Do you really know the feeding value of your corn?

A surprising amount of variation is revealed in the composition and feeding value of corn from several Asian countries, writes GENE JIN*.

Consistent bird performance is a primary goal for the poultry producer. In reality, however, bird performance varies widely, from excellent to catastrophically poor. Even when every effort is made to determine the cause of such variability, for example disease or feed related factors, there are instances where no obvious explanation can be found.

One culprit, which may be responsible for variable bird performance, is variation in feeding value of the corn used in the diet. Whilst many nutritionists would consider corn as being almost completely digested and consistent from batch-to-batch, a recent study has revealed wide variability among corn samples sourced in Asia. Differences in corn genetics, growing conditions, handling, drying and storage are all likely contributors to this variability. It is this batch-to-batch variation in corn feeding value which can account for at least some of the unexplained performance variation often seen in commercial practice.

As part of a large-scale study commissioned by Danisco Animal Nutrition (formerly Finnfeeds), 24 different commercial corn samples were obtained from China, Philippines, Thailand and Vietnam.

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The "quality" of these corns was estimated via several in vitro measurements including total starch, amylose, amylopectin, rate of starch digestion, protein and protein dispersibility index.

Since starch contributes approximately 75% of the energy content of corn, parameters were chosen that estimate the amount, type and potential digestibility of starch. The starch molecule is simplistically comprised of amylose and amylopectin, which are linked together to form complex structures. The relative amounts of amylose and amylopectin and the way in which they link together differ between samples of corn. Corn samples containing more amylose tend to be less digestible because amylose cross-links with amylopectin crystalline structures in the starch granule. Measurement of the amylose and amylopectin content of corn may provide a useful estimate of corn "quality", in terms of the amount of corn starch the bird will be able to digest. "Rate of starch digestion" represents an attempt to mimic in the laboratory the digestion process in the bird prior to the terminal ileum. The procedure estimates corn starch digestibility in the bird by measuring the rate at which corn starch is degraded during a two-hour incubation period. "Protein dispersibility index" is a laboratory procedure widely used in the feed industry for estimating the protein quality of soybean meal. This procedure was chosen for the purpose of this study as an estimate of the corn protein digestibility in the bird.

Twenty-four different batches of feed were formulated, each containing a different corn sample, included at 55% in diets that otherwise remained constant across all 24 batches. Broiler growth rate, feed consumption and feed conversion ratio (FCR) were determined at 28 days of age.

Corn - a variable ingredient

Variation was found between the 24 different batches of corn, in all parameters measured (table 1.) Total starch content ranged from 64.4 to 72% (average 67%). Greater variation was found among those parameters that estimated the "quality" of starch present; both amylose and amylopectin content ranged widely between samples. Amylose ranged from 16.7 to 30.5% (average 23.5%) and amylopectin ranged from 69.5 to 83.3% (average 76.5%). Rate of starch digestion ranged from 68% to 82% (average 78%) and yet the perception among nutritionists is

Table 1: Mean, range and standard deviation values for 6 laboratory estimates of corn quality determined on 24 corn samples sourced from Asia.

	Starch %	Amylose %	Amylopectin %	RDS[1] %	Protein %	PDI[2] %
Minimum	64.5	16.7	69.5	68	7.6	45.4
Maximum	69.4	28.3	83.3	82	9.2	74.8
Mean	67.1	23.5	76.5	78	8.1	64.6
Standard Deviation	1.64	2.72	2.72	3.1	0.49	6.98

[1] RSD = Rate of starch digestion
[2] RDI = Protein Dispersibility Index
All values expressed on a dry matter basis.

that 80-85% of corn starch is digested before the terminal ileum.

These in vitro results suggest that variation between corn samples may be much higher. Protein dispersibility index ranged widely from 45% to 75% (average 64.6%). Interestingly, corn samples with a higher rate of starch digestion also tended to have a higher protein dispersibility index. This suggests that "problem factors" in corn that negatively affect starch digestibility may also negatively affect digestibility of protein.

The corresponding performance of broilers fed diets including the 24 different corns was also variable. Since all diets were otherwise identical in composition and source of ingredients except for the corn, any performance variation between diets could be directly attributed to variation in corn feeding value. At 28 days, FCR ranged from 1.49 to 2.67 (average 1.81) and liveweight ranged from 680g to 1110g (average 912g).

In practice, nutritionists typically formulate broiler feeds by assigning a fixed estimate of energy value (e.g. metabolisable energy) to corn in the feed formulation matrix. The over-simplicity and risk associated with this approach is evident from the inherent variability that exists among different batches of the same ingredient. This approach inevitably results in variation in feeding value and producer profitability from the same feed formulation, due to variation in quality between batches of the same ingredient. As a consequence, commercial feed formulation represents a balancing act between managing the cost of the feed and the risk of variation in bird performance. Nutritionists have traditionally attempted to reduce the risks of variable performance through attention to, for example, ingredient sourcing, use of rapid laboratory estimates of ingredient quality and application of safety margins in the feed formulation process.

How can variation be reduced?

Many studies have shown that adding dose-optimised levels of a xylanase, amylase, protease blend (Avizyme 1500, Danisco Animal Nutrition) to corn-based poultry diets can both improve average bird performance and reduce variation between the best and worst performing birds. The enzyme blend has been shown to improve starch digestibility and, hence energy digestibility, of the corn. The poorer the initial quality of the corn, the greater the response to enzyme addition. By releasing more energy from lower energy corns than from higher energy corns, differences between different batches of corn are reduced and variation in resulting bird performance is reduced.

In the same study described earlier, this enzyme blend was also added to diets containing the 24 different samples of corn and fed to broilers to 28 days of age.

The enzyme blend improved FCR by on average 4.4%, from 1.81 to 1.73, and variation (standard variation) in FCR between the 24 diets was reduced by 30%.

Summary

It is clear from a recent study that variation in the nutritive value of corn from Asia is large, and as large as perhaps that seen with wheat or barley. The reason for this variation probably relates to starch quality and this is supported by the variation found in some in vitro measures of starch quality. Corn genetics, environment under which the corn was grown and harvested and the conditions of feed manufacture all contribute to variation in the nutritive value of the final feed.

Whatever the source of the variation, it can be significantly reduced by use of appropriate feed enzymes. The benefits are twofold - the average performance of corn-based diets is increased and performance consistency is improved from one batch of feed to the next.

If it were possible to identify the “problem factors" in corn i.e. predetermine corn quality prior to enzyme supplementation, then this would provide a basis for optimising enzyme addition rates according to corn quality. The net result would be even greater cost efficiency from enzyme use.

Determination of wheat and barley quality is in fact already a commercial reality (Avicheck, Danisco Animal Nutrition).

The development of such a tool for corn in broiler diets represents a key objective in current enzyme research. ¦

Key words: Avizyme 1500, xylanase, amylase, protease, corn, broiler