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YOUNG PIG NUTRITION
A ROLE FOR FEED ENZYMES

The potential role for feed enzymes in the early growth phase of young pigs is discussed by Dr Gary Partridge, Technical Services Manager, Finnfeeds International

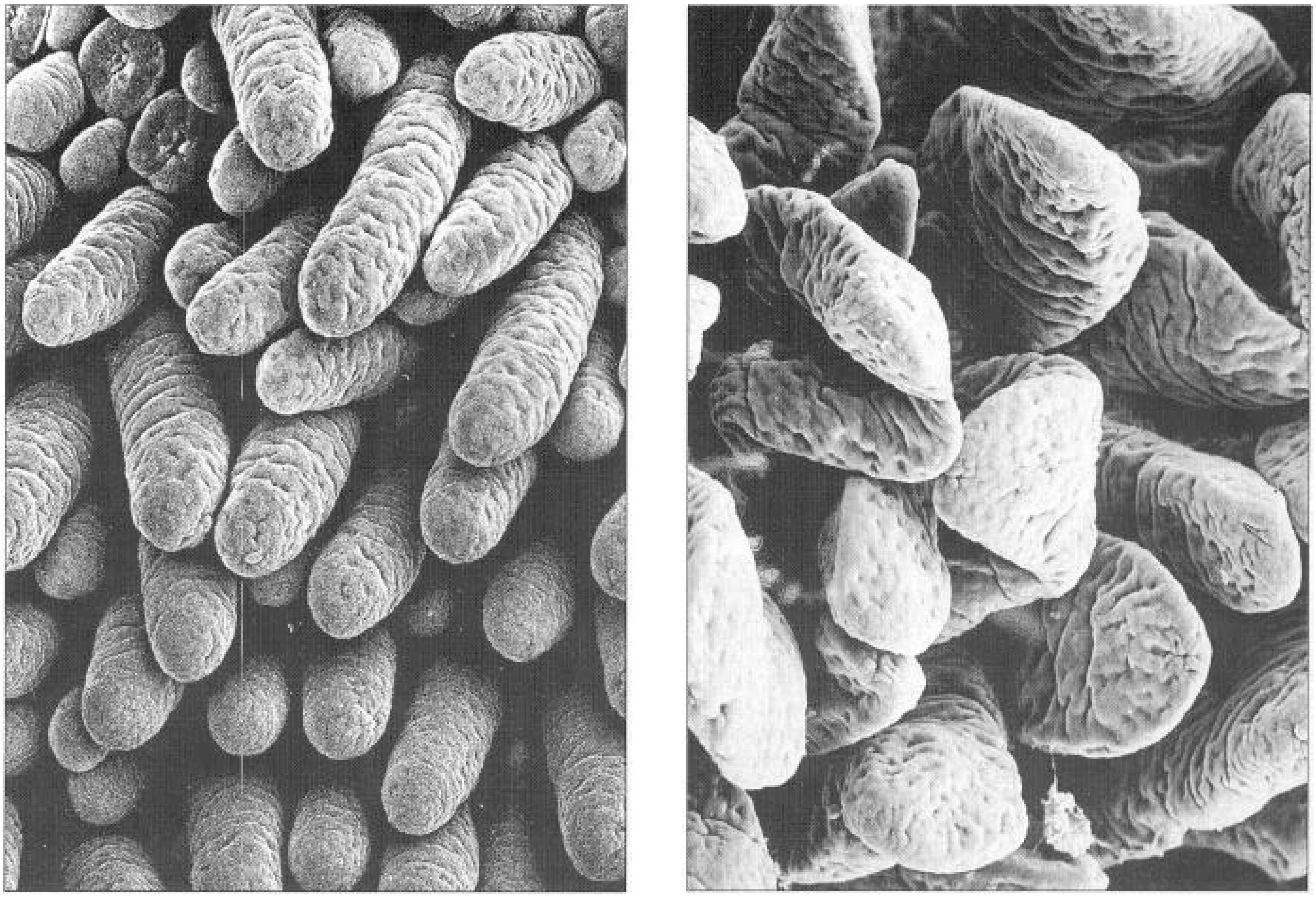
The ability to exploit the full lean growth potential of pigs from birth to 30kgs is a common failing on many commercial units, and has important economic consequences. Several studies have illustrated the benefits of fast, early growth on subsequent lifetime performance, both in terms of weight for age and, in some studies, on ultimate carcass leanness.

Nutrition plays a key role in exploiting this potential of modern genotypes and a knowledge of the factors in diets which may compromise performance, as well as the physiological limitations of pigs at different ages, is fundamental to addressing the problem. In this article we look at some of the problems faced by the young pig, both in the immediate post weaning periods (up to 10kgs), and in the transition phase onto more conventional diets, using 'standard' raw materials (10-30kgs approximately). The potential role for feed enzymes in this critical early phase of growth is discussed.

From weaning to 10 kgs

In an ideal world of pig production weaning would be a gradual process, rather than an abrupt event in the young animals' life. Unfortunately the constraints imposed by many management systems can often result in poor health and performance in the immediate post-weaning period - the classic 'growth check' experienced on many units. Its severity will obviously be influenced by many factors and some of the key ones are outlined in Table 1.

Fig 1 The effects of weaning on gut structure on the piglet



Before weaning **After weaning**

Changes in gut structure and associated enzyme development after weaning

The tiny projections (villi) which are found on the lining of the small intestine in the sucking pig have a very characteristic shape and size (Fig 1). The villi are covered by cells which migrate from the bottom of the villus (the crypt) to the top over a two to four day period. During this time digestive enzymes are being manufactured within the cell and secreted into the gut at the tip of the villus to digest the food substrates which the sow's milk supplies e.g. lactase to digest lactose (milk sugar); peptidases to digest milk proteins. The breakdown products from these enzymatically-controlled reactions are then absorbed across the cells of the gut wall (e.g. glucose and galactose from lactose; amino acids and peptides from milk proteins).

In the piglet the shape of the villi lining the digestive tract is radically altered at weaning from being long and slender, providing a large surface area for absorption, to short and leaf-shaped, or 'clubbed' with a reduced absorptive area (Fig 1). Villus height is frequently halved at weaning and crypt depth doubled (Table 2), the latter an indicator that the whole cell production process is also speeded up, so that more immature cells reach the tip of the villus. These cells have a limited ability to produce sufficient, or appropriate, digestive enzymes to break down some of the 'new' foodstuffs provided in the post-weaning diet e.g. cereal starch, vegetable proteins, new fat sources.

Similar adaptive changes are taking place in the cells of the pancreas, an important organ of the body concerned particularly with enzyme production. Again, however, this is a relatively slow process (Fig 2) and leaves the young animal particularly vulnerable to digestive disturbance due to enzyme insufficiency during the post-weaning period.

One of the key factors which can hasten the development of the digestive enzyme system in the newly-weaned pig is stimulation of feed intake. Creep-feeding can aid this process (Table 3) as can provision of a wet diet immediately after weaning (Table 4). Neither technique however, entirely removes the negative effects of weaning on gut structure - so other mechanisms such as dietary 'antigenicity' may be involved.

The 'antigenicity' theory proposes that some of these changes in gut structure may be triggered by the presence of certain foodstuffs in the diet, with soya proteins being particularly implicated. In effect the suggestion is that a form of food 'allergy' is prompted by the piglet's early experience of novel ingredients in the ration.

For this reason manufacturers of specialist starter diets for pigs tend to favour relatively expensive, high-processed vegetable protein sources (e.g. 'alcohol-washed' soya protein concentrates) which contain very low levels of the protein 'fragments' which may cause a problem (Table 5). The same process also removes one particular group of carbohydrates (the oligosaccharides) which are also thought to promote digestive disturbance in young animals, when present at high levels.

Table 1 The post-weaning growth check – key factors involved

- Insufficient quality and quantity of digestive enzymes to deal with new dietary components
- Major changes in gut structure at weaning
- Poorly developed stomach acid section
- Removal of the natural antibacterial system present in sows' milk
- Reduced feed intake
- Form of post-weaning diet offered e.g. dry pellet or meal vs liquid
- Environmental changes - stress elects on immune system development

Table 2. The effects of weaning on gut structure in young pigs. Measurements taken in the small intestine at four weeks of age.

Villus height (μM)		Crypt depth (μM)	
Unweaned	Weaned	Unweaned	Weaned
681	359	161	344

Table 3. The effects of creep feeding on digestive development

	Suckled	Suckled + Creep fed (d 14-21)	Effect of creep feeding
Stomach weight (g/kg)	4.6	4.9	+ 7%
Stomach acid output (mmol H/hour)	3.4	5.9	+ 79%
Proteolytic enzyme output (k units/hour)	4.4	12.4	+ 182%

Raw materials in the post-weaning diet

The choice of raw materials and their quality is of paramount importance to the newly weaned pig, given its immature digestive system. Table 6 illustrates a typical range of raw materials considered in diets to around 10kgs. The use of relatively expensive protein sources such as milk and whey protein, soya protein concentrates, plasma protein and low temperature processed fishmeals is considered cost-effective in many production systems, because of their relatively high digestibility. Cereal sources are often cooked by techniques such as steam flaking (oats), micronising or extrusion (wheat, barley, maize) to provide some degree of starch gelatinisation (effectively 'rupture' of the starch granules) - although experimental evidence to back-up the use of such processes in three to four week weaned animals is often equivocal. Newer techniques such as expansion of the whole diet are also finding favour as a way of improving diet digestibility and/or upgrading certain raw materials which ordinarily would not feature strongly in diets for newly-weaned pigs.

From 10 to 30kgs

This phase of growth should be geared towards fast acceleration after changing animals onto diets based, generally, on a much simpler and cheaper range of raw materials. On many commercial units, however, this is often a period of missed opportunity as animals have to 're-adjust' to a new raw material mix, where various anti-nutritional factors (ANFS) can play a much more significant role in animal performance. Table 7 shows a typical range of raw materials considered for formulation into diets during this period, and the principal ANFs associated with each.

A role for feed enzymes from weaning to 30kgs

The problems of enzyme deficiency in the newly-weaned piglet and the effects of various ANFs on animal performance are particularly relevant to the potential application of feed enzymes to young pig rations. Effective feed enzyme systems are frequently blends containing principally carbohydrase and protease activities. They function in the animal by a number of inter-related mechanisms:

- disrupting plant cell walls to increase the release of 'packaged' nutrients in the gut. These materials are then accessible to the animal's own digestive enzymes.
- ensuring that nutrient digestion and absorption is maximised in the small intestine. This avoids excessive passage of nutrients to the hindgut for microbial fermentation, which is an energetically inefficient process and may predispose animals to overgrowth of the hindgut with pathogenic bacteria.

Fig 2

Endogenous Enzyme Production in Piglets

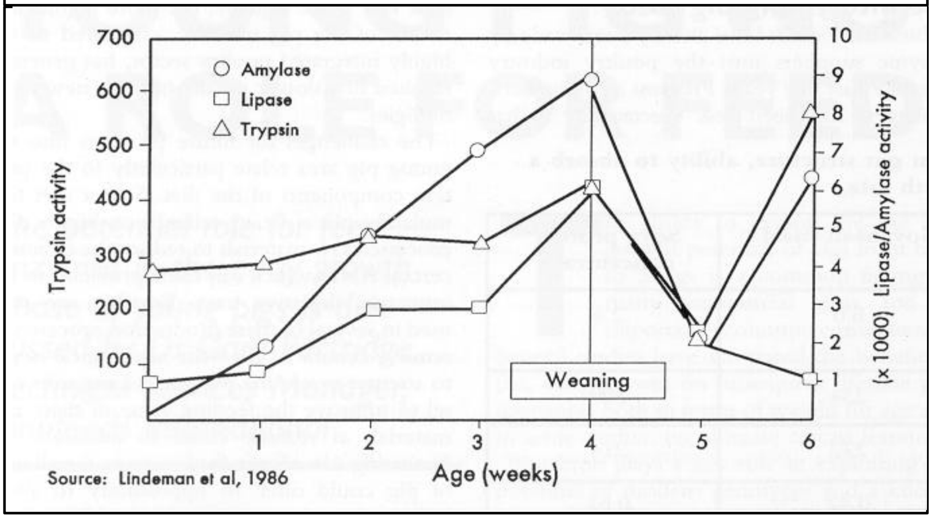


Table 4. Villus height (um) in the small intestine of weaned pigs offered dry or liquid feeds

		Days after weaning				
		0	4	6	8	11
Distal Jejunum	Liquid	329	364	312	388	375
	Dry	329	283	269	220	254
Ileum	Liquid	297	324	267	368	375
	Dry	297	305	211	238	243

- eliminating or reducing the disadvantageous effects of ANFs in certain raw materials e.g. beta glucans in barley, arabinoxylans in wheat (Table 7) These soluble carbohydrates are known to interfere with nutrient absorption due to their gel-forming properties i.e. they can create viscous conditions in the gut.
- supplementing the digestive capacity of young, or unthrifty, animals whose production of digestive enzymes may be limiting.

Production benefits of feed enzymes in the young pig

A recent summary of commercial trials with pigs over the weight range 8-25kgs found responses to enzyme addition of five-six per cent in daily live weight gain and four-five per cent in feed conversion ratio (Fig 3). Some studies have also reported reductions in the incidence of diarrhoea and/or antibiotic treatments when feed enzymes have been incorporated (Table 8). Such responses may be expected where gel-forming carbohydrates are being removed, or reduced, by feed enzyme action i.e. reducing the likelihood of excessive hindgut fermentation which could promote an osmotic diarrhoea in the young animal. Reduced variability in weight between individuals has also been reported in some trials after enzyme treatment (Table 8).

Interest in the application of feed enzymes into young pig rations is also stimulated commercially by the opportunities it affords for replacing cooked cereals by uncooked cereals, without compromising animal performance. The advent of expanded feed for young pigs may also create an increased requirement for post-process application of

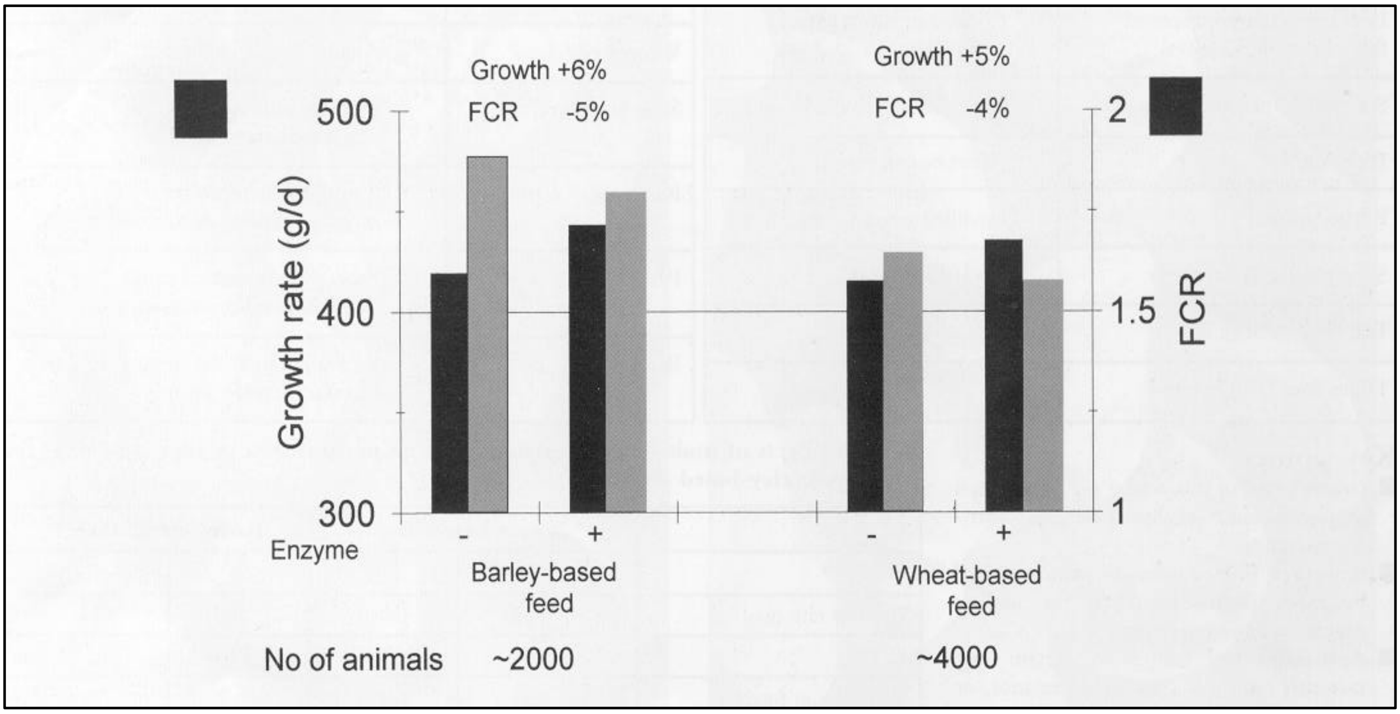


Fig 3: Summary data from 53 trials showing the effects of multi-enzyme systems (Porzyme SP and TP) on pig performance (8-25 kgs)

liquid feed enzymes, if recent work from poultry is taken as an indicator. Expanding feed for broilers can increase problems of gut viscosity, presumably due to an increased solubilisation of cell wall fibres. Addition of a suitable in-feed enzyme can correct this problem and restore bird performance. Further studies on expanded pig feed are warranted, given its increasing uptake by the animal feed industry.

Future prospects for enzyme use into young pig feeds

Substantial inroads have already been made by enzyme suppliers into the poultry industry over the past five years. Progress into pig diets, however, has been less spectacular. It has rapidly become apparent that there are important species differences in response, both to the enzyme level required and their characteristics. This remains a key area of research over the next few years. Equally, the more fragmented nature of the pig industry, compared to the highly integrated poultry sector, has generally resulted in a slower uptake of these new technologies.

The challenges for future products into the young pig area relate particularly to the protein components of the diet. Starter diet formulation places heavy reliance on highly pre-processed raw materials to reduce the effects of certain ANFs which can cause problems to the immature digestive tract. Enzymes are now used in several of these production processes to remove certain ANFs - the next logical step is to attempt to use the pig gut as a reaction vessel to improve the feeding value of these raw materials at realistic costs. In addition, the increasing use of wet feed systems for all ages of pig could offer an opportunity to allow 'steeping' in the presence of suitable enzyme blends prior to feeding. These exciting possibilities would enable much greater flexibility in diet formulation and allow the gains made in generic progress to be fully exploited by appropriate nutritional inputs on farm.

Table 5. Effects of different soya products # on gut structure, ability to absorb a marker sugar (xylose), and post-weaning growth rate.

	Milk protein	Soyabean meal	Soya protein concentrate
Residual soya antigens in products (total)	0	6.0	2.4
Villus height (µm)	364	234	309
Crypt depth (µm)	198	222	214
Xylose absorption (mg/100ml)	0.82	0.42	0.61
Coliforms (% of total bacteria)	2	37	24
Postweaning growth (g/d)	326	182	208

pigs were orally sensitised to these products before weaning Source: Li *et al* (1991)

Table 6. Raw materials in diets for newly-weaned piglets

Protein sources	Energy sources
Denatured skim milk powder	Cooked raw maize
Whey powder	Cooked or raw wheat
Low temperature processed fishmeal or herringmeal	Cooked or raw barley
Spray dried porcine plasma	Steak flaked dehulled oats
Blood meal	Sweet biscuit meal
Potato protein	Fat-filled whey powder
Soya protein concentrate	Soya, coconut oils
Full fat soya bean meal	
Hipro soya bean meal	

Table 7. Raw materials considered in diets for pigs 10-30kgs and their principal anti-nutritional factors (ANFS)

Raw materials	ANFs
Barley	Beta glucans; Arabinoxylans
Wheat	Arabinoxylans
Wheatfeed	Arabinoxylans; cellulose
Soya bean meal	protease inhibitors; lectins; oligosaccharides; pectins
Rapeseed	Tannins; glucosinolates; oligosaccharides; pectins
Peas	Protease inhibitors; lectins; oligosaccharides; pectins
Beans	Protease inhibitors; lectins; tannins; oligosaccharides; pectins

Key Points

- Growth rate of the young pig to 30kgs is frequently under-exploited on many commercial units.
- Immediate post-weaning growth is limited by many factors including the piglet's immature digestive system.
- Anti-nutritional factors in certain raw materials can limit animal performance, or increase variability between individuals.
- In-feed enzymes can aid the digestive process and have a significant effect on productive performance in the young pig.

References available, on request, from author.

Table 8 Effects of multi-enzyme preparations on performance of pigs (10-25kgs) fed wheat or barley-based diets

	Wheat-based diet		Barley-based diet	
Enzyme*	-	+	-	+
Growth rate (g/d)	406	450	382	436
FCR	1.80	1.63#	1.91	1.62#
Variation in final weight (%)	5.6	2.8	6.9	2.4
Antibiotic treatments	24	11	17	6

*Porzyme TP (wheat) and SP (barley) # differs from control, $p<0.05$ Source: Bohme (1990)

Keywords: Piglet, Porzyme tp-100, Porzyme 8100, Porzyme 8300, Endogenous enzyme, Swine, Uniformity, Digestive disorders