

Feed enzymes may improve corn, sorghum diets

ABSTRACT

The supplementation of barley- and wheat-based poultry diets with feed enzymes is common throughout the world. Now, there is the potential to use enzymes to make more efficient use of low-viscous cereals fed to poultry, such as corn or sorghum.

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Until recently, it was assumed by many that corn and soybean meal do not contribute to digestive problems in poultry, and diets based on these ingredients could not be enhanced by the use of feed enzymes. However, further work, utilizing some of the knowledge gained from enzyme use in viscous grain-based diets, has led to the development of specifically designed products that have the potential to significantly improve performance of broilers fed low-viscous grains.

Low-viscous cereals

With a dietary energy value higher than other cereals, low-viscous grains, such as corn, have traditionally been used as the basis of many domestic livestock diets in the U.S. Contrary to the common assumption that corn is relatively constant from batch to batch, evidence shows that its energy content actually varies considerably. Harvesting conditions, for example, can have a substantial influence on energy contents, and the 1992 harvest in Ontario produced corn apparent metabolizable energy values varying from 2,926 to 3,474 kcal/kg (1,335 to 1,579 kcal/lb.) when weather conditions caused delays and crops had to be harvested wet (Leeson et al., 1993). There is also evidence to suggest that the digestibility of corn starch is not as high as previously thought. Although excreta digestibility in birds is generally regarded as being in excess of 98%, recent studies have shown the digestibility of both starch and fat within the ileum of young broiler chicks fed a corn-soybean meal diet, supplemented with 6% soybean oil, to be surprisingly low (Noy and Sklan, 1995).

When determined in birds at various ages between 4 and 21 days, starch digestibility up to the end of the small intestine was as low as 82%, with no evidence of any increase as the birds got older.

This evidence suggested a significant proportion of corn starch may pass undigested to the hindgut, where it would be fermented and give poor energy utilization. Microscopic examinations of ileal digesta samples showed clear evidence of large corn endosperm particles remaining undigested within the chick ileum (Autio and Poutanen, VTT Biotechnology & Food Research, Espoo, Finland).

Vegetable proteins

The composition of soybean meal

protein is significantly affected by both variety and growing conditions, as well as subsequent processing methods. A recent survey of soybean meal samples collected from different locations around the world, and carried out by Finnfeeds International, actually found quality to be quite variable (Hessing et al., 1995).

Variability was found not only in the protein and amino acid content, but also in the level of antinutritional factors present, such as trypsin inhibitors and lectins.

Subsequent work in Canada demonstrated considerable variation in the residual lectin contents of commercially processed soybean meals. (Figure 1). With levels of 20-40% of the lectins commonly found in raw soybeans, the work clearly showed the limits of current soybean processing techniques.

TABLES

1. Effect of feed enzyme (amylase, xylanase and protease) supplementation of reduced energy diets on broiler performance from 1 to 49 days

	Standard diets	Control	Reduced energy diets -3, -5, -5% ME for starter, grower, finisher +Enzymes ³
Bodyweight, g	2,958	2,958	2,981
Variability in bodyweight (standard deviation, g)	±52	±40	±12
FCR (feed:gain) ¹	1.92 ^a	1.99 ^b	1.92 ^a
Corrected FCR ²	1.93 ^a	2.00 ^b	1.93 ^a

^{ab}P < 0.05

¹Commercial FCR, not adjusted for mortality

²Corrected 3 points per 100 g live weight to 3,000 g live weight

³Multi-enzyme complex consisting of xylanase from *Trichoderma longibrachiatum*, protease from *Bacillus subtilis* and alpha-amylase from *Bacillus subtilis* (Quarles and Wyatt, Colorado Quality Research, U.S.)

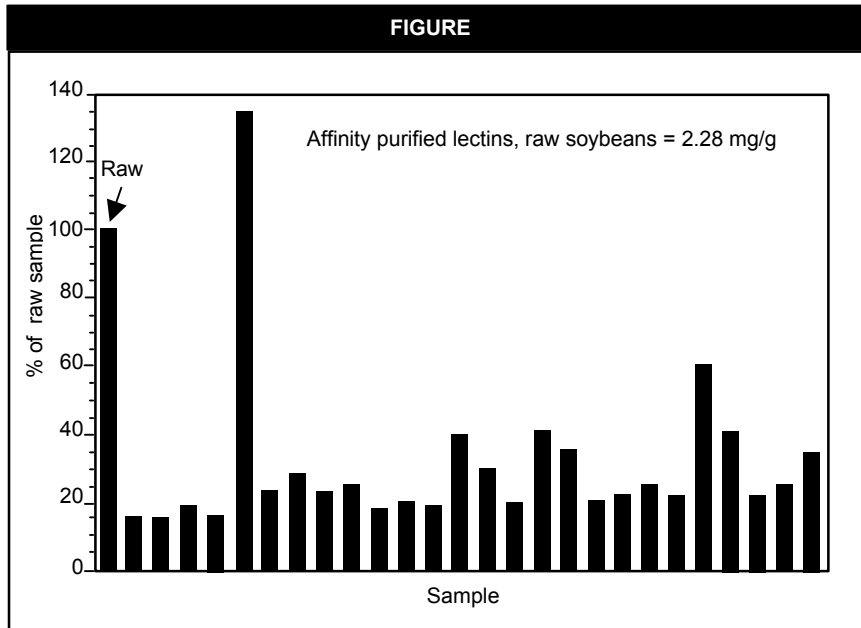
2. Effects of enzyme addition to corn-soybean diets on energy digestibility in broiler chicks, summary of three trials

	University of Minnesota, U.S. ²	University of Viscosa, Brazil ²	University of Sao Paulo, Brazil ³
Number of diets tested	4	4	3
Bird age, days	35	32	37
Ileal digestible energy, kcal/kg (kcal/lb. in parenthesis)			
Control	2,809 (1,277)	2,907 (1,321)	3,080 (1,400)
+ Enzyme ¹	2,950 (1,341)	2,971 (1,350)	3,153 (1,433)
% improvement	+5.0%	+2.2%	+2.4%
Significance of enzyme effect (P value)	0.001	0.050	0.050

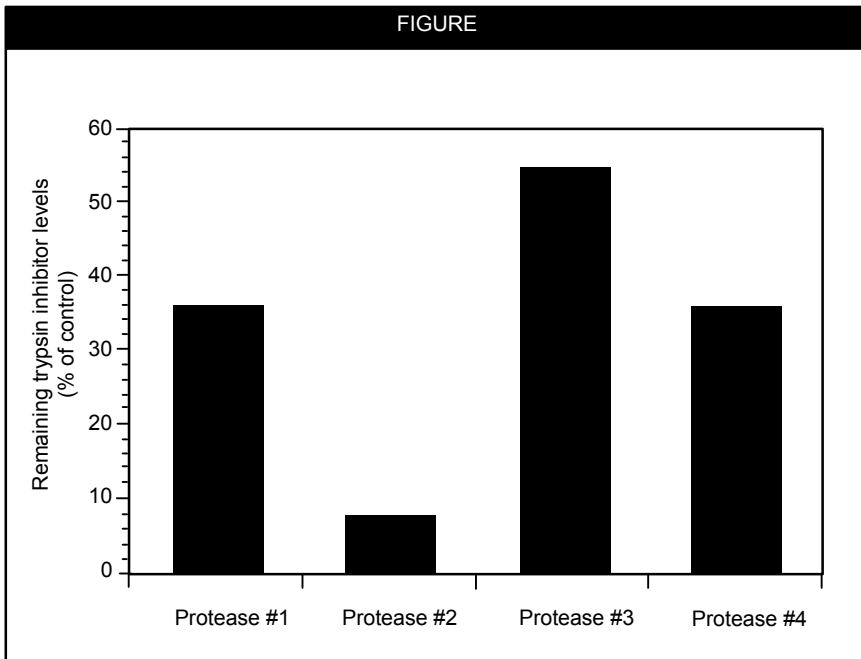
¹Multi-enzyme complex consisting of xylanase from *Trichoderma longibrachiatum*, protease from *Bacillus subtilis* and alpha-amylase from *Bacillus subtilis* added at 1 kg/metric ton

²Pack et al., 1997

³Sakomura et al., 1998



1. Residual lectin levels in 26 U.S. commercial soybean meals relative to untreated soybeans (raw soybeans = 100%; Maenz and Classen, University of Saskatchewan)



2. Effectiveness of four different proteases to degrade soya trypsin inhibitors during soybean processing (Huo et al., 1993)

Improving nutritive value

Based on these variations, research by Finnfeeds International has shown that the nutritional value of low-viscous cereal diets can be significantly enhanced by supplementation with an appropriate enzyme complex.

Although corn and sorghum are considered to be low-viscous grains, it has now been shown that the addition of xylanase enzymes can still produce a reduction in digesta viscosity. While the absolute level of viscosity is fairly low in these diets, a further reduction can still improve nutrient digestion in the upper

intestinal tract, resulting in improved energy utilization and bird performance. In addition, there is evidence to suggest that some of the products of xylanase action (xylo-oligomers) can help stabilize the gut microflora of the chick, thereby improving the health status of the bird.

The use of proteases to degrade trypsin inhibitors and lectins contained in soybeans can be highly effective in improving their nutritional value.

Trials have confirmed the effects and, indeed, have demonstrated improvements in both protein digestibility and broiler performance as a result of protease pre-

treatment of soybeans (Ghazi et al., 1996a,b).

The potential of proteases for effective removal of antinutritional factors during feedstuff processing is shown in Figure 2, and proteases can be added to the feed for the same purpose.

Enzyme selection

The development of new substrate-specific enzyme complexes has been the key to effectively tackling the nutritional limitations of com-soy or sorghum-soy based broiler diets under commercial conditions. However, the selection of the most effective enzyme source and type for this purpose appears to be of critical importance to success. Figure 3 demonstrates the impact on broiler performance of three different amylase enzymes, each combined with both a protease and xylanase, while the data reported in Figure 4 shows the importance of proper selection of the most appropriate protease. These figures also show how an inappropriate enzyme can make little or no difference to bird performance, while careful screening to select the most effective can reap significant improvements in feed conversion ratio (FCR).

Experimental, commercial success

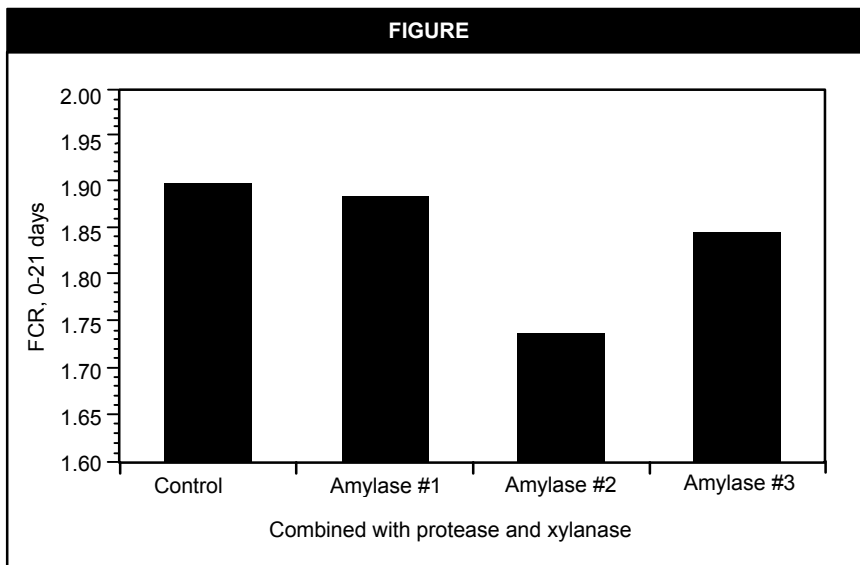
Trials carried out at research institutes and in cooperation with commercial poultry companies have verified the enormous potential of feed enzyme supplementation of low-viscous cereal diets.

In large scale trials carried out by Colorado Quality Research, supplementation of corn-soy diets with an appropriate enzyme complex allowed the metabolizable energy (ME) content of the starter, grower and finisher rations to be reduced by 3, 5 and 5%, respectively, with no loss in broiler performance (Table 1). In the finisher ration, this equated to a reduction in tallow inclusion from 3.8% to 0.1 %, and replaced by corn.

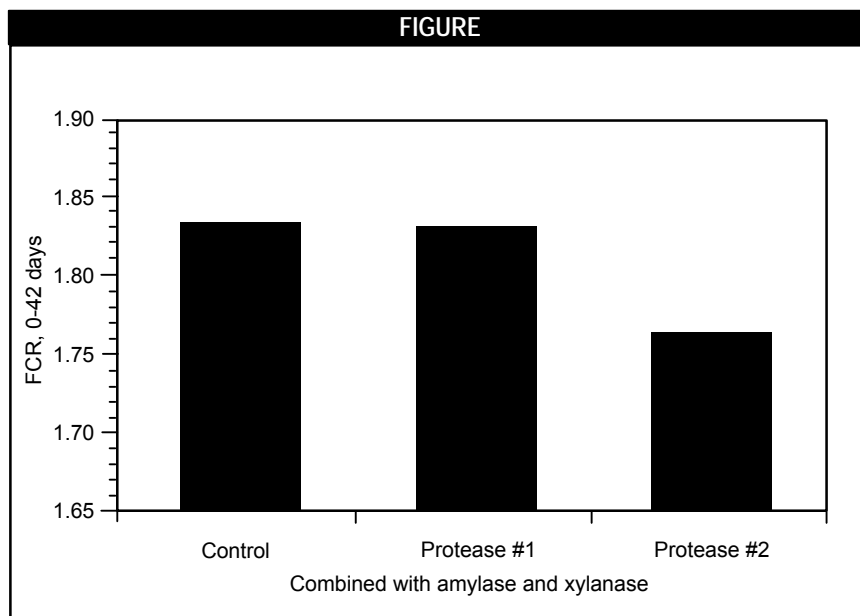
In addition, the variation in bodyweight at 49 days old was substantially reduced, a factor that is of considerable commercial importance.

Enzyme supplementation evidently reduces the impact of variation in bird digestive capacity, either directly (through augmentation of digestive enzyme capacity) or indirectly (by stabilisation of the intestinal microflora.)

The consistency of responses to enzyme addition across a variety of diets has been confirmed in digestibility assays involving three institutes (Table 2). When tested in young broilers of 4-5 weeks of age the enzyme addition significantly improved the



3. Comparison of three different amylases, each combined with protease and xylanase (Salmon and Bedford, Lakeside Research, Canada)



4. Effectiveness of two different proteases combined with amylase and xylanase (Walker and Bedford, ADAS Gleadthorpe, U.K.)

ileal digestibility of energy in a range of diets, regardless of their composition.

This reflected the potential of enzymes to maximize the digestive capacity of the chick to utilize the dietary nutrients efficiently in the upper intestine.

Conclusion

In poultry diets based on low-viscous cereals (corn and sorghum) plus soybean meal, the use of enzymes specifically designed for these substrates is now a commercial reality. The significant improvements in nutrient digestibility allow substantial alterations in feed formulations to reduce ration cost, replacing expensive energy sources, such as fat, with corn.

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The effects of enzymes on feed substrates may also be seen in a reduction in bird body weight variation and possible improvements in bird health. For the commercial broiler producer feeding low-viscous grains, the economic benefits to be gained from appropriate feed enzyme complex are now very real indeed.

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