

# **Influence of Dietary Enzymes on Gut Health**

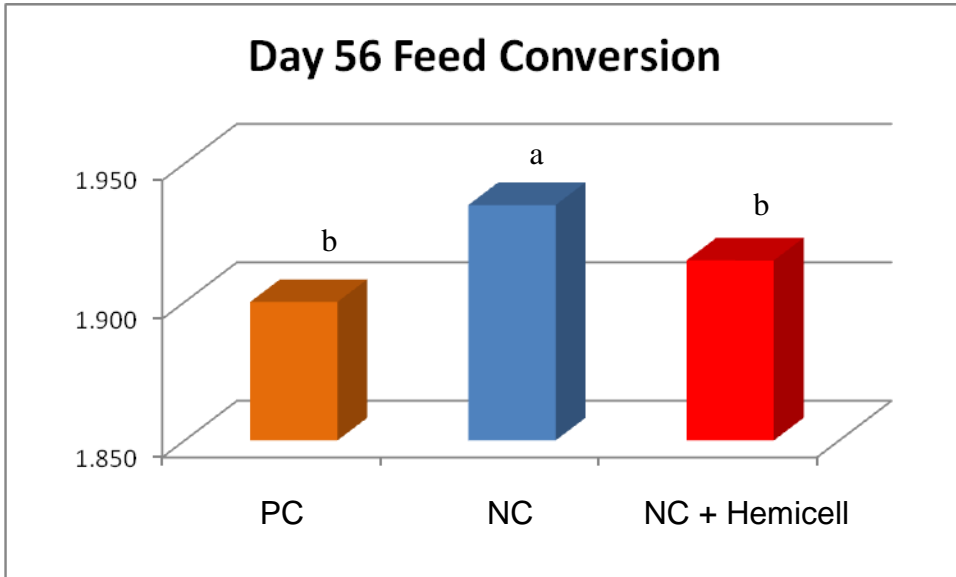
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## **Introduction**

From the beginning of commercial poultry production, maximizing profit has been the main goal. Profit equals the best feed conversion, days to slaughterer, slaughter weights, livability, and uniformity for the least amount of money. The poultry industry is willing to take less in performance if it maximizes profits. An example of this is with coccidiosis control. Producers will pick the least expensive anticoccidial drug, which controls coccidiosis while foregoing the use of a higher priced more effective drug. They are sacrificing some measure of performance loss from coccidiosis loss lower feed costs. Teeter (2009), in his metabolism studies demonstrated that even low level coccidiosis late in a grow-out can potentially cost as much as an inadequate lighting program or poor pellet quality. Product choice is often also dependent on bundling of products; i.e. if you will buy this product we will give you a good price on another. Often the bundled product is not the first choice especially in disease control. With this loss in performance added in, are there products, such as feed enzymes, that are already being used that can give a boost or generate value beyond nutrient replacement, especially from the stand point of improving gut health? Many studies have shown the nutrient sparing effects of enzymes, such as the release energy from the feed at a cost lower than the equivalent amount of expensive oil/ fat. Southern Poultry Research (SPR) has conducted several broiler and turkey full grow-out studies using corn-soybean meal based diets supplemented with the feed enzyme Hemicell, a  $\beta$ -Mannanase. Decreasing a standard broiler diet by 55 kcal/lb significantly decreased broiler live weight and increased feed conversion ratio. With the same diet supplemented with Hemicell, live weight and feed conversion were brought back to levels comparable with birds fed the positive control diet (Figures 1 and 2).

**Figure 1. Day 56 broiler adjusted feed conversion**

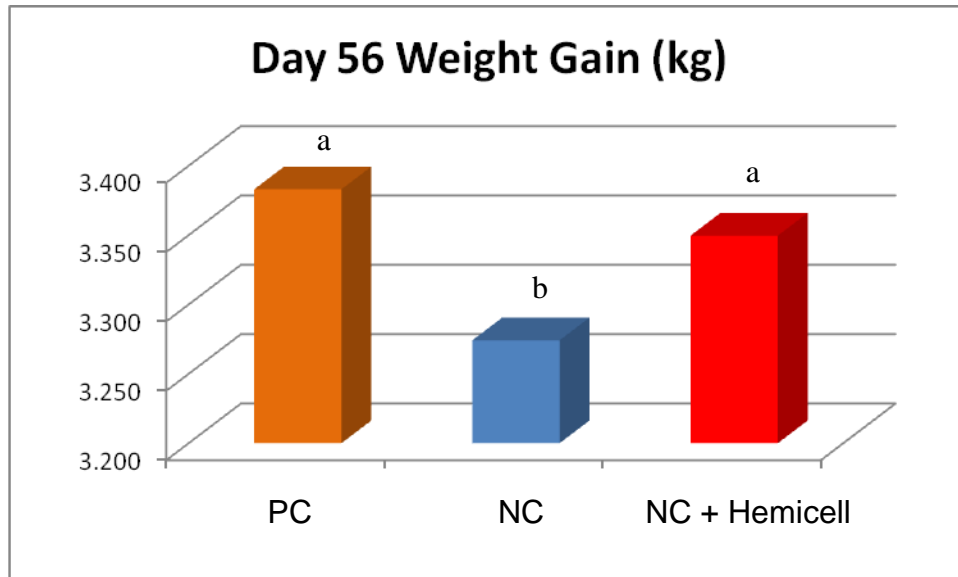


PC= positive control (starter 1465 Kcal/lb, grower 1490 Kcal/lb, finisher 1515 kcal/lb),

NC= negative control PC- 55 Kcal/lb

<sup>a-b</sup> Means columns with no common superscript differ significantly ( $p < 0.05$ )

**Figure 2. Day 56 average broiler weight gain (kg)**



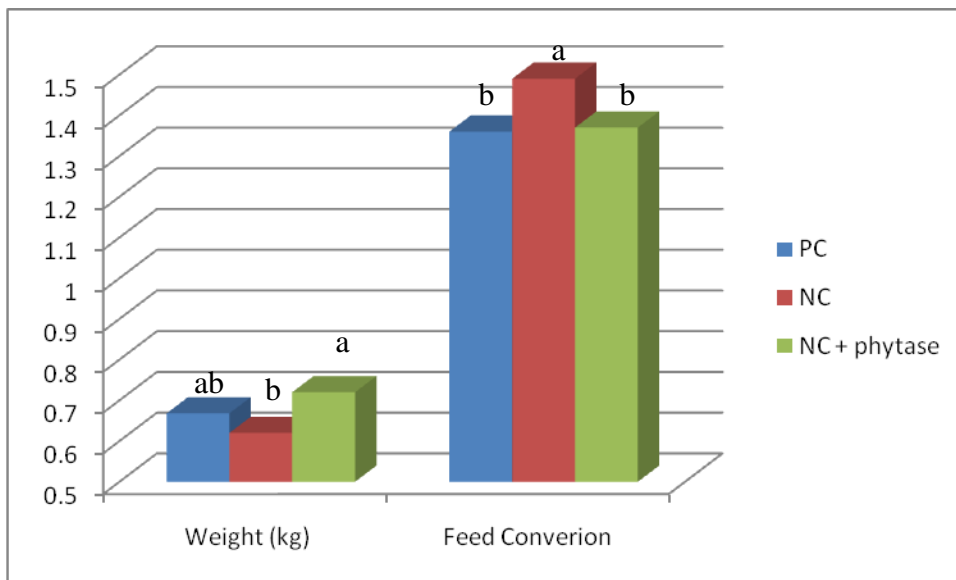
PC= positive control (starter 1465 Kcal/lb, grower 1490 Kcal/lb, finisher 1515 kcal/lb),

NC= negative control PC- 55 Kcal/lb

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Phytase is one of the most researched enzymes used in poultry diets. Phytase improves phosphorous utilization by liberating phosphorus from grain and oilseeds. In an effort to understand the functions of phytase, other than phosphorus utilization, a study was conducted at SPR (Lumpkins, et. al, 2009) using 3 treatments: Treatment 1- positive control diet, 0.45% AP, Treatment 2- negative control diet, 0.30% AP, and Treatment 3- negative control + 5,000 FTU/kg of phytase. The results showed that supplementation of 5,000 FTU/kg of phytase to the NC diet improved body weight gain by 7.8% over the positive control diet (Figure 3). The presence of high concentrations of phytase significantly improved protein, energy, and phosphorus and calcium digestibility in comparison to both the positive and negative control fed birds (Table 1). Duodenal 5AC mucin mRNA expression was in significantly lower abundance in birds fed the high phytase diets compared to the PC fed birds and numerically lower than the NC fed birds. There were numeric reductions with high phytase diets with ileal 5AC mucin mRNA abundance. Clostridium thrives on mucin, and a reduction in mucin levels could correspond to a reduction in *C. perfringens* and the occurrence of Necrotic Enteritis.

**Figure 3: Day 21 Performance comparison PC, NC, vs. NC + 5,000 FTU/kg Phytase**



PC= positive control,0.45 %; AP NC= negative control, 0.30% AP

<sup>a-b</sup> Means columns with no common superscript differ significantly (p < 0.05)

**Table 1: Day 21 metabolizable energy, % protein digestibility, % phosphorus digestibility, and % calcium digestibility, PC, NC, vs. NC + 5,000 FTU/kg Phytase**

Treatment	ME (kcal/Kg)	% Protein	% Phosphorus	% Calcium
1. PC, 0.45% AP	3263 b	85.5 b	70.1 b	67.0 b
2. NC, 0.30% AP	3272 b	84.6 b	66.6 c	68.9 b
3. NC +5,000 FTU/kg phytase	3459 a	90.2 a	81.5 a	74.5 a

<sup>a-b</sup> Means columns with no common superscript differ significantly ( $p < 0.05$ )

Research has shown reductions in effects of some intestinal diseases with diets supplemented with enzymes. In a 21 day, Hemicell broiler study (Jackson, et. al, 2003), birds were challenged with coccidia (*E. acervulina* and *E. maxima*) followed by a *C. perfringens* challenge. The Hemicell treatment did not reduce Necrotic Enteritis mortality but did significantly improve adjusted feed conversion and weight gain compared to the challenged controls.

One of the factors for improvement of gut health with enzymes is a change in microbiota by altering the substrate of the diet with enzymes. This works on a similar principle found with the use of probiotics. an intestinal commensal bacteria. When intestinal commensal bacteria are administered to a host, they are believed to work on the principle of competitive exclusion by increasing the population of beneficial bacteria in expense of detrimental bacteria such as *Salmonella spp*, *Clostridium perfringens*, and *C. septicum*. Fernandez et al. (2000) showed a decrease in *Campylobacter jejuni* in diets supplemented with xylanase, on the colonization of *Campylobacter jejuni*. The xylanase supplemented diet influenced changes in mucin composition and reduced intestinal viscosity, thus lowering the number of residing *Campylobacter jejuni*. Carbohydrate fermentation within the ceca of a bird supports high levels of *Clostridium* species. Under stress conditions, from coccidiosis, feed restriction, highly viscous diets, and etc., the *Clostridium* can move up the intestine by reverse peristalsis where it can proliferate leading to Necrotic Enteritis. The use of enzymes will reduce the concentration of carbohydrates in the gastrointestinal tract, which could reduce fermentative processes in

the ceca thus reduce levels of Clostridium. This reduction in cecal Clostridium may have the potential of reducing Necrotic Enteritis as well as Gangrene Dermatitis thought to be associated with *C. septicum*.

### **Summary**

Feed enzymes do provide more than just nutrient replacement. Non-starch polysaccharides (NSP), such as  $\beta$ -mannan, decrease performance by increasing intestinal viscosity and reduces apparent nutrient digestibility, which both reduce the exchange rate of nutrients with the mucosa and alters the GIT microbial populations. The addition of various enzymes directed at specific NSPs can alleviate many of these anti-nutritional properties. Reduction in NSP's could reduce cecal fermentation resulting in lower levels of detrimental bacteria. By changing the percentage of "beneficial" bacteria, poultry performance (feed conversion and weight gain) can be improved. Less sub-clinical or clinical enteric diseases and carcass contamination, lower disease related mortality, and better uniformity can be achieved. Enzymes also have the potential to improve protein, energy, phosphorus and calcium digestibility, and reduce gel forming mucin levels. The field proven economic advantage of the nutrient sparing effects of enzymes is reinforced by this bonus function on gut and bird health.

### **References**

- Fernandez, F., R. Sharma, M. Hinton, and M. R. Bedford. 2000. Diet influences the colonization of *Campylobacter jejuni* and distribution of mucin carbohydrates in the chick intestinal tract. *Cell. Mol. Life Sci.* 57:1793–1801
- Jackson, M. E., D.M. Anderson, H. Y. Hsiao, F. L. Jin, G. F. Mathis, a D. Fodge, 2003005. Beneficial effect of  $\beta$ -Mannanase feed enzyme on performance of chicks challenged with *Eimeria sp.* and *C. perfringens*. *Avian Dis.* 47: 759-763.
- Lumpkins, B.S., B. Humphrey, G. Mathis, and M. Persia, 2009. Performance, nutrient digestibility and expression of intestinal mucin RNA of 21 day old broiler chickens supplemented with 5000 FTU of Phytase. PSA 09, Raleigh, NC Abst. No. 190 page 60.
- Teeter, R.G., A. Beker, C. Brown, M. Singh, C. Broussard, and S. Fitz-Coy, 2009. Coccidiosis medicated lesion score effects on calorific cost at 5 age intervals throughout the broiler growth curve to 48 days. PSA 09, Raleigh, NC Abst. No. 181 page 57.