Probiotics for pigs – how can they be made to work?

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The removal of antibiotic growth promoters from farm animal feeds has led to renewed interest in the use of live microbial cultures or direct fed microbials, also called probiotics, as a replacement.

A new approach to propagate probiotic bacteria, on-farm, to induce viable strains in sufficient numbers for better establishment and colonisation in the intestine of the pig, has been developed. This new system has proven to be very efficient in Denmark, especially in liquid feeding systems for pigs.

The intestinal microflora of the pig is capable of resisting the establishment of certain intestinal pathogens, and it has often been shown that certain lactic acid bacteria in the intestinal microflora possess an inhibitory activity towards coliform pathogens.

The addition of large numbers of lactic acid producing bacteria to the porcine microflora, in vitro, can result in a consistent and reproducible decrease in the viability of these pathogens.

It is also well known that the application of industrially produced probiotic bacteria, in vivo, generally generates very variable results. A probiotic, which is effective in one herd, may be ineffective in another. What works today may not work tomorrow. This has led to a degree of scepticism on behalf of sizeable sections of the farming and frontline veterinary communities as to the worth of bacterial probiotics in practical pig farming.

There are two broad ranges of possible reasons for this variation in practical farm results. They are not mutually exclusive and in fact may be interactive or co-dependant:

- The chosen probiotic strain may have somehow lost its potency.
- The chosen strain is being used, in the field, at less than optimum numbers.

Potency

Bacteria reproduce very quickly and they adapt rapidly to the environment in which they find themselves. The number of bacterial generations, between the isolation/fermentation, and the method of cultivation in the bacteria factory, may reduce the potency of the original isolate.

One Lactobacillus spp. may be found to be effective at inhibiting coliform pathogens on first isolation in controlled tests but may 'lose' its efficacy over time.

In the microflora of the intestine, the applied bacteria are in competition with other microbial species for nutrients and space, so that the production of compounds inhibitory to other species confers a survival advantage. This production of so-called bactericins, as distinct to the production lactic acid, may 'vary' because of the industrial manufacturing process, and may even be deactivated.

The industrial propagation of the probiotic bacteria is a very carefully controlled, even cloistered, one. They live in a screened isolation, are excluded from encountering any competitive organism, and are grown in pure culture in a nutrient rich medium, which is designed to encourage cell numbers and not bactericin production. The production of an inhibitor, active against an absent competitor represents a waste of resources for the bacterial cell.

The result may be that the members of the population which do not produce the inhibitor may grow faster and that every time the cultures are transferred to new media, the proportion of non-inhibitor producing cells increases. In this way the isolates adapt to their new 'environment' with no competing species, and the population loses its inhibitory activity against the pathogens.

There is speculation that the probiotic cultures can lose their ability to produce the bactericins it uses to kill other competitive bacteria, like E. coli, salmonella and clostridia.

Viability and numbers

During the industrial production process the factory manager has to choose when to harvest and dry the culture. Ideally the optimum is to have maximum number of cells in the active growing stage of their life cycle.

If harvested too early, the total number of cells is less than optimum and represents both a reduced plant efficiency and a less than optimum use of physical resources.

If too late, the proportion of the cells in the biomass, past their optimum, rises rapidly. These cells are more fragile than the younger, stronger ones and are more susceptible to further damage during the separation, drying, packaging and storage phases.

Freeze drying can kill between 60-90% of the bacteria. Thereafter, storage can see a further drop in viability of up to 99%, even if the cells are stored optimally.

Moreover, if these cells are then incorporated into feed pellets, they have to endure a further damaging process. The process of extruding feed produces great heat and shearing which kills a percentage of cells and thus further complicates the viability problem.

Enrobing techniques are claimed to protect the cells but the numbers of viable cells in the preparations sold ready for extrusion are typically only 10% that of the normal untreated bacteria equivalent.

Quoted counts for bacterial cells depend on the method used and can be confusing as well as misleading.

There has been some recent research into the viability of dried bacterial preparations and the idea that a bacteria cell can be

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either simply living or dead has been challenged.

Lahtinen et al have followed the work of Kell and colleagues and developed the idea that bacteria cells can be categorised in four ways:

- Viable (active and culturable).
- Dormant (inactive but culturable in an optimised growth media).
- Active but not culturable.
- Dead and not culturable.

If the simple cell numbers present is used, are the cells viable or not with respect to their ability to implant in the animal's intestine?

If a CFU method is quoted it will usually be based on enumeration on a highly nutritious growth medium containing vitamins and trace elements. These may or not be present in the liquid pig feed or if present may be rendered unavailable to the probiotic bacteria because of the superior numbers and potency of competitive wild infective bacteria and yeasts. Thus, CFU numbers made on a preparation some time before may be suspect with respect to the preparation's ability to implant in the pig's intestine.

Thus, the efficacy of live bacterial cultures (probiotics) as feed additives will dependent on:

- The initial viability and vitality of the probiotic strain employed.
- The state of the microbial population, as presented to the liquid feed; not just CFUs.
- The time of application of this probiotic to the liquid feed.
- The conditions prevalent in the intestine (intestinal physiology).
- The dietary materials reaching the intestine.
- The current microbial population of the intestine.
- The colonisation of the applied population in the intestine.
- Their ability to produce bactericins.

We believe it to be possible to improve the reproducibility of probiotic preparations by the provision of a diet suitable for the activity of the micro-organism.

Probiotics should be and can be matched to the diet or visa versa. In our opinion if we are to replace the use of antibiotics in animal feeds with probiotic bacteria, then it must be:

- Cost effective – adding sufficient numbers of CFU's for a given price.
- Provide consistency in activity – using live and viable bacteria.
- The feed diet must be consistent and suitable for the activity of the probiotic bacteria.
- The right strains suitable for the host.

A new approach

A new approach to sub-propagate probiotic bacteria on farm so as to induce viable strains in sufficient numbers for better establishment and colonisation of the liquid feed, and thus the intestine of the pig, has been developed in Denmark. This new approach has proven very efficient especially in wet feed applications in Denmark.

The farmer purchases a special plastic bag of Turbo Pre Pro containing an optimised bacterial nutrient medium and the probiotic of his choice. He adds water and leaves it to process for up to 24 hours. This preparation is then added to the liquid feeding system on a regular (daily) basis. The probiotic bacteria grown are now viable and vitalised, they dominate the liquid feed system, repress the wild yeast and infective bacteria and then colonise the intestine in numbers which are adequate for a positive effect on the animal. These wild yeasts and bacteria are the ones that remove the trace minerals and amino acids which are added as a feed supplement for the pig's health!

In Denmark we have seen very positive effects specially in sows on liquid feed diets. The application of abundant viable probiotic bacteria has resulted in an increased appetite and a better feed uptake for the sow giving:

- Lower mortality in stressed sows prior to farrowing (Clostridium difficile).
- Better and successful farrowing, resulting in fewer stillborn or enfeebled piglets.
- More milk during the first weeks of lactation.
- More uniform litter at weaning.
- Greater number of weaned piglets. ■