Natural Antimicrobials, Parasitic Bacteria and Bacteriophages

INTERVENTION SUMMARY	
Status	Currently Available
Location	Packaging/retail
Intervention type	Surface treatment or mixed into product, or impregnated into product packaging.
Treatment time	Part of product, or product packaging.
Regulations	Some oil extracts approved in EU, US and Australia, other bacteriocins, eg. nisin, have approval in US only (nisin is under consideration in the EU)
Effectiveness	Potentially – if used as part of whole of chain microbial reduction approach
Likely Cost	Variable
Value for money	Cost of extraction may be too expensive
Plant or process changes	Not likely to be a huge impact as can be incorporated into processing eg. impregnated into packaging, included in product mixing etc.
Environmental impact	Minimal
OH&S	None identified
Advantages	Some oil extracts may add a flavour benefit to the meat product eg. rosemary, garlic, cloves.
Disadvantages or Limitations	Cost of extraction of some antimicrobials may be too expensive for some applications Some food components may inhibit the bacteriocins May limit markets due to changing product characteristic eg flavour

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Natural products such as sugar, salt, vinegar, or herbs and spices have long been used to preserve foods and slow the onset of spoilage. Recently, extracts and essential oils of certain plants have been shown to have antioxidant and antimicrobial effects, as well as imparting flavour to foods. Some have shown promise as potential food safety interventions when added to ground beef. Micro-organisms themselves produce substances that are inhibitory to other bacteria, and this property potentially could be harnessed and used in food production. There are also bacteria that prey on other micro-organisms, and bacteriophages, which could be used to prevent spoilage and reduce the risk of food poisoning.

Plant Extracts

Plant extracts have received a lot of attention for use in meat products due to their antioxidant and antimicrobial activities as well as flavour properties. Such extracts have included garlic, rosemary, clove, and pimento as well as essential oil from *Thymus eigii*, *Picea excelsa*, and *Camellia japonica*. These natural extracts have the potential to be used with other preservation methods to reduce pathogens in ground beef (Zhu *et al*. 2005; Ahn *et al*. 2004).

Microbial Products

Bacteriocins are naturally occurring compounds, such as nisin, that are active against bacteria. Nisin seems to be more effective against Gram positive bacteria and also when used in combination with chemicals such as EDTA. Reductions of 1.8-3.5 log in Gram positive bacteria have been reported (Cutter and Siragusa 1995). Gram positive bacteria include *Staphylococcus*, *Listeria* and lactic acid bacteria. Gram negative bacteria include *E. coli*, *Pseudomonas* and *Salmonella*. Nisin is approved for use in the US in casings and on cooked ready-to-eat (RTE) meat and poultry products. A blend of encapsulated nisin preparation (90.9%), rosemary extract (8.2%) and salt (0.9%) is approved for use in frankfurters and other similar cooked meat and poultry sausages.

The cost of extraction of natural antimicrobials can make them expensive particularly when used in complex food systems, and the bactericidal activity can be inhibited by binding of the bacteriocins to food components and inactivation by enzymes such as proteases (Ganzle *et al*. 1999).

A number of lactic acid bacteria have been shown to inhibit pathogen growth in ground beef: for example, *Lactobacillus reuteri* has is a highly effective competitive inhibitor to *E. coli* O157:H7 in ground beef stored under modified atmosphere packaging, and has been responsible for actual reductions of up to 6 log during 20 days storage (Muthukumarasamy *et al.* 2003) , while *Lactobacillus plantarum* can reduce the population of *E. coli* O157:H7 by 1.5 log and *Salmonella* by 3 log when added to ground beef before vacuum packaging. Taste panels have indicated that there are no detrimental effects on the ground beef after 5 days storage with the lactic acid bacteria (Smith *et al.* 2005), and there were significant reductions in the numbers of *E. coli* O157:H7 and *Salmonella* in the product. These bacteria naturally produce bacteriocins that are effective against some pathogens such as *Listeria*, *E. coli* O157:H7 and *Salmonella*, and can also be added to cooked meat products as starter cultures, before packaging, to inhibit growth of spoilage organisms.

Parasitic Bacteria

Parasitic bacteria, especially *Bdellovibrio bacteriovorus* prey on a range of Gram negative pathogens and spoilage organisms (Hanlin and Evancho 1992). These organisms are present in soil and faecal contents of many species, and can be isolated and purified. Little work has been done on their applications to foods, but *Bdellovibrio* isolates have achieved 2.5-7.9 log reductions in *E. coli* and *Salmonella* populations during 7 hours in culture, and 3.0-3.6 log reductions on stainless steel (Fratamico and Cooke 1996), over a period of 24 hours. The organism is most effective at 30-37°C, but between 12 and 19°C, parasitism still occurs, but more slowly (Fratamico and Whiting 1995).

Bacteriophages

Bacteriophages are the viruses of the microbial world – they attack and can destroy their host microorganisms in a similar fashion to how the influenza virus (flu) attacks the human population. Like flu, there are virulent strains and more benign strains. Recently, it has been found that the virulent strains

can be purified and used to prevent growth of spoilage and pathogenic organisms in a range of foods, and can reduce shedding of *E. coli* O157:H7 when fed to cattle (Greer 2005). Phages are a natural product, so environmental issues would be minimal, and their host-specificity means that they are safe, as they do not attack the "good bacteria" in the intestine. This specificity, however, also means that their usage is fairly limited in that a phage against *E. coli* would not give protection against *Listeria*, for example. Also, the target microorganisms may develop resistance to the phage through their natural evolutionary process.

Proponent/Supplier Information

Further information on natural antimicrobials including nisin and protective bacterial cultures can be obtained from:

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Website: www.danisco.com.au

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