5 myths regarding carbohydrases in pig feeds

Carbohydrases used to improve the nutritive value of cereals have been surrounded by confusing information regarding their benefits and proper use.

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Energy is an expensive ingredient in today's pig diets. The downside of cheaper feed energy sources is often a reduced availability of nutrients, resulting in a trade-off between cost of diet and animal performance. Carbohydrase enzymes are recognized for their ability to increase the flexibility to use less digestible energy sources in feed formulations without compromising animal performance in several markets.

Currently, more than 20 products contain xylanase activity, either alone or in combination with other enzymes, and these have been approved by the European Union (EU) for use in pig diets. As the EU requires enzyme suppliers to prove the efficacy of their products in at least three scientific animal trials per species and stage of production, there is a significant amount of data out there regarding carbohydrases in pig diets. Nevertheless, there are other markets that are still skeptical about the use of carbohydrase enzymes in pig diets. This can to some extent be attributed to lack of experience and confidence in formulating with alternative energy sources. It also is attributable to misconceptions or myths about carbohydrase enzymes, lack of understanding in terms of their appropriate application and unrealistic expectations, which can all result in disappointment.

Figure 1: Common carbohydrase enzymes used in pig diets and substrates

Carbohydrase	Main substrate
Xylanase	Arabinoxylan
Beta-glucanase	Beta-glucan
Amylase	Starch
Beta-mannanase	Beta-mannan

For the enzyme to provide a benefit in the formulation of pig diets, the diet must contain the relevant specific substrate for the enzyme to work properly.

Myth No.1: Carbohydrases improve pig performance regardless of diet composition

Carbohydrases break down starch or

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Figure 2: Arabinoxylan levels in response to changes in diet composition

Ingredients (%)	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Corn	69.4	59.7	52.6	42.7	
DDGS		15.0	30.0	30.0	
Wheat					64.0
Wheat midds				10.0	19.9
SBM	29.0	22.5	15.7	15.0	13.5
Total arabinoxylan level	3.81	5.09	6.46	7.70	7.64

The level of arabinoxylans, a substrate for xylanase enzymes, changes with the composition and complexity of the diet.

indigestible fibrous material in the pig's digestive tract and make more energy available for the animal to absorb. Like any other enzyme, carbohydrases are substrate specific. This means that in order for the enzyme to provide a benefit in the formulation of pig diets, the diet must contain the relevant specific substrate for the enzyme to work on (see Figure 1 for the major types of carbohydrase enzymes used in pig diets and their corresponding substrate). Depending on the diet ingredients and the total level of dietary substrates, the enzyme will have more or less to work on in the digestive tract of the animal.

It is generally accepted and expected that the value of the enzyme will increase with the level of substrate in the diet. For example, Figure 2 shows how the level of arabinoxylans, a substrate for xylanase enzymes, changes with the composition and complexity of the diet. However, there are indications that the response to the enzyme will to some extent also depend on the energy stress the animal is experiencing. So factors limiting the dietary energy uptake, such as low voluntary feed intake in the young pig, total dietary energy content, heat stress and feeder space limitations in grow-finishing pens can influence the magnitude of the response to the enzyme.

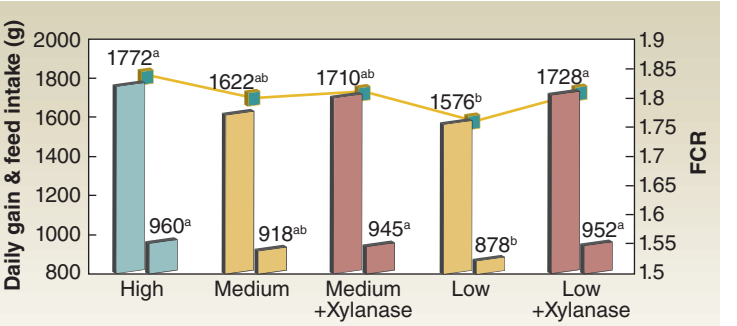
Myth No.2: All carbohydrases are the same

Carbohydrases such as xylanase, beta-glucanase and amylase can be produced from a range of plants, animals and microorganisms. Although particular types of enzymes, such as xylanase, share a common substrate (arabinoxylan) their substrate affinities and activities can differ widely. They also can differ in their pH optima. This will affect their activity in the digestive tract of the pig, which can again have an overall impact on the bio-efficacy of the enzyme.

The characteristics of xylanases are determined by the type of organism they are being produced from. Xylanases commonly used in the feed industry are produced by *Aspergillus niger*, which is fungal, *Trichoderma reesei* or *Bacillus subtilis*, which are bacterial. The pH optima of bacterial xylanases are in general slightly higher than the pH optima of fungal xylanases. The enzymes can also differ in heat stability, which in turn affects their ability to withstand processing conditions during pelleting of feed.

To improve their inherent heat stability, enzymes can either be manipulated to this end or a coating can be applied to provide the enzyme with protection from heat. Depending on the methodology and technologies applied, there will be additional heat resistance differences between commercial enzymes.

FIGURE 3: Reducing wheat variability in pig diets with xylanase



Individually fed boars, 28-60kg, 5 week trial
High, medium and low performing wheats, determined in prior weaner growth trials
65% wheat in diets, 5% wheat by-products. Xylanase addition at 1 kg/metric ton
$^{ab}P<0.05$ Source: Partridge et al (1999)

Trials including a xylanase in diets differing in wheat quality have shown that the enzyme is able to smooth out the variation in pig performance. However, the effect was greater on the low-quality wheat compared to the medium-quality wheat.

Myth No.3: The response to xylanase added to wheat is high regardless of wheat quality

Many factors can influence the feeding value of wheat and can vary from harvest to harvest, making it a highly variable feed ingredient. Data from the United Kingdom, Canada and Australia have shown the digestible energy content of different wheat samples can typically vary by as much as 1.3MJ/kg.

The problem for pig producers is that variability in wheat quality will translate into variability in pig performance. In a trial conducted in the United Kingdom, six different wheat varieties were grown on the same plot of land and incorporated into otherwise identical pig diets. There was an 18 percent variation in young pig growth rate between different wheat samples and a difference in feed conversion ranging from 1.28 to 1.47.

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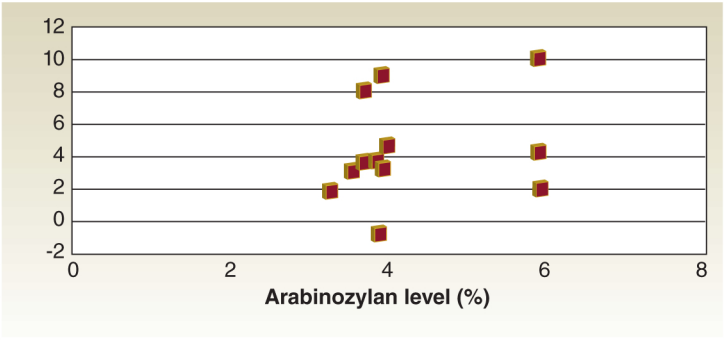
Myth No.4: Carbohydrases are only relevant to the EU

Northern European countries traditionally feed high levels of wheat and barley in pig diets and, therefore, have high levels of substrate that can be dealt with by xylanase and beta-glucanase. But the same is also true for Canada and Australia. Countries that have traditionally been feeding more corn-based diets have been forced in recent years to replace corn with cheaper energy sources to minimize the cost of diets.

Alternatives such as corn DDGS, corn germ meal, wheat middlings and wheat generally have a lower and/or more variable energy content compared to corn and contain greater levels of substrate for the enzymes to work on. In summary, the application of carbohydrase enzymes is becoming increasingly more relevant around the globe.

» There are markets still skeptical and nervous to carbohydrase enzymes in pig diets «

FIGURE 4: Feed conversion ratio (%) in response to xylanase



Performance response (%) in grow-finishing pigs fed corn-based diets from 13 trials carried out in Asia. Average corn and dietary energy level of all trials was 51 percent and 1491 DE kcal/lb., respectively. Average arabinoxylan level across trials was 4.24 percent in diets. Average feed conversion ratio in control pigs was 2.85 and improvement in treatment pigs was 4.86 percent.

Myth No.5: Xylanase never works in corn-based diets

The impact of xylanase on corn-based diets depends on dietary energy intake and whether some of the corn has been replaced with by-products. It also is about the magnitude of response. Figure 4 shows how grower-finisher pigs in 13 Asian trials (both commercial and university-based) fed corn-based diets react to xylanase and the associated levels of arabinoxylans in those diets. The response was measured on top of diets that were down formulated in energy or in diets where corn was to some extent replaced by lower energy feed ingredients, such as wheat, wheat middlings and rice bran.

Recent scientific publications in the U.S. also indicate that xylanase application positively impacts performance in growing pigs fed corn-based diets and significantly improves energy digestibility (Myers and Patience, 2013). A trial with a different commercial xylanase showed performance enhancements in growing pigs fed corn-based diets incorporating corn DDGS with a response similar to that seen in pigs fed wheat-based diets (Kiarie *et al.*, 2013). **PIGI**