting documentation e.g. conformance monitoring, chiller loading procedures etc.;
- if the product is hot boned, show that you have reviewed your cooling rates and the Hot Boning Index is within limits;
- indicating that when you process 'at risk' stock e.g. young animals, you put them on the end of the kill and boning schedules;
- discussing that interventions will give a degree of added security to the process, but they cannot be relied on to completely eliminate *E. coli* O157.

Further information

Information sheet 'Testing meat for *E. coli* O157:H7 and H-' February, 2002 – available from: www.meatupdate.csiro.au

Pathogen reduction interventions for carcases, Meat Technology Update Newsletter 2/03

The research published in this newsletter was conducted by the Food Safety and Quality Group of Food Science Australia at their Brisbane Laboratory and was supported by MLA. For further information please contact Dr Trish Desmarchelier or Dr Narelle Fegan at the following address:

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