

# Enzymes improve performance of broilers fed corn-soy diets

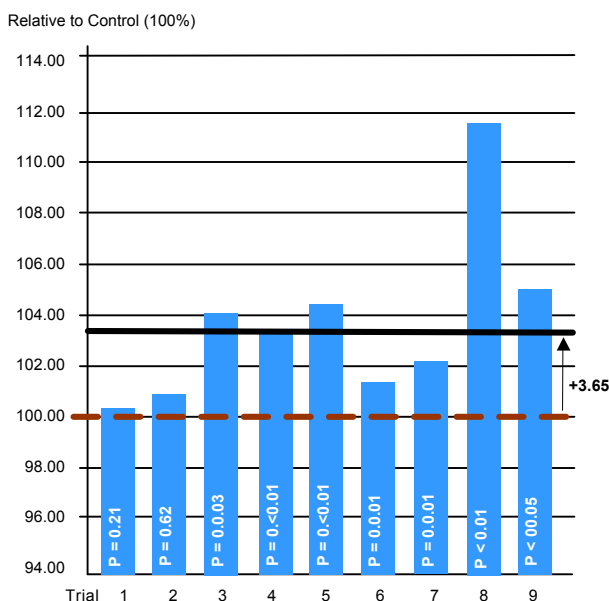


Nine trials conducted in the Asia Pacific area testing an enzyme combination showed an average improvement of 3.65% in weight gain and 5.02% in feed:gain. Dr GENE JIN\* explains the mode of action of enzymes for corn-based diets.

Enzymes are currently routinely used in wheat and barley based broiler diets on a worldwide basis, and there is broad agreement with respect to how these products deliver their benefits. Enzymes directed towards corn-based diets are a more recent phenomenon and are still under

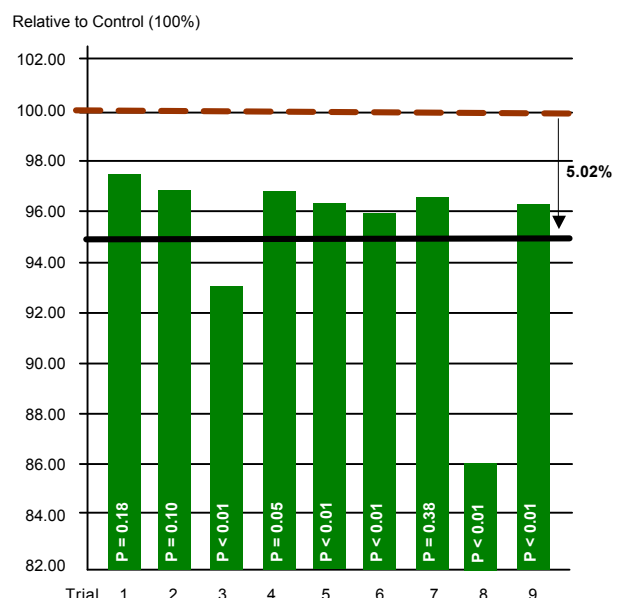
scrutiny as to their mode of action. Many nutritionists would consider corn as being almost completely digested and consistent from sample to sample. Recent data, however, suggests that the variability of corn (Collins *et al*, 1998; Leeson *et al*, 1993) can be as great as that determined in wheat

**Figure 1: Summary of 9 trials on the effect of Avizyme 1500 on body weight gain in corn-soy based broiler diets in Asia-Pacific countries.**



Trial 1 + 2: University of The Philippines, Los Banos, Philippines  
 Trial 3: Institute of Agricultural Sciences in South Vietnam, Vietnam  
 Trial 4: University of Agriculture and Forestry, Vietnam  
 Trial 5: Feed Research Institute, CAAS, China  
 Trial 6: Queensland Poultry Research and Development Centre, Australia  
 Trial 7: University of New England, Australia  
 Trial 8: Queensland Poultry Research and Development Centre, Australia  
 Trial 9: University of Agricultural Sciences, Bangalore, India

**Figure 2: Summary of 9 trials on the effect of Avizyme 1500 on feed:gain in com-soy based broiler diets in Asia-Pacific countries.**



Trial 1 + 2: University of The Philippines, Los Banos, Philippines  
 Trial 3: Institute of Agricultural Sciences in South Vietnam, Vietnam  
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(Classen *et al*,1995) and barley (Scott *et al*,1997). Further, studies have shown that corn starch digestibility at the terminal ileum can be as low as 85% and does not seem to increase with age (Noy *et al*,1994). Research from Finnfeeds International has shown that ileal starch digestibility of some samples can fall well below 80%, indicating that there is indeed considerable variation between samples (Finnfeeds 1998, unpublished). The current paper summarizes the results of the feed enzyme, Avizyme 1500 on broiler performance in corn-soy diets in Asia Pacific countries within the last 5 years. The possible modes of action will be discussed.

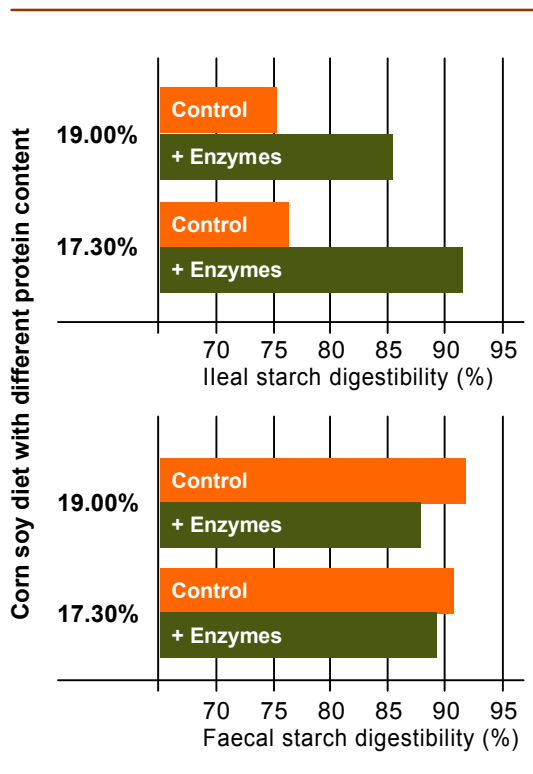
### The feeding studies

The experiments reported in this paper were conducted in Australia (3), China (1), India (1), the Philippines (2) and Vietnam (2). All these studies were conducted at universities or research institutes. All feeding studies were replicated and were statistically analyzed. All diets were corn-soybean meal based either in pellet or mash form. The source of added oil was soy oil (Vietnam study), tallow (Australian study), or coconut oil (the Philippines). Diet specifications were ME 2780 to 3050 kcal/kg for grower and 2830 to 3150 for finisher, with normal levels of protein and amino acids. In total, 162 pens with 12,900 birds were fed, which represents an average of 18 pens and 76 birds per treatment.

### Results

Avizyme 1500 improved performance of corn-soybean based diets under a wide variety of dietary and environmental conditions. On average, growth rate was improved by 3.65% with a range from the lowest 2.2% in the Philippines to the highest 11.7% in Australia (Figure 1). All results except for those 2

**Figure 3: Effect of addition of corn targeted enzyme complex on ileal and faecal starch digestibility in broilers fed diets of varying protein content.**  
(Coon *et al*, 1998, unpublished)



experiments from the Philippines were significantly ( $P < 0.05$ ) enhanced in bodyweight gain. Feed conversion efficiency (feed:gain ratio) was improved from 2.45% to 13.88% with an average of 5.02% (Figure 2). All results were statistically significant ( $P < 0.05$ ) except two trials from the Philippines ( $P = 0.18$  and  $P = 0.10$ ) and one from Australia ( $P = 0.38$ ).

### Mode of Action

If viscosity is not a factor in corn quality then some other parameter(s) yet to be identified must be affecting quality. It is striking that some studies have shown that corn starch may not be particularly well digested at point of exit from the ileum. This is evident from the work of Noy and Sklan where ileal corn starch digestibility did not increase above 85% with age despite an almost logarithmic increase in amylase output. Work conducted by Coon *et al* (1998, unpublished) also identified corn starch digestibility was by no means nearing

completion at the terminal ileum (Figure 3).

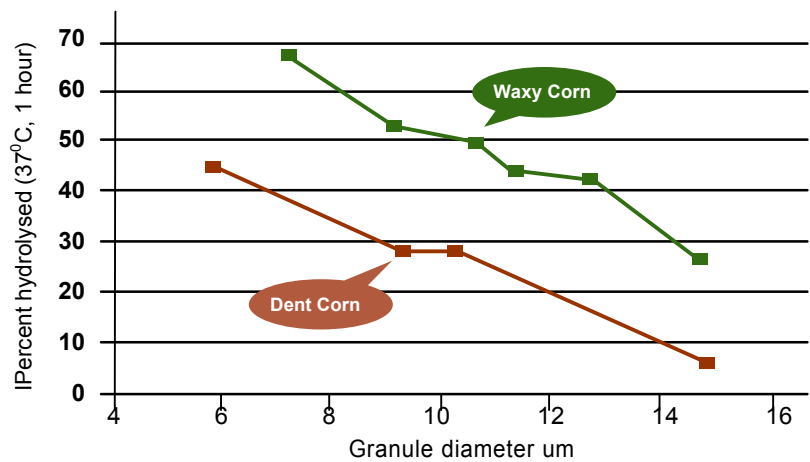
As can be seen from Figure 3, large benefits in starch digestibility were conferred by addition of the enzyme at the ileal but not the faecal level. Since enzyme addition did enhance performance it questions the value of the faecal measurement. Secondly, starch digestion is evidently very active in the large intestine of the chicken, since digestibility increases by almost 15% in transit Figure 3 (Coon *et al*, 1998, unpublished). On the assumption that starch digested in the ileum is likely to derive a greater energy benefit to the bird than starch fermented in the large intestine, it is clear that the addition of the enzyme will provide a greater energy benefit to the bird despite the apparently flat faecal digestibility result. In many respects, the mode of action of this enzyme in a corn-based ration is likely to reflect that of an enzyme in a viscous cereal based ration. In diets where nutrients are digested slowly (either through viscosity or other reasons), enzymes speed the process up and deny ileal and large intestinal bacteria their starch and protein substrates, thereby limiting competition. These anti-nutritional factors in barley and wheat are the viscous  $\beta$ -glucans and arabinoxylans respectively. Although it is not clear exactly why corn shows such variability, there are a few likely reasons for variation in starch digestibility.

Rate of digestion of corn starch is not intrinsically as rapid as that for wheat and barley and is controlled by several factors including starch crystallinity, drying and processing, and the subsequent formation of retrograde starch. The degree of protein encrustation also plays a role in the accessibility of the starch to enzymatic digestion. Starch structures are arranged in amylose (less digestible) or amylopectin (branched chain, more digestible) molecules within the starch granule. Amylopectin is not only more digestible than

amylose but is also more susceptible to gelatinisation as a result of feed processing (gelatinised starch is 100-1000 times more rapidly degraded by amylase than raw starch). However, after gelatinisation, there is a proportion of this starch which, after cooling and storage, slowly forms highly enzyme-resistant complexes with protein and fibre, called retrograde starch. Since variety and environment control granule crystallinity and amylose:amylopectin ratio, and handling and processing influence the proportion of retrograde starch, it can be appreciated that there can be significant differences between corn samples with respect to rate of starch digestibility. As a result, variability in corn feeding value can be as large as that determined for wheat and barley.

It is important to note that whilst retrograde starch is classically considered to be formed as a result of high temperature processing, it is also likely that similar processes occur during wet harvest years when the grain is dried vigorously in forced-air driers. Further, storage of the recently harvested grain in vertical silos with metal sides can result in silo temperature exceeding 50°C (Finnfeeds internal data) which over a period of time can lead to significant annealing of starch, a

**Figure 4: Relationship between starch granule diameter and in vitro rate of starch digestion in both normal dent corn and waxy (high amylopectin) corn lines.**



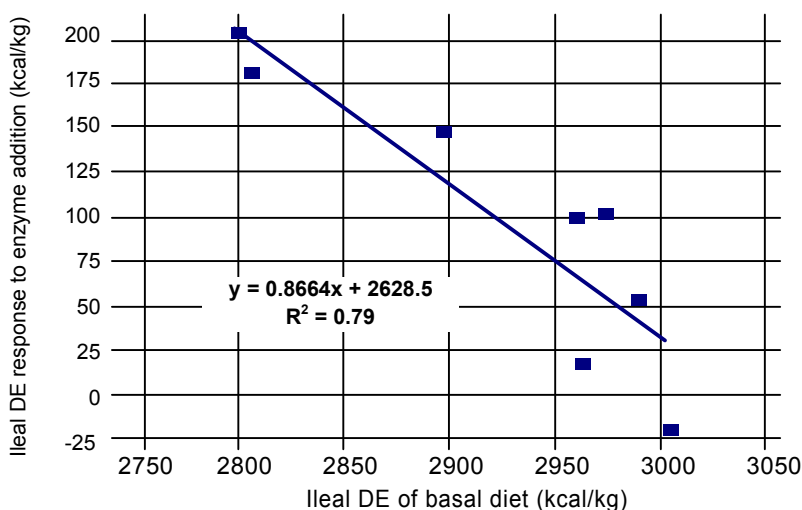
process not unlike retrogradation.

Other physical attributes of corn or sorghum are implicated in controlling its digestibility. Several workers have identified starch granule size as being important in determining the relative rate of starch digestion. The larger the granule the slower it is digested. The data in Figure 4 indicate the relationship between granule size (diameter) and rate of digestion in a waxy (high amylopectin) and normal (dent) feed corn line. Note the greater rate of starch digestibility of the waxy line compared with the dent at all granule diameters, demonstrating the impact that amylose to amylopectin ratio has on rate of digestion.

## Conclusions

Trials conducted in Asia Pacific indicate Avizyme 1500 increased body weight gain by 3.65% in broilers fed corn-soy based diets and feed conversion efficiencies were improved by 5.02% on average. Enzyme addition may have two effects: the average energy content was enhanced and at the same time there was a clear reduction in the variability. A larger enzyme effect on the poorer quality corn and a smaller effect on already good quality batches of corn might be expected with the addition of feed enzymes (Figure 5). More consistent nutritional quality and bird performance may be expected in diets containing an appropriate enzyme supplement.†

**Figure 5: Effect of the energy content of enzyme-unsupplemented diet on the energy response to enzyme addition. Broiler chicks at 28 days of age, 8 different corn batches. Diets containing 53% corn, identical composition except for corn. (Roslin Institute, Edinburgh, unpublished)**



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