Without antibiotics:

A healthy role for enzymes

Indirectly, feed enzymes can influence the population of bacteria in the pig's intestines

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Feed topics

Some well-proven antibiotic growth promoters can no longer be used in pig diets in the European Union. With their enforced removal, an effective alternative strategy is needed that will maintain cost-efficient production. None of the serious contenders among current non-antibiotic additives seems likely to be adequate on its own in all farm situations. We believe the answer will come from combining various products to exploit their diverse, yet synergistic, modes of action.

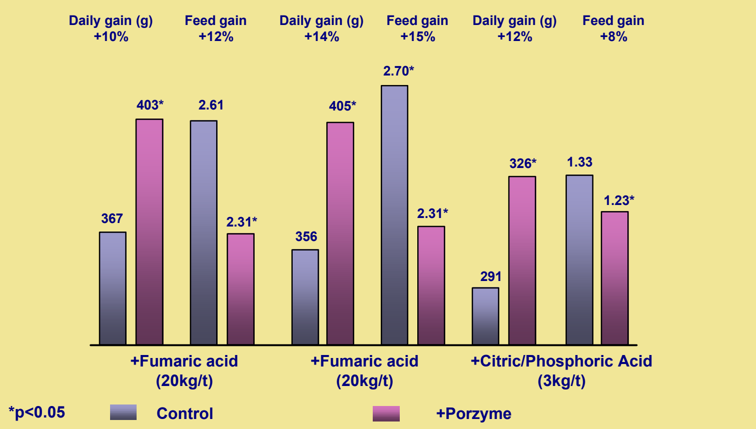
A combination of the use of specific organic acids with effective enzyme products is already finding favour in many markets in the absence of sub-therapeutic antibiotics. While the enzyme deals with raw material anti-nutrients, an appropriate acid (or mixture of different acids) positively influences the pH and microbial loading of the feed - and also, purportedly, of the gut.

Additive effects of organic acids when used in combination with feed enzymes have been shown in our trials. Examples based on 2 different studies are set out in Figure 1. The first tested Porzyme feed enzymes and fumaric acid in 2 basal diets. The other had the enzymes in a single diet with a blend of citric and phosphoric acids.

Effective feed enzyme products for pigs are now well recognised for their beneficial effects on growth and feed utilisation, particularly in the young animal up to 25kg and increasingly in the growing/finishing pig. By releasing fibre-bound nutrients and breaking down certain antinutritional factors in the feed, these enzymes give rise to improved nutrient digestibility and absorption in the small intestine.

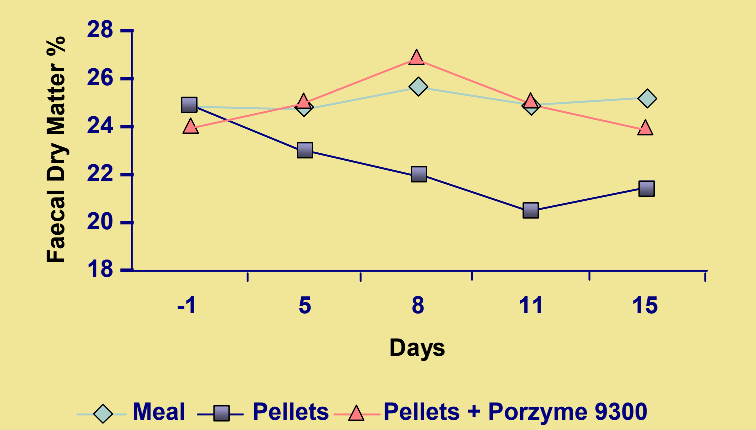
Often, however, nutritionists are less familiar with the consequences of these improvements regarding the microbial populations of the pig's intestines, in terms of both total numbers and composition. In fact there is increasing evidence that enzyme addition influences the gut flora in a positive way.

This can be explained partly by the effect of poor digestion in making more nutrients available to bacteria in the lower section of the digestive tract. With a greater feed supply, their numbers increase and they can then spread higher up the intestine. Extensive microbial proliferation in the small intestine of the pig is particularly undesirable as it creates competition for released feed nutrients between the host and the microflora. At the extreme it can also increase the likelihood of pathogenic bacteria becoming established and damaging the absorptive lining of the gut.



Ref: Technical Reports 8300 POL.96.10; 8300.POL.95.07

FIGURE 1: Trials showing the additive effects of organic acids when used with Porzyme feed enzymes.



Ref: Hazzledine and Partridge (1996), Carolina Swine Nutrition Conference

FIGURE 2: On a unit suffering from non-specific colitis, effect on faecal drymatter (%) of adding xylanase to a pelleted feed.

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Also well established is that certain types of fibre (and protease inhibitors such as trypsin inhibitors and lectins) can change the balance of hind-gut microbial communities, favouring the proliferation of pathogenic species. A classic example concerned work in Australia illustrating the provocative nature of dietary fibre on swine dysentery. Although the disease relates to a bacterial infection with *Serpulina hyodysenteriae,* its incidence in Serpulina-challenged pigs was significantly reduced by feeding them grains that had been specially processed to be highly digestible and/or naturally low in fibre.

The message from the data was clear: maximise digestibility of the 'indigestible' fibre (both soluble and insoluble), together with the starch in the grain, and it is possible to beneficially influence the microbial population of the gut in animals exposed to predetermined doses of pathogens. The potential role for carbohydrase feed enzymes in this scenario is evident. Their defined mode of action is to improve digestibility of starch in the small intestine and break down both soluble and insoluble fibre, effectively limiting the flow of nutrients to the hind-gut.

Similarly clear effects of dietary grain source on a digestive problem have been reported in the case of the non-specific colitis syndrome. A series of trials established that this syndrome, characterised by diarrhoea in young growing pigs, was worst where diets were wheat-based and had been pelleted. Pelleting was found to solubilise more grain fibre, encouraging bacteria to multiply in the lower intestine. But there was no need to resort to feeding meal instead of pellets, because normal faecal drymatter could be maintained by adding an appropriate carbohydrase enzyme (xylanase, Porzyme 9300) as the trial data in Figures 2 and 3 confirm.

Additionally, effective feed enzymes have been shown to increase the flow of feed (digesta) inside the pig. A faster flow rate and better absorption of nutrients at the gut surface result from the enzymes' reduction of digesta viscosity and water holding capacity. This has a positive influence not only on feed intake, but also on microbial proliferation in the gut - see Figure 4, taken from a microscopic analysis conducted in Finland.

In practice this means that fewer digestive disturbances occur where enzymes are added to feeds containing no antibiotic growth promoters. Figure 5 sets out results from investigations in France, Australia and Germany. Each demonstrates a significant reduction in the need for antibiotic injections to counter digestive problems provoked by the diet.

Further information is starting to emerge from the novel technique of identifying specific bacteria in the intestines by measuring the bacterial DNA in the intestinal contents. A sample analysis from broilers is shown by Figure 6. Early signs from this work indicate that enzyme action on arabinoxylan fibres in feed grains influences the composition of the gut flora by increasing the production of small carbohydrate fractions known as xylo-oligomers. These can act as a substrate for the growth of certain bacterial groups.

While the research is still in its preliminary stages, it has started to point to a considerable potential for maximising the use of specific enzymes in 'pre-probiosis' concepts. The presence of specific feed enzymes also appears to stimulate volatile fatty acid production in the hind-gut. It now seems that this may also play an important contributory role in altering the microbial population of the large intestine.

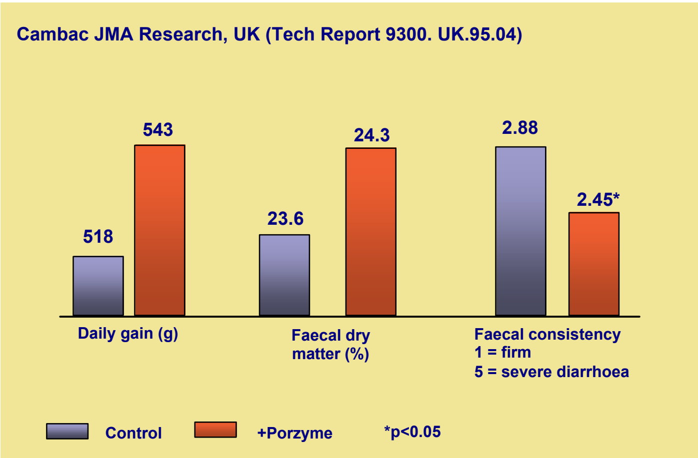

FIGURE 3: Effect on productive performance and faecal characteristics of pigs on a colitis-affected unit, from enzyme addition to a pelleted, wheat-based diet.

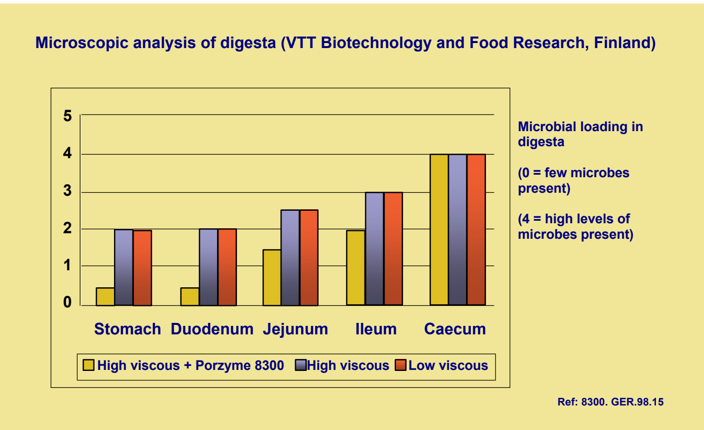

FIGURE 4: Microbial loading in the digesta of pigs fed wheat-based diets of low or high viscosity, with or without Porzyme. (0 = few microbes present, 4 = high levels of microbes present)

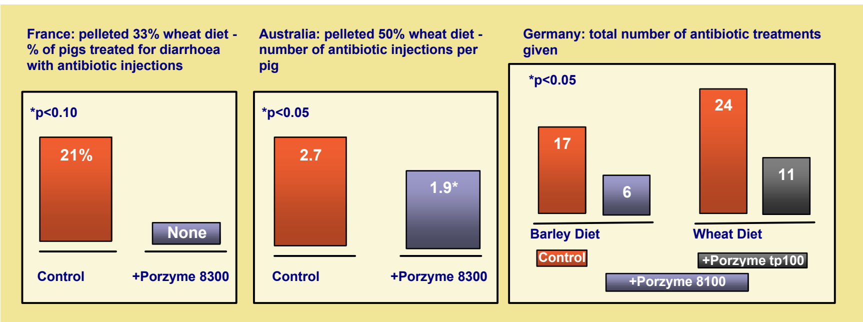

FIGURE 5: Number of antibiotic injections needed to counter digestive problems in pigs offered antibiotic-free diets, with or without Porzyme.

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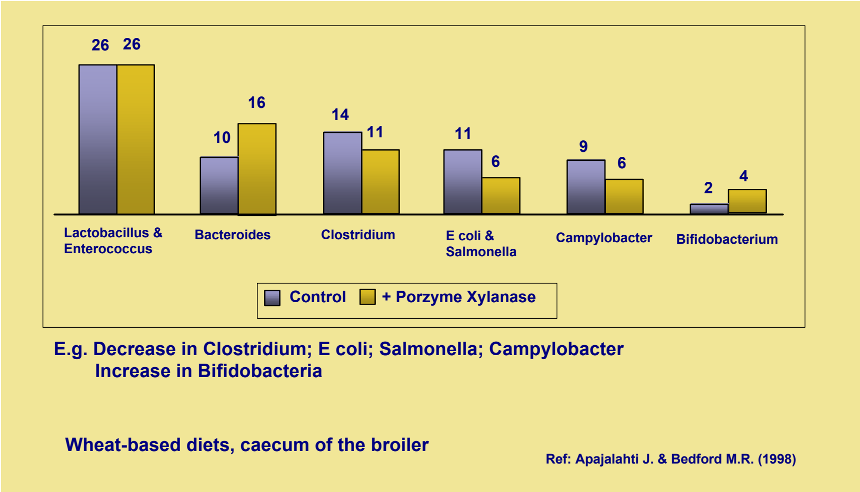

FIGURE 6: Relative abundance (%) of bacterial DNA in the caecum of broilers fed wheat-based diets, with or without xylanase.

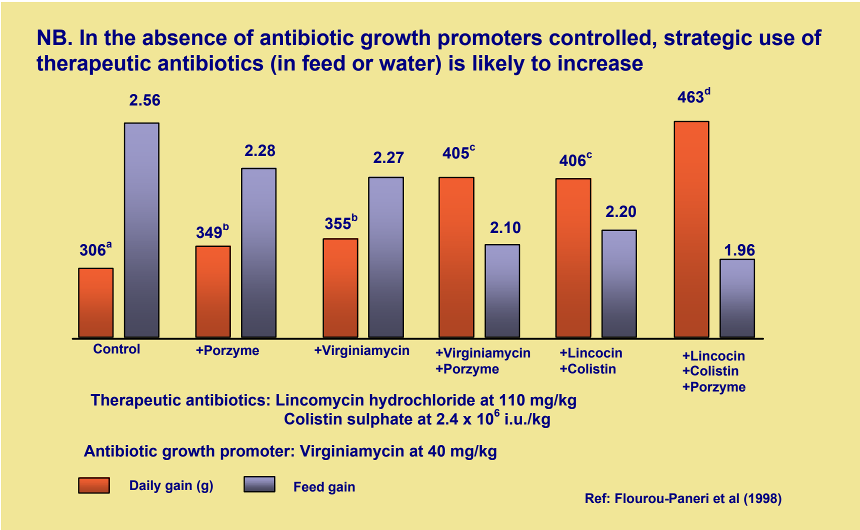

FIGURE 7: Additive effects of therapeutic and sub-therapeutic antibiotics when used in combination with feed enzymes.

Such effects will be useful in strategies to replace in-feed antibiotics for growth promotion. Moreover, the withdrawal of certain growth promoters in the feed is likely to coincide with the increased use of strategic therapeutic medication programmes. Under those circumstances it will be of considerable practical importance to exploit any additive effects between enzymes and antibiotics.

Such additivity can be expected because the mode of action of feed enzymes on the gut flora is clearly different to that of therapeutic and sub-therapeutic antibiotics, which directly target specific bacterial groups. A number of research trials have confirmed that they are additive: an example is shown by the chart in Figure 7.

Another combined approach is therefore indicated. Here, the medication programme would deal with the large microbial loading that arises almost inevitably as animals move from one microbial environment to another, such as after weaning and at the change from weaner to grower/finisher accommodation. Routine use of selected enzymes would reduce some of the factors in the feed which potentially have a negative impact on animal performance through changing the composition of the gut microflora.

(References available on request from the authors.)

Key words:
Porzyme 8100, Porzyme 8300, Porzyme 9300, Porzyme tp100, xylanase, beta-glucanase, amylase, protease, wheat, pig, swine, pellet, mash, processing, AGP, organic acid, colitis, diarrhoea, gut microflora, digestive disorders, digestibility.