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Effect of ß-Mannanase on Broiler Performance and Dry Matter Output Using Corn-Soybean Meal Based Diets†

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Abstract: The effect of a commercial beta-Mannanase enzyme (CTCZYME; CTC Bio Inc., Seoul, Korea) on broiler performance and dry matter output in corn-soybean meal diets was investigated. One hundred and twenty one-day-old male chicks of a commercial broiler strain were fed for 19 d on a nutritionally adequate diet based on corn and soybean meal. At that time birds were randomly allocated to four treatments, each of which had six replicates of five birds each. Aliquots of the basal diet were supplemented with four levels of the CTCZYME: 0%, 0.025%, 0.05% (recommended level) and 0.1%. Chromic oxide was used as an indigestible marker. After eight days of acclimation excreta was collected daily, weighed and dried at 130°C for 24 h to obtain the dry matter output. After seven days of excreta collection the birds were weighed and the experiment was terminated. There were no significant differences for body weight gain, feed conversion or feed intake. The addition of CTCZYME at the inclusion level of 0.05% and 0.1% significantly reduced ($p<0.002$) the daily dry matter excreta output per bird. Analysis of the excreta showed a reduction of the nitrogen level as the level of CTCZYME increased, indicating an improvement in nitrogen utilization by the bird. Gross energy of the excreta decreased as the inclusion level of the enzyme increased. When the inclusion levels of the enzyme increased, calcium and phosphorus levels increased, possibly due to a concentration effect. Higher levels of chromium in the excreta were observed with the increment of the enzyme, suggesting an improvement on the digestibility of the feed product of the effect of the beta-mannanase. These data indicate that nutrient digestibility is enhanced by the effect of CTCZYME. The reason for the increasing digestibility not affecting the broiler performance may be due to the short time the enzyme was included in the diet. Another possibility is that a change in carcass composition may have occurred; more protein could have been deposited on the carcass instead of fat when the enzyme was included but further studies are required to confirm this assumption. Also, it has to be taken into account that the dietary protein levels provided the needs for the bird and they probably did not need to assimilate the now more available amino acids due to the effect of CTZyme.

Key words: Beta-mannanase, broilers, dry matter, excreta

INTRODUCTION

Many different factors present in feedstuffs have been identified as inhibitors of nutrient utilization. Nonstarch Polysaccharides (NSP) have been included in this category. The NSP are complex high molecular weight carbohydrates present in plant cell walls. The NSP increase viscosity of digesta, modify the physiology of the gastrointestinal tract and change the ecosystem in the gut (Choct, 2002). Among the NSP, different types can be found such as arabinoxylans, galactose, mannose, lignin, beta-glucans and uronic acid (Choct, 1997). Soybean meal contains approximately 22.7% NSP-type carbohydrates (Chesson, 1987). These are distributed in acidic polysaccharides (8-10%), arabinogalactans (5%) and cellulose (1-2%), with about 1.3% present in the form of beta-mannans (Dierick, 1989). When beta-mannans are present in feed, they depress growth and feed conversion and increase nitrogen and fecal output, decreasing metabolizable energy as well (Daskiran *et al*., 2004; Lee *et al*., 2003). It has been reported that the use of a beta-Mannanase in corn-soybean meal diets has improved body weight gain and feed conversion (Jackson *et al*., 2004; Zou *et al*., 2006). The present study was conducted to evaluate the effect of different inclusion levels of an exogenous beta-Mannanese (CTCZYME) in corn-soybean meal based diets on broiler performance and dry matter output.

MATERIALS AND METHODS

In this experiment, 120, 1-day-old Cobb 500, male chicks were obtained from a commercial hatchery, placed in wire floor starter batteries in a temperature-

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Table 1: Composition and calculated nutrient content of basal diets

Ingredient	g/kg
Yellow corn	638.35
Poultry oil	10.22
Soybean meal	287.26
DDGS	0.00
Limestone	5.25
Defluorinated phosphate	18.39
Feed grade salt	3.03
Sodium bicarbonate	0.86
MHA 84[1]	2.48
L-Threonine	0.33
L-Lysine HCl	1.83
Vitamin premix[2]	5.00
Mintrex P_Se[3]	1.00
Celite	20.00
Chromic oxide	3.00
Titanium dioxide	3.00
Total	1000.00
ME kcal/kg	3020.00
Crude protein	19.63
Calcium	0.90
Total P	0.68
Nonphytate P	0.45
Methionine	0.55
Cystine	0.32
Lysine	1.14
Tryptophan	0.23
Threonine	0.75
Isoleucine	0.78
Valine	0.88
Leucine	1.64
Arginine	1.25

[1]Provides per kg of diet: vitamin A (from vitamin A acetate) 7715 IU; cholecalciferol 5511 IU; vitamin E (from dl-alpha-tocopheryl acetate) 16.53 IU; vitamin B_{12} 0.013 mg; riboflavin 6.6 mg; niacin 39 mg; pantothenic acid 10 mg; menadione (from menadione dimethylpyrimidinol) 1.5 mg; folic acid 0.9 mg; choline 1000 mg; thiamin (from thiamin mononitrate) 1.54 mg; pyridoxine (from pyridoxine HCl) 2.76 mg; d-biotin 0.066 mg; ethoxyquin 125 mg. [2]Provides per kg of diet: Mn (as manganese methionine hydroxy analogue complex) 40 mg; Zn (as zinc methionine hydroxy analogue complex) 40 mg; Cu (as copper methionine hydroxy analogue complex) 20 mg; Se (as selenium yeast) 0.3 mg.
[3]Novus International, Inc., St. Louis MO 63141

controlled room and fed a nutritionally complete diet (Table 1) to 19 days of age. At that day, the birds were transferred and randomly assigned to unheated grower batteries and weighed by pen. Five birds were allocated per pen with six replicates per treatment for a total of 24 pens. The birds were given access to experimental diets and tap water for *ad libitum* consumption. Lighting was continuous 24 hr using incandescent bulbs. Care and management of the birds followed recommended guidelines (FASS, 2010). All procedures were approved by the University of Arkansas Institutional Animal Care and Use Committee.
The basal diet (Table 1) was prepared and divided into two aliquots. One received no enzyme supplement while the other received an enzyme level of 0.10% (twice the manufacturers recommended level for this enzyme). Aliquots of these two diets were mixed in order to obtain four diets with 0% (no enzyme), 0.025% (half the recommended level), 0.05% (recommended level) and 0.10% (twice the recommended level). The four diets were presented to the birds as mash feed to avoid possible heat damage during pelleting. Feed samples were collected and sent to a commercial laboratory for analysis of enzyme activity. Chromic oxide was included in the diet as a tracer at 3 g/kg. Titanium oxide and Celite were also added for a parallel study on comparison of indigestible markers; this will be reported in a separate study.
After 8 days of acclimation to the experimental diets, the excreta was collected daily and weighed. Excreta were dried at 130°C for 24 h to obtain the dry-matter output. After seven days of excreta collection, the experiment was terminated. The birds were weighed by pen to evaluate the weight gain from 19 to 33 d. Feed intake and feed conversion from this period of time was also calculated. Excreta were analyzed for nitrogen, calcium, phosphorus, gross energy and chromium levels.
Pen means served as the experimental unit. Data were subjected to a one-way ANOVA using the General Linear Models option of SAS (SAS Institute, 1991). Significant differences were separated using Duncan's multiple range tests. Statements of probability are based on $p<0.05$.

RESULTS AND DISCUSSION

Performance: Results for performance are presented in Table 2. Feed intake was significantly greater in the treatment with half of the recommended level (0.025% of CTCZYME). Dietary CTCZYME supplementation had no effect on live performance at levels of 0%, 0.025%, 0.05% and 0.1% between 19 and 33 days. The different levels of enzyme inclusion in the corn-soybean meal diet did not affect body weight gain and feed conversion. This is in agreement with Kong *et al.* (2011) where beta-mannanase inclusion did not affect performance when an average energy diet was used but in contrast with Jackson *et al.* (2004) using similar corn-soybean meal diets.

Excreta: Results for fresh and dry fecal output are presented in Table 3. The inclusion of beta-mannanase in the diet at levels of 0.05% (recommended level) and 0.10% (twice the recommended level) had a significant ($p<0.002$) impact reducing the total dry matter output. This reduction suggests that the CTCZYME improves the feed digestibility and that the bird uses the more available nutrients.
In support of the reduced dry matter output, results for levels of nitrogen, phosphorus, calcium, chromium and gross energy in the fecal output are presented in Table 4. As the inclusion level of CTCZYME increased, the

Table 2: Performance of broilers fed different levels of CTCZYME beta-mannanase enzyme from 19 to 33 d

% in diet	19 d BW (kg)	33 d BW (kg)	19-33 d BW gain (kg)	19-33 d FCR	19-33 d Feed intake (kg/bird)	Mortality[1] (%)
0.000	0.742	1.809	1.063	1.731	1.835[b]	0.335
0.025	0.755	1.863	1.117	1.722	1.935[a]	0.701
0.050	0.750	1.791	1.045	1.778	1.838[b]	3.061
0.100	0.738	1.793	1.047	1.781	1.862[b]	3.971
p-value	0.280	0.130	0.130	0.100	<0.0001	0.500
SEM	0.007	0.022	0.022	0.020	0.009	2.469
CV	2.212	2.964	5.033	2.762	3.122	2.737

[1]Mortality data were transformed to $\sqrt{n+1}$ for statistical analysis and presented as natural numbers

[ab]Means within a column with different superscripts differ significantly ($p<0.05$)

Table 3: Effect of CTCZYME beta-mannanase enzyme on fresh and dry fecal output

Enzyme (%)	Fresh matter/day (kg)	Dry matter/day (kg)	Fresh matter/bird/day (kg)	Dry matter/bird/day (kg)
0	0.782[c]	0.178[a]	0.156[c]	0.0357[a]
0.025	0.853[a]	0.183[a]	0.170[a]	0.0366[a]
0.05	0.800[bc]	0.170[b]	0.160[bc]	0.0340[b]
0.100	0.824[ab]	0.169[b]	0.164[ab]	0.0339[b]
p-value	0.004	0.002	0.004	0.0020
SEM	0.015	0.002	0.003	0.0005
CV	10.915	9.696	10.915	9.6960

[a-d]Means within a column with different superscripts differ significantly ($p<0.05$)

Table 4: Effect of CTCZYME beta-mannanase enzyme on the Nitrogen, Phosphorus, Calcium, Chromium and calories in fecal output and basal diet

Enzyme (%)	Crude protein (%)	P (ppm)	Ca (ppm)	Cr (ppm)	Calories (kcal/kg)
0	26.62	17819	21041	5018	3458
0.025	24.125	17633	21490	5719	3477
0.050	23.25	18321	24924	6059	3427
0.100	18.56	21290	34230	7505	3235
Basal diet	17.56	8206	10441	2417	3898

Table 5: Effect of different levels of CTCZYME beta-mannanase enzyme on ileal apparent metabolizable energy by broilers

Enzyme level (%)	GE diet (kcal/kg)	GE excreta (kcal/kg)	Cr diet (ppm)	Cr excreta (ppm)	Ileal AME (kcal/kg)
0	3898	3411	2417	5018	2255
0.025	3898	3387	2417	5719	2467
0.050	3898	3300	2417	6059	2582
0.100	3898	3141	2417	7505	2886

amount of nitrogen excreted decreased. Similar results regarding dry fecal matter and nitrogen levels have been reported in diets containing guar gum supplemented with a beta-mannanase (Daskiran *et al.*, 2004). The amount of chromium increased as the inclusion levels of enzyme increased. Since the chromium is considered an indigestible material this increase is another proof that the beta-mannanase increases digestibility of the dietary nutrients. The gross energy of the dry fecal output decreased as the enzyme level increased (Table 5). This also reflects greater energy utilization from the feed when CTCZYME is present and was responsive to the higher usage levels.

The results of the current study suggest that the enzyme makes the nutrients more available for the bird to use it although this it is not reflected in broiler performance. Firstly, this was a short-term study designed primarily to evaluate the effects on the faecal output and may not have been sufficient time to reflect differences in digestibility through performance differences. Another possibility in regard to the apparent increase in nitrogen digestibility is that carcass composition could be changing and instead of increasing the fat deposit, muscle deposit is increasing by using the more available nitrogen. This could be the reason why the nitrogen appears in less concentration in the faeces when the enzyme increases in the diet. There was no apparent effect on the digestion of calcium and phosphorus as both of these minerals had increased levels in the excreta as the inclusion level of the beta-mannanase increased; since the protein and carbohydrate portions are being reduced the apparent concentration of these minerals in a smaller amount of dry matter is reflected. Finally, the improvements in amino acid digestibility and AME observed when the CTZyme was included in the diet was not reflected on performance because of the already adequate content of nutrients in the basal diet. This explanation is in accordance with Kong *et al.* (2011), who found a positive response to the enzyme when a low energy diet was used. In contrast, when an average energy diet was fed to the birds, no response was found to the beta-Mannanase supplementation in the studies by Kong *et al.* (2011).

Although further study is required, the reduction of the dry output together with the reduction of nitrogen and gross energy excretion appear as an opportunity to reduce the levels of protein and energy in the diet and perhaps increase meat yield. The reduction in nitrogen output has a very important environmental impact as well.

At the same time, the fact that the beta-mannanase improves the availability of nutrients to the bird opens the possibility of including in the formulation other feedstuff rich in beta-mannans that could lower the costs of the feed without reducing the broiler performance.

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