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A new weapon against salmonellosis?

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Salmonellosis, a well-known cause of food poisoning in man, also poses a threat to our livestock industries because of the direct losses it causes in animals. The Department of Agriculture Microbiology Section is now investigating a new way to control Salmonellosis by using a living vaccine which "self destroys" once it has done its job of immunising the animals.

Cause of the disease

Salmonellosis is caused by bacteria of the genus Salmonella. There are more than 2000 known serotypes of Salmonella, which vary greatly in their ability to cause disease in different animals and in man. Several hundred of these serotypes are known to be present in Western Australia. Some serotypes only come into prominence infrequently...some people will remember the Salmonella muenchen problems in poultry meats in the late 1970s...but Salmonella typhi-murium is the most common type threatening human and livestock health.

How salmonellis works

Salmonellae usually attack the gastro-intestinal system, causing diarrhoea and fever. Death can result if they invade the rest of the body, causing septicemia. Many animals, birds and even people can carry and excrete Salmonellae without any outward sign of disease. These carriers provide a continuous source of environmental contamination with Salmonella so it may seem surprising that Salmonellosis is not more widespread.

There are good reasons for this. The first is the 'numbers game' which is important in many bacterial diseases. Salmonellae have to compete with other bacteria which live in the normal intestine. Research has shown baby chickens dosed with normal gut bacteria at an early age are able to throw off small numbers of Salmonellae because the other bacteria prevent the Salmonellae from becoming established.

Competitive inhibition

This competitive inhibition does not work if the dose of Salmonella is large, as often happens when large numbers of animals are crowded together. Crowding and transport produces stress, the other important factor predisposing an animal to salmonellosis. Researchers do not clearly understand why stress is important. We know that stress often stops animals from eating. This, or even a sudden change in feed type, can cause changes in the population of bacteria which live in the gut, letting the Salmonellae build up. Stress also has a big effect on the secretion into the gut of substances which may help to provide the Salmonellae with a favourable environment. The hormones released by a stressed animal also have a damaging effect on its immune system, making it less capable of resisting infections of all kinds. Salmonellae are poised to take advantage of this deficiency.

In crowded and stressed animals the number of Salmonellae being excreted by carrier animals escalates very rapidly, and the likelihood of infection of other animals also increases. The results can vary. In poultry, all that may happen is that the number of Salmonellae in the gut rises. The birds might not look sick, but their carcasses readily become contaminated at the processing plant. Then if the carcasses are not properly cooked (Salmonellae are readily
killed by cooking) or if other foods not to be cooked become contaminated by the carcase, humans can become infected with Salmonellae and suffer food poisoning.

In other animals, stress and crowding can lead rapidly to an outbreak of salmonellosis, with scouring and deaths. This has been a particular problem in the live sheep export trade where in the past salmonellosis has caused spectacular losses in badly stressed sheep.

What can be done about salmonellosis? Certainly eradication is not a feasible proposition. Salmonellae occur in everything from seagulls to lizards. It is simply not practical to attempt to eradicate them completely from the general environment although great progress has been made towards this end within the poultry industry where the birds can be protected from outside sources of infection.

Antibiotics and other drugs are not the answer either. Salmonellae rapidly develop resistance to antibiotics, so although antibiotics have a place in treatment when outbreaks occur, they have no place in preventing the disease.

Management is certainly the most effective means of preventing salmonellosis. Avoiding stress is the most important steps. The Department's Sheep and Wool Branch has made great progress in improving the management of sheep for export, so that deaths due to salmonellosis have declined substantially. Unfortunately, even the best management cannot entirely prevent crowding or stress when large numbers of animals are to be transported, and some losses from salmonellosis can still occur.

Research in the Microbiology Section has shown that the most important of the Salmonellae causing losses among live sheep is Salmonella typhi-murium. Today, research is being aimed at finding practical ways to give sheep added protection by vaccination.

Protection by vaccination

Killed salmonella vaccines have been available for a long time, but have never been used widely. For effective results, animals must be given two injections of killed Salmonella vaccine several weeks apart. Even then the immunity produced is not very strong. In the Microbiology Section, we decided killed vaccines were not a very practical proposition for large numbers of export sheep because of the time-scale and labour involved. The industry needed a vaccine which could be administered easily and cheaply, and preferably as a single dose. That almost certainly demanded a living vaccine, but here our problems started. Unlike many viruses, Salmonellae cannot be easily 'attenuated' (or made safe) while retaining their ability to immunise animals.

Some years ago unusual strains of Salmonellae with rough-textured appearance were discovered. At first these mutants were considered to be laboratory curiosities and they were relegated to the 'avery towers' of bacteriology. Recently however, their properties have been studied more closely. Bacteriologists found that the 'rough' strains lacked the enzymes needed to make a component of their cell wall—hence their rough appearance. It was found that the lack of this cell wall component drastically reduced the ability of these strains to cause disease. Unfortunately it was also found that the cell wall component was needed to immunise animals and interest in rough strains as potential vaccines begin to wane. Then came a breakthrough. A rough strain of Salmonella typhi-murium was discovered that lacked one particular enzyme, uridine diphosphate-galactose-4-epimerase (or 'gal-E'). If the gal-E strain is provided with an animal source of the sugar galactose it produces normal cell wall material and can immunise the animal.

However waste products accumulate in the gal-E bacteria and eventually causes them to break apart and die. This 'self destruction' feature gives us the opportunity to use gal-E mutants as vaccines. They can live in an animal for only a short while...long enough to immunise it but not long enough to cause disease.

Research overseas has shown that gal-E strains can be used to immunise calves and chickens. Our research at the Animal Health Laboratories has shown that sheep can be protected from Salmonella typhi-murium by vaccination with the gal-E mutant. The vaccine is given orally.

This research is still in its early stages but we believe there is a potential to produce a vaccine which could be simply poured into the drinking water of a mob of sheep before export, a useful new weapon in our anti-Salmonella campaign.