Getting more from mixed grain diets

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Feed cost is a major component of the economics of poultry production, so the price of feed ingredients is a key element of profitability. Corn and wheat are the predominant cereal grains used in poultry diets globally, however, climate changes and the increase in global demand cause continuous changes in grain price.

This volatility in raw material prices drives nutritionists to find ways of maintaining productivity while managing raw material price fluctuation.

One of the methods employed is to reformulate diets to include cheaper feed ingredient alternatives. For example, in June 2011 the US corn price increased 150% in a year causing the top two US poultry companies to include wheat in their diets (Reuters). The International Grains Council report in June 2011 stated 'although rising meat production will support demand for feed maize, some price-conscious users are expected to include larger amounts of alternative feeds, such as wheat and barley'.

In the EU, Toepfer International Market (April 2011) reported that demand for corn is falling and barley demand increasing as compound feed makers are using this to a maximum level in their feed formulations.

Similarly, cheaper alternative sources of vegetable proteins, such as dried distillers grains with solubles (DDGS) from bio-ethanol manufacturing, sunflower meal and rapeseed meal, are currently used to replace part of the soybean meal in poultry diets to reduce feed cost.

The question is, how much of these can be included in animal diets and what are the constraints?

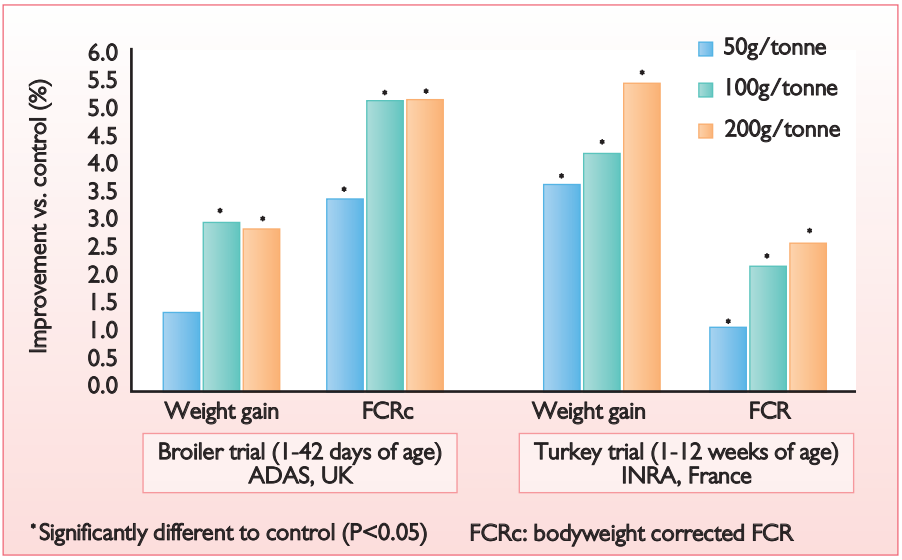

Fig. 1. Performance benefits from the addition of a combination of xylanase and beta-glucanase enzymes (Axtra XB) to diets based on wheat and barley.

Non-starch polysaccharides

Using cheaper, alternative raw materials to increase flexibility in feed formulation as a way of managing costs is critical to maintain profit at a time of price volatility. However, the result of including these cheaper raw materials in poultry diets is always an increase in the amount of dietary fibre or, more specifically, non-starch polysaccharides (NSP, Table 1).

NSP such as arabinoxylan and beta-glucan (Table 2) are known to be anti-nutrients that inhibit the digestion and utilisation of intrinsic dietary nutrients by the animal.

Two major mechanisms have been proposed to explain the anti-nutritive effects of NSP. The first mechanism is associated with

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Table 1. Levels of non starch polysaccharide (NSP) in some feed ingredients (% as fed). Danisco Non Starch Polysaccharide database (2011); Zijlstra et al. (2007).

Ingredient	Insoluble NSP	Soluble NSP	Total NSP
Corn	5.5	0.9	6.4
Wheat	7.4	2.6	9.9
Barley	11.2	4.7	15.9
Rye	8.0	4.9	12.8
Soybean meal	11.9	3.0	14.9
Rapeseed meal	15.5	5.0	20.5
Sunflower meal	-	-	27.6
Wheat DDGS	13.3	6.8	20.1
Corn DDGS	15.7	1.2	16.9

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the fact that starch and protein are encapsulated by the fibrous cell wall so that digestive enzymes cannot physically reach them.

The second mechanism relates to the viscous nature of digesta caused by soluble NSP, which can affect nutrient utilisation in the diet in a variety of ways. The effects of high intestinal digesta viscosity are summarised in Table 3.

Complexity of diets

The complexity of formulating diets with alternative feed ingredients is further compounded by inherent variability in the nutrient content of raw materials. For example, protein and amino acid content can vary.

Starch composition, including amylose/amylopectin ratio and starch granule particle size distribution, can differ.

Differences also occur in the levels of other significant anti-nutritional factors such as phytate. All this variability inherent in feed ingredients affects nutritional value and, subsequently, animal performance.

Research shows that variation in the performance of broilers fed wheat is particularly attributable to the change in digesta viscosity caused by variations in NSP levels in the wheat.

Similar variation in the feeding value of wheat DDGS is expected based on the quality of the wheat initially used in the bioethanol manufacturing process.

Feed enzymes

The inclusion of higher levels of fibrous raw materials which can reduce digestibility, causing variability in nutrient availability and consequent poultry performance, has been largely overcome by the use of appropriate feed enzymes.

These exogenous enzymes degrade cell wall components such as soluble and insoluble arabinoxylans and beta-glucans, releasing encapsulated nutrients inside the cell wall at the same time as reducing digesta viscosity caused by soluble fibre.

The net effect is an alleviation of digestive problems, and consequent improvements in animal performance.

Feed enzyme technology allows producers and feed companies to switch to alternative, cheaper energy and protein sources, without compromising animal performance in any way.

Feed processing challenge

Steam conditioning followed by pelleting is the most common form of thermal treatment used in the manufacture of poultry feeds.

Commercially, concerns over food safety and feed hygiene have resulted in feed mills often using pelleting temperatures of 90-95°C, with variable conditioning time.

Processing poultry feed ingredients at high temperatures not only risks destroying heat sensitive nutrients and additives but also leads to increased starch gelatinisation and fibre solubilisation.

This causes an increase in viscosity of the digesta, leading to poorer digestion and nutrient absorption.

The issue of feed enzyme stability during conditioning and pelleting therefore becomes highly relevant and new enzyme technologies, such as selecting for inherently

Table 2. Levels of arabinoxylan and beta-glucan in some feed ingredients (% as fed). Danisco Non Starch Polysaccharide database (2011); Choct (2006); Zijlstra et al. (2007).

Ingredient	Arabinoxylan	Beta-glucan
Corn	3.9	0.1
Wheat	6.0	0.7
Barley	7.4	3.8
Rye	7.9	1.8
Triticale	9.5	1.5
Oats	13.6	2.5
Soybean meal	3.8	-
Rapeseed meal	6.5	-
Wheat DDGS	11.4	-
Corn DDGS	9.2	-

Cause	Effect
Reduced feed passage rate	Reduced feed intake
Reduced mixing of digestive enzymes with substrate nutrients	Reduced nutrient utilisation
Increased secretion of endogenous enzymes and mucin	Increased endogenous losses
Increased mucus secretion	Reduced nutrient absorption
Changes in gut microflora	Compromised gut health
Increase relative weights of digestive organs	Increased metabolic cost means higher maintenance requirements
Wet droppings	Hock burns, breast blisters and carcase downgrades

Table 3. The effects of high intestinal digesta viscosity on broiler physiology.

thermostable feed enzymes and/or protecting dry enzymes with a heat and moisture stable layer, have been developed to overcome these higher thermal processing issues.

The benefits of adding temperature stable enzymes in heat treated feed is further supported by published data which indicates that the exogenous enzyme effects of reducing the intestinal viscosity in poultry are even more pronounced in feeds that are subjected to high conditioning and pelleting temperatures.

Advanced enzyme solutions

An exogenous enzyme's ability to improve nutrient digestibility of raw materials depends on the specific substrates available as well as the enzyme's stability during processing.

As indicated, arabinoxylans and beta-glucans are major components of the fibrous anti-nutrients present in many of the potentially cheaper alternative raw materials such as barley, wheat, sunflower meal and rapeseed meal.

Therefore using Axtra XB, a new combination of endo-1,4-beta-xylanase and endo-1,3(4)-beta-glucanase, heat stable to 90°C, allows producers to reduce feed costs and maintain bird performance without compromising feed hygiene requirements.

In a series of recent trials with leading poultry research institutes globally Axtra XB, at the recommended inclusion rate of 100g/tonne, gave average net benefits in broiler feed utilisation of over €14 per tonne of feed.

Similarly, strong and consistent benefits were seen in both turkey (Fig. 1) and layer trials.

Conclusion

For internal risk mitigation of price volatility in feed raw materials, the key is to increase flexibility in feed formulations, allowing a switch to alternative but cheaper raw materials without compromising bird performance.

Appropriate, and independently proven, feed enzymes are known for their ability to counteract the anti-nutritive effects of NSP and improve the availability of dietary nutrients, which increases the opportunity to use alternative feed raw materials in poultry diets.

Using Danisco's experience and Axtra XB matrix value recommendations for their particular poultry diets enables the producer to capitalise on reducing feed costs by being able to switch to less expensive raw materials, while maintaining bird performance and maximising net profits. ■