Review of the use of enzymes in pig nutrition. Implementation and profitability depending on the diets

Rafael Durán Giménez-Rico

16-Apr-2014 (2 months 1 days ago)

At moments in which the prices of the ingredients (and the feeds) are high, the focus of nutritionists is directed towards the design of diets at the minimum cost possible without it being detrimental to the nutritional quality of feeds. In Spain, the predominant cereals are wheat, barley and maize to a lesser extent, and we always depend on their specific price and availability at certain moments. The rest of the ingredients are the vegetable protein sources (soya, sunflower, rapeseed meals, etc.), and other by-products (wheat pollards and bran, wheat or maize DDGS). Nowadays the tendency is towards the design of diets that are somehow more complex (richer in fibre) in order to reduce feeding costs. We must bear in mind that the ability of pigs for digesting more fibrous diets, without endangering the production efficiency, will be essential if we want to keep the normal efficiency.

Definition of the "dietary fibre" fraction and consequences when increasing its level

The term crude fibre (CF) is old-fashioned. The real digestive challenge goes further than the simple CF, and is shown by NAPs (Non-Amylaceous Polysaccharides): they represent the real dietary fibre: the fraction of the diet digested with difficulty or not digested at all in the small intestine. Englyst *et al*. (2007) call them "non-glycemic carbohydrates". By definition, the dietary fibre is not digested enzymatically in the small intestine. In Table 1 we have the arabinoxylans content (NAPs) of several ingredients used in pig feeding.

Table 1: Total arabinoxylans content of severalingredients and their solubility %

Ingredient	Arabinoxylans total content, %	Soluble/total arabinoxylanes, %
Maize	3,9	8
Wheat	6,0	25
Rye	8,5	33
Barley	7,4	12
Wheat pollard	16,5	10
Wheat bran	20,9	7
Maize DDGS	12,7	10
Soya meal	3,8	21
Rapeseed/canola meal	6,5	22
Sunflower meal	7,9	13

Pigs fed with diets rich in NAPs (more common diets nowadays) would be faced with: i) the need for an extended chewing; ii) an increase of the endogenous losses due to an increased salivation and a rise of the gastric secretions; iii) significant increase in size and weight of the digestive tract with time; and iv) alterations in the intestinal transit due to a combined effect of the soluble and insoluble NAPs.

As a consequence, it is feasible to expect an increase of the maintenance energy requirements and the protein expense. The use of diets rich in NAPs is reflected as an increase in the amount of faeces produced. Depending on the geographical area there can be a penalty on the producer. Any solution that we dare to propose today should be oriented towards the reduction of the negative effects caused by a level of NAPs that is higher than ever.

Digestive ability of the pig

A higher level of NAPs in the diet, even in growing and fattening pigs, will have a negative effect on the digestibility of the rest of the nutrients.

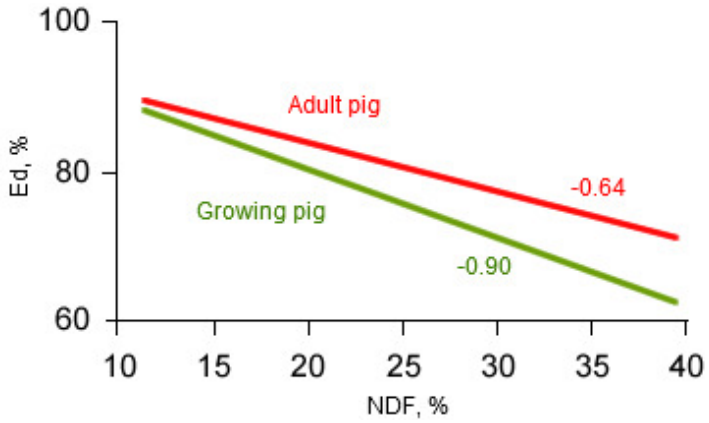
It is assumed that an adult pig can attain a more complete digestion of the nutrients thanks to the support of its fermentation ability (large intestine), but the energy efficiency of these processes is relatively low (absorption of VFAs). Even so, despite this, there are enough evidences of the effect of exogenous enzymes. A very recent and comprehensive review by Svihus (2011) highlights that phytases and carbohydrases are effective.

The retention time of feed in the stomach, as well as a higher pH than that of chickens, make pigs offer "ideal working conditions" for the added enzymes.

Studies by Noblet (2004) are tremendously concluding: the fibre in the feed affects its digestibility negatively.

1. DCe = 98,3 – 0,090 * NDF
2. DCe = 96,7 – 0,064 * NDF

NDF = Neutral Detergent Fibre, that almost corresponds to the NAPs (Noblet, 2004)



Digestibility of the energy in pigs (Noblet, 2001)

Exogenous enzymes in pigs; use and effects

The use of phytases is very widespread nowadays and its use is almost not controversial. Carbohydrases are less accepted, and their use is less recognized. Xylanases and beta-glucanases are the most used ones. In this brief review I would like to highlight our own data with carbohydrases.

Table 2: Common carbohydrases used in diets for pigs and feed substrates.

Carbohydrase	Main substrate
Xylanase	Arabinoxylans
β-glucanase	β-glucans
Amylase	Starch
β-mannanase	β-mannans

Xylanases and beta-glucanases would improve the digestibility of the feed by acting on more or less indigestible fibre-rich raw materials. Carbohydrases are substrate-specific. This means that for the enzymes to entail a benefit in the formulation of diets for pigs, the diet must contain the specific substrate in a sufficient amount so the enzyme can work (see Table 2).

From our many studies in the last years I wish to highlight the effect of xylanase + beta-glucanase in table 3. Improvement in digestibilities can be seen, as well as the effect on the uniformity of the results (an effect sometimes "forgotten" with the use of enzymes).

Table 3: Effect of the carbohydrases on the digestibility of growing and fattening pigs: % of improvement with respect to the control without enzymes (compilation of data from 11 experimental tests, own data, 2013. Mean values, and CV in parentheses).

11 trials in growing-fattening stages	Ileal energy digestibility coefficient	Faecal energy digestibility coefficient	Ileal protein digestibility coefficient	Faecal protein digestibility coefficient
Control diet (C),%	70.6 (9.4)	83.0 (6.2)	72.8 (11.0)	82.9 (7.0)
C diet + enzymes, %	74.4 (7.3)	85.4 (3.6)	76.8 (7.7)	85.4 (4.9)
improvement %	5.4	2.9	5.5	3.0
CV reduction, %	22	42	30	30

We must bear in mind that in diets based on maize and soya, the levels of NAPs (arabinoxylans) can be near 4%, whilst in the case of wheat-soya, they would be 5-6%, and with wheat-bran-soya the levels would be near to 8%.

Exogenous enzymes: their use in feed formulation

Currently, enzymes are used giving them a certain nutritional value in each specific case or adding them to the feed as a security measure and/or in order to relax some limits for certain ingredients (generally in piglets). In any case, in the first scenario we can speak, currently (Table 4), about the following reductions in the cost per tonne of feed.

Table 4: Effect of the use of carbohydrases in the reduction of costs (€) per tonne of growing and fattening feed (base: FEDNA requirements 2006 and prices updated as of February 2014).

	Growth 20-60 kg	Fattening 60-100 kg
Control diet (C)	242.323	228.920
C + PHYTASE	239.140 (-3.18)	225.903 (-3.02)
C + Carbohydrases	234.057 (-8.27)	221.313 (-7.61)

Final reflection

The use of enzymes in swine is very widespread in the case of phytases, and it is increasingly more interesting and real in the case of carbohydrases, mainly because of the demonstration that its use is beneficial. In a moment in which the prices of the raw materials, despite the break that they are giving, are still very high, it is essential to devote some time to think about this option in the area of nutrition-formulation.