Effects of Dietary *Aspergillus* Meal Prebiotic on Turkey Poult's Production Parameters and Bone Qualities†


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Abstract: The objective of this study was to evaluate the effects of 0.2% dietary *Aspergillus* Meal (AM) on performance and bone parameters of neonatal turkey poult's. A total of 200 day-old hatch turkey poult's were used for this experiment. Two dietary treatments, similar in energy and protein content differing only by the addition of 0.2% AM, were used. Poult's were divided into 2 treatment groups with 25 birds per treatment and four replicates each. Group 1 received a basal non medicated control diet and group 2 received dietary AM. At the end of 30 d, poult's were weighed, euthanized, and tibias were collected to evaluate bone quality using an Instron shear press machine and bone parameters such as tibia weight, diameter, ash, calcium and phosphorus assays. Samples of distal ileum were collected and the content subjected to protein and energy analysis. Poult's fed with dietary AM had a significant improvement in BW and feed conversion ratios (p<0.05). Distal ileum content showed significantly less concentration of energy and protein when compared with the poult's receiving control diet. Tibia weight, diameter, breaking strength, ash, calcium and phosphorus were significantly higher in poult's that received dietary AM prebiotic. These results suggest that the increase in performance and bone parameters in neonatal turkey poult's fed with 0.2% AM, is improved upon feeding *Aspergillus niger* mycelium prebiotic.

Key words: *Aspergillus* meal, prebiotic, turkeys, productive parameters, bone qualities

INTRODUCTION

According to the definition by Gibson and Roberfroid (1995), prebiotics are “non-digestible food ingredients that beneficially affect the host by selectively stimulating the growth or activity of one or a limited number of bacterial species already resident in the colon, and thus attempt to improve host health”. Some prebiotics have been shown to selectively stimulate the growth of endogenous lactic acid bacteria in the gut thereby improving the health of the host (Gibson and Wang, 1994). Thus, prebiotics can selectively modify the colonic microflora and potentially influence gut metabolism (Laparra and Sanz, 2009). The presence of normal gut microflora may improve the metabolism of host birds in various ways including absorptive capacity (Yokota and Coates, 1982), protein metabolism (Salter et al., 1974), energy metabolism, fiber digestion (Furuse and Yokota, 1984) and gut maturation (Furuse et al., 1991). A healthy population of these beneficial bacteria in the digestive tract enhances the digestion and absorption of nutrients, detoxification, elimination processes and helps boost the immune system (Chow, 2002; Tokunaga, 2004; No et al., 2007; Kong et al., 2010). The commercially available fermentation product of *Aspergillus niger*, Fermacto®, referred to as *Aspergillus* Meal (AM), has no live cells or spores and is proven to enhance the digestive efficiency of the gut (Potter and Shelton, 1984; Harms and Miles, 1988). Prebiotics have been shown to stimulate Calcium (Ca) and Magnesium (Mg) absorption in the intestine and increase bone mineral concentrations in humans and rats (Tokunaga, 2004; Abrams et al., 2007; Lobo et al., 2009). However, the effects of prebiotic feed supplements on bone development in poultry are lacking. The objective of this study was to evaluate the effects of dietary AM prebiotic on performance and bone parameters of neonatal turkey poult's.

MATERIALS AND METHODS

Diet composition and preparation: Control and treated poult's were fed a corn-soybean starter diet. The diets were formulated without added antibiotics or coccidiostats and contained levels of nutrients recommended by the National Research Council (1994). The two treatments, similar in energy and protein content, differed only by the presence of 0.2% of the
prebiotic, AM, a dried primary fermentation AAFCO/GRAS (AAFCO, Inc., 2011) Aspergillus niger Strain (Fermacto®, PetAg Inc. Hampshire, IL60140 USA). This mycelium is unique because it contains only 16% protein and 45% fiber (Harms and Miles, 1988).

**Experimental design**: A total of 200 day-of-hatch turkey pouls were used for this experiment. Pouls were divided into 2 treatment groups with 25 birds per treatment (four replicates each) and received either a basal non medicated control diet or the same diet with AM prebiotic. All pouls were fed for 30 days. At the end of 30 days, body weight, feed conversion and mortality were recorded and all pouls were euthanized. Tibias from five pouls in each replicate were collected to evaluate bone quality. Samples of ileum were also collected from the same birds and their content subjected to protein and energy analysis.

**Distal ileum content analysis**: Ileal sections (from Meckel's diverticulum to the ileo-caecal junction) were taken after sacrificing the pouls. The ileal content was collected and then frozen. Nitrogen content was determined with an automatic analyzer (Leco FP-528 nitrogen, Leco Corp., St Joseph, MI) by AOAC 968.06 procedure (AOAC International, 2000) using EDTA as the standard and the protein content was calculated as nitrogen x 6.25. Gross energy in the ileum content was determined with an adiabatic bomb calorimeter (model 1261 isoperibol, Parr Instrument Co., Moline, IL) using analytical grade sucrose as the standard. Crude protein and gross energy were determined in triplicate samples.

**Bone parameters**: Bone parameters were measured according to the methods described by Zhang and Coon (1987). Tibias from each poult were cleaned of attached tissues. Bones from the right leg were subjected to conventional bone assays and tibia from the left leg were used to determine breaking strength.

**Conventional bone assays**: The bones from right tibia and femurs were dried at 100°C for 24 h and weighed again. The bones were subsequently ashed at 600°C overnight, cooled in a desiccator and weighed. The samples were then ashed in a muffle furnace (Isotemp muffle furnace, Fisher Scientific, Pittsburgh, PA) at 600°C for 24 h in crucibles. Finally, the content of calcium and phosphorus in the tibia was determined using standard methods (AOAC International, 2000).

**Bone breaking strength**: Bone breaking strength was measured using an Instron shear press with a 50-kg load cell at 50-kg load range with a crosshead speed of 50 mm/min; bone was supported on a 3.00-cm span (Huff et al., 1980).

**Statistical analysis**: All data were subjected to one-way analysis of variance as a completely randomized design using the General Linear Models procedure of SAS (SAS Institute, 2002). Significant differences among the means were determined by using Duncan's multiple-range test at p<0.05.

**RESULTS AND DISCUSSION**

Prebiotics are nondigestible food ingredients containing oligosaccharides that are selectively fermented by one or more bacteria known to have positive effects on gut physiology. Bacteria fed with a preferential food substrate have a proliferative advantage over other bacteria (Gibson and Wang, 1994). Aspergillus fiber contains beta-glucans (McCleary and McCleary, 2000), Fructo-Oligosaccharides (FOS) (Sangeetha et al., 2004), chitosan (Jonker et al., 2010; Muzzarelli, 2010) and Mannan-Oligosaccharides (MOS) (Uchima et al., 2011; Vera et al., 2011). Beta-glucan is a powerful immune-enhancing nutritional supplement. It affects the intestinal villi and primes the innate immune system to help the body defend itself against viral and bacterial invaders (Tsukada et al., 2003; Lowry et al., 2005; Jonker et al., 2010). MOS protect the GI tract from invading toxins by binding the toxin active sites (Biggs et al., 2007). FOS and chitosan refer to a class of host non-digestible carbohydrates that are readily fermented by the beneficial bacteria in the intestine. A healthy population of these beneficial bacteria in the digestive tract enhances the digestion and absorption of nutrients, detoxification and elimination processes and helps boost the immune system (Chow, 2002; Tokunaga, 2004; No et al., 2007; Kong et al., 2010).

Previously, we have shown that dietary AM induces important changes in the intestinal morphometry in neonatal turkey pouls, suggesting that AM prebiotic has a beneficial impact on the mucosal architecture and goblet cells proliferation (Tellez et al., 2010). In the present study, dietary AM prebiotic supplemented for 30 days, significantly increased the body weight of neonate pouls and improved feed conversion compared with pouls that received only the control basal diet (Table 1). The energy and protein content in the ileum was significantly lower in pouls that received dietary AM prebiotic compared with control pouls suggesting better digestibility and absorption of those nutrients (Table 2). These results are in agreement with the morphometric changes observed previously (Tellez et al., 2010). Table 3 summarizes the effect of AM on bone breaking strength and other bone parameters (variables) in turkey pouls at 30 d of age. Significant increases in tibia weight, diameter, breaking strength, ash, calcium and phosphorus were observed in pouls that received dietary AM when compared with neonatal pouls that received the control basal diet. FOS has been shown to stimulate Calcium (Ca) and Magnesium (Mg) absorption in the intestine and increase bone mineral concentrations in humans and rats (Tokunaga, 2004; Abrams et al., 2007; Lobo et al., 2009). Dietary short-
Table 1: Effect of Aspergillus meal on productive parameters in turkey pouls at 30 days of age

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Aspergillus meal</th>
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<tr>
<td>Body weight (kg)</td>
<td>600.3±52.26b</td>
<td>720.8±63.82a</td>
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<tr>
<td>FC (Feed: gain)</td>
<td>1.3±0.029b</td>
<td>1.23±0.023b</td>
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<tr>
<td>Mortality (%)</td>
<td>2.0±0.15b</td>
<td>2.6±0.24b</td>
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A total of 200 day-old hatch turkey pouls were used for this experiment. Pouls were divided into 2 treatment groups with 25 birds per treatment (four replicates each) and received either a basal non medicated control diet or the same diet with AM prebiotic. All pouls were fed for 30 days. At the end of 30 days, body weight, feed conversion and mortality were recorded.

Data is expressed as mean±standard error. Values within a row with no common superscript differ significantly p<0.05. FC = Feed Conversion

Table 2: Effect of Aspergillus meal on chemical proximal analysis of distal ileum content in neonatal turkey pouls at 30 days of age

<table>
<thead>
<tr>
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<th>Control</th>
<th>Aspergillus meal</th>
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<tr>
<td>EC (Calories/g)</td>
<td>425.0±28.21b</td>
<td>250.0±31.45a</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>3.0±0.061b</td>
<td>1.23±0.078b</td>
</tr>
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Ileum samples from five pouls in each replicate were collected and their content subjected to protein and energy analysis.

Data is expressed as mean±standard error. Values within a row with no common superscript differ significantly p<0.05. EC = Energy Content

Table 3: Effect of Aspergillus meal on bone breaking strength and bone parameters of neonatal turkey pouls

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<th>Control</th>
<th>Aspergillus meal</th>
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<tr>
<td>Tibia weight (g/100 BW)</td>
<td>0.85±0.02b</td>
<td>0.9±0.009a</td>
</tr>
<tr>
<td>Tibia strength (kg force)</td>
<td>0.1±0.011b</td>
<td>0.18±0.009b</td>
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<tr>
<td>Tibia diameter (mm)</td>
<td>4.1±0.17b</td>
<td>4.6±0.28b</td>
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<tr>
<td>Total ash from tibia (%)</td>
<td>45.0±1.04b</td>
<td>48.8±0.35b</td>
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<tr>
<td>Calcium (% of ash)</td>
<td>35.4±0.27b</td>
<td>39.4±0.27b</td>
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<tr>
<td>Phosphorus (% of ash)</td>
<td>17.1±0.12b</td>
<td>20.1±0.12b</td>
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</table>

Tibias from five pouls in each replicate were collected to evaluate bone qualities. Samples of ileum were also collected from the same birds and their content subjected to protein and energy analysis.

Data is expressed as mean±standard error. Values within a row with no common superscript differ significantly p<0.05.

Beneficial bacteria which can alter not only gut dynamics, but also many physiologic processes due to the end products metabolized by symbiotic gut microflora. Additives such as enzymes, probiotics and prebiotics are now extensively used throughout the world. The chemical nature of these additives are better understood but the manner by which they benefit the animal is not clear (Chow, 2002; Schneeman, 2002; de Vrese and Schrezenmeir, 2008). The results of this study suggest that the increase in performance and bone parameters in neonatal pouls fed with 0.2% AM, may be related to a synergistic effect between beta-glucan, MOS, chitosan and FOS from Aspergillus niger mycelium.

REFERENCES


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