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# Exploiting enzyme technology to save feed costs in pig production

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**Particularly at times of high feed prices the focus of attention for nutritionists is on maximising nutrient availability in pig feeds. In South Africa the predominant grain is maize, with specific regional interests in the use of wheat and barley, dependent on their relative price and availability. The other primary constituents are vegetable proteins (e.g. soybean, rapeseed and sunflower meals) and grain by-products (e.g. wheat middlings/bran). In general terms the ability of pigs to digest more fibrous diets, without compromising productive performance, is fundamental to improving our opportunities to reduce cost per kg gain in the current economic environment.**

## 'The dietary fibre challenge'

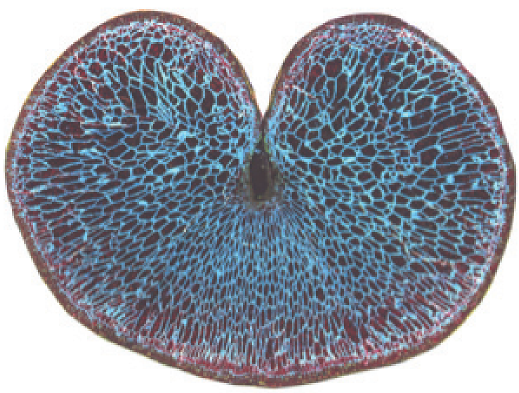
The challenging effects of dietary fibre in pigs include factors such as satiety; gut motility; nutrient digestion and absorption; and changes in the gut microflora as a consequence of fibre addition. Improving the feeding value of fibre-rich raw materials is consequently about negating the anti-nutrient effects of dietary fibre to ensure that animal performance is maintained or improved, but at lower cost. Dietary fibre is nowadays more precisely defined as 'non starch polysaccharides (NSP) + lignin' (Figure 1) and understanding the fibre fraction of individual raw materials, and its inherent variability, is very important when designing diets to maximise pig performance. The term "crude fibre" (still present on many feed labels around the world) is predominantly only a measure of cellulose plus lignin and consequently itself is a very crude, inaccurate measure of fibre content and its likely effects on animal performance. Other factors in dietary fibre e.g. its hemicellulose content (Figure 1) and, more specifically, its NSP content are far more influential on nutrient digestion and absorption in the animal's gut.

Pigs feeding on more fibrous diets have to overcome a number of challenges. These include: 1) extra chewing of certain fibrous raw materials; 2) increased endogenous losses as a consequence of more salivary, gastric and pancreatic secretions; 3) increased gut weight stimulated by the presence of more fibre in the diet over time; and 4) changes in digesta transit time, often governed by the balance between soluble and insoluble fibre in the diet. More fibrous diets also have the potential to increase faecal volume which will have ultimate implications for the costs of manure management which can be a further challenge, particularly in some areas of the world.

The net effect of all the above is a potential increase in maintenance energy and protein costs to the animal when feeding more fibrous diets, so any solutions we propose must be able to offset these negative effects.

**Continued on p 14**

**Figure 1 : Carbohydrates – defining the dietary fibre fraction***

| **CARBOHYDRATES** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ileal digestible carbohydrates | Fermentable Carbohydrates | | | | | | |
| | | **Non Starch Polysaccharides (NSPs)** | | | | | |
| Mono- and di-saccharides, starch | Oligosacc-harides e.g. FOS,MOS Resistant starch | Storage NSPs e.g. mannans inulin | Pectins | Water soluble NSPs | Insoluble cell wall NSPs | | |
|  | | | | e.g. Soluble arabino-xylans increase viscosity in the gut | **Neutral Detergent Fibre (NDF)** | | |
| | | | | | Hemicellu-lose | Cellulose | Lignin |
| | | | | | e.g. Insolu-ble arabinox-ylans can 'package' useful nutrients making them unavailable to the animal | **Acid Detergent Fibre (ADF)** | |
| | | | | | | Cellulose | Lignin |
| | | | | | | | **AD Lignin** |
| | | | | | | | Lignin |
| *n.b. the size of the boxes in this figure is not in proportion to the level of each component | | | | | | | |

Exploiting enzyme from p 13

**Precisely defining the fibre fraction**

Describing the NSP content of raw materials is fundamental to our understanding of dietary fibre and how to deal with its negative consequences. Arabinoxylan (Table 1) is a key component of the NSP content of many raw materials and it varies in its solubility. Soluble arabinoxylan in raw materials such as wheat and rye (around 30% of the total arabinoxylan present, Table 1) is the reason for the "viscous" nature of these grains when present in the gut. This viscosity effect, although less detrimental in pigs than poultry, can still negatively influence the gut microflora in terms of its content and composition.

**Dealing with the fibre challenge with exogenous enzymes**

Our early experiences with a xylanase enzyme specifically designed to deal with the anti-nutrient effects of arabinoxylan-rich raw materials in the diet (e.g. wheat middlings, Figure 2) proved the potential of this technology. This experience has widened in recent years in independent research trials, particularly in the US on maize-based diets containing other arabinoxylan-rich raw materials such as maize distillers dried grains with solubles (DDGS). Although this raw material is not currently seen in South Africa, its arabinoxylan content and composition (e.g. soluble/insoluble ratio) is very similar to wheat middlings (Table 2). In recent trials it has been shown that the addition of this xylanase source can positively impact pig performance through its effects on nutrient availability (Figure 3) in diets based on maize and maize by-products and in the presence of phytase.

**Are all xylanase sources equal in efficacy in the pig gut?**

Independent trials in Denmark over several years by VSP (Videncenter for Svineproduktion) have highlighted interesting differences between various xylanase sources in terms of their effects on grower-finisher pig performance and their consequent economic benefits. The economic effects in each trial are difficult to directly compare across various years because of the varying assumptions made about feed prices (e.g. much more expensive feed costs in recent years), so the fairest comparison is in terms of percentage benefits in feed conversion ratio and their economic significance at the time that each trial was run (Table 3). The results over time show clear differences in bio-efficacy between the various xylanases.

**Figure 2: Effect of xylanase addition on performance of young pigs (9-20kg) fed high fibre diets containing 30% wheat middlings* (n.b. maize replaced by wheat middlings in the negative control diet with small adjustments in amino acid additions but no additional fat, so DE was reduced by ~240 kcal/kg feed) * starch 36.4%, NSP 20.5% (95% insoluble)**

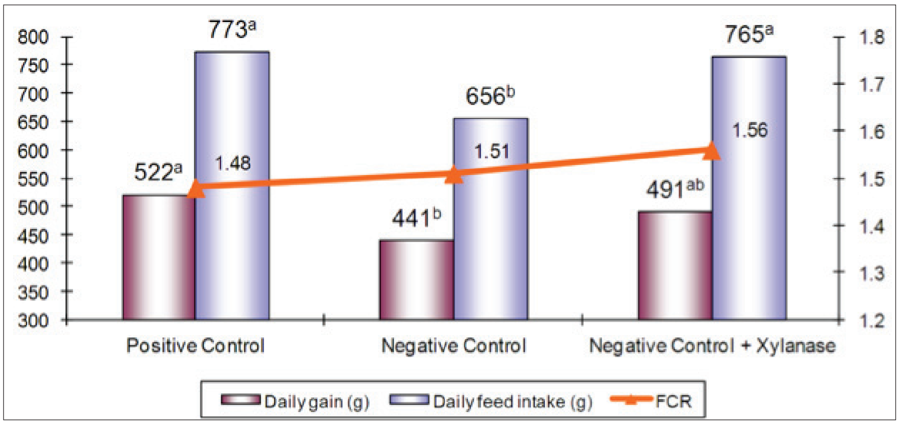



**Table 2 : Comparison of non-starch polysaccharide (NSP) content of maize DDGS and wheat middlings**

| | Maize DDGS | Wheat middlings |
|---|---|---|
| Total soluble NSP % | 1.3 | 1.3 |
| Total insoluble NSP % | 19.3 | 24.7 |
| Total insoluble NSP/Total NSP % | 94 | 95 |
| Total insoluble Arabinoxylans/ Total insoluble NSP % | 55 | 61 |

**Table 1: Total Arabinoxylan content of various feed raw materials and its solubility (%)**

| Raw material | Total arabinoxylan content (%) | Soluble/total arabinoxylan (%) |
|---|---|---|
| Maize | 3.9 | 8 |
| Wheat | 6.0 | 25 |
| Rye | 8.5 | 33 |
| Barley | 7.4 | 12 |
| Wheat middlings | 16.5 | 10 |
| Wheat bran | 20.9 | 7 |
| Maize Distillers Dried Grains with Solubles (DDGS) | 12.7 | 10 |
| Soybean meal | 3.8 | 21 |
| Rapeseed/canola meal | 6.5 | 22 |
| Sunflower meal | 7.9 | 13 |

### Take-home messages

- Fibrous raw materials (e.g. grain by-products) offer interesting opportunities to save feed costs in pig rations, but their high fibre content is a potential challenge to nutrient availability and consequent pig performance;
- Enzyme technology e.g. a well-proven and researched xylanase based product to target the arabinoxylans present in many fibrous raw materials, offers clear opportunities for cost savings without detriment to animal performance;
- Each xylanase source has its own unique characteristics (e.g. pH optimum, temperature optimum, rate of reaction according to substrate level, sensitivity to endogenous secretions) so it should be no surprise that different products will vary in bio-efficacy. Nutritionists and purchasers making difficult choices should therefore seek guidance from independent *in-vivo* research;
- With Net Energy costs of ~1.3 R/kcal currently it is important to exploit all possible opportunities to save feed costs in pig production. Well-proven enzyme technology offers one possible opportunity to offset these high feed energy costs, at the same time as maximising protein/amino acid availability.

***References available on request***

**For further aspects relating to this article see the AFMA annual symposium presentation "Advances in enzyme technology to improve the feeding value of grain by-products in swine nutrition" by Dr Gary Partridge, Wednesday 2nd October 2013 (Pretoria, South Africa) on the AFMA website.**

**Figure 3 : Effect of xylanase +/- phytase addition in maize-based diets containing 20% maize DDGS in two trials a) University of Kentucky, USA – performance b) University of Illinois, USA - digestibility**

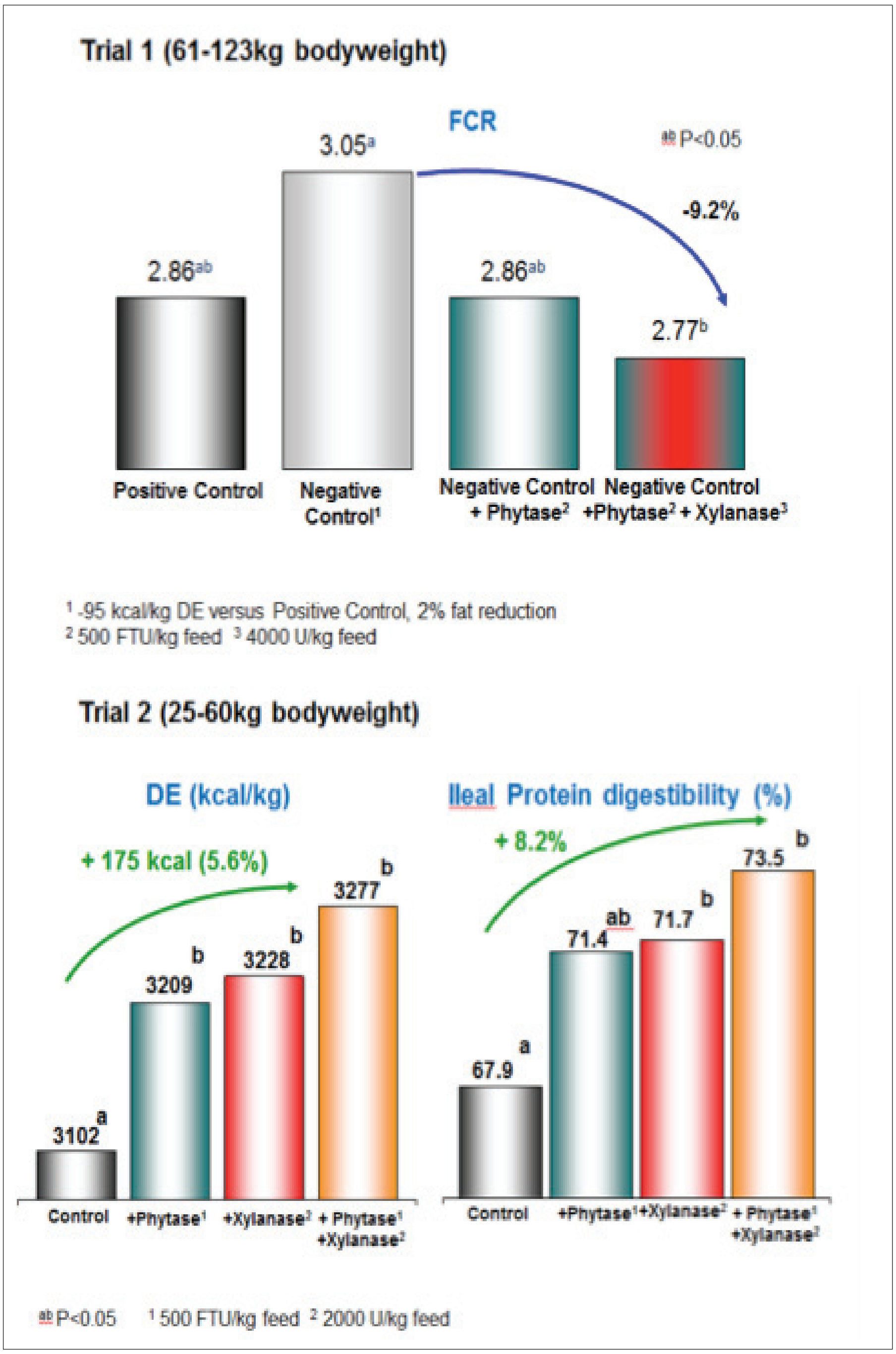



**Table 3 : Xylanase products tested by Videncenter for Svineproduktion, Denmark in growing-finishing pigs**

| Trial Report Number | Pelleted or Mash feed | Xylanase product | Improvement in FCR versus the corresponding control (%) | Statistical effect on Production Value Index[1] versus the corresponding control |
|---|---|---|---|---|
| 403 | Pelleted | P | 2.6% | 7% improvement (P<0.05) |
| 558 | Pelleted | P | 2.8% | 6-9% improvement (P<0.05) |
| 558 | Mash | P | 3.1% | |
| 826 | Pelleted | B | -0.3% | Non significant |
| 848 | Pelleted | R | 0.4% | Non significant |
| 960 | Pelleted | E | 0.4% | Non significant |

[1] Gross margin per pen place per year at the time of the trial, excluding product costs