Effect of endo-β-D-Mannanase (Hemicell®) Supplementation on Growth Performance of Two-Week-Old Broilers Fed Diets Varying in β-Mannan Content

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Story in Brief

Two experiments were conducted to evaluate the efficacy and optimum inclusion level of a commercial endo-β-D-mannanase (Hemicell®) in broiler diets varying in β-mannan levels. Guar gum was used to alter the β-mannan level in a corn-soy based diet. In Exp. 1, guar gum was added at 0, .5, 1, and 2% each with (.05%) and without dietary endo-β-D-mannanase supplementation. Enzyme supplementation significantly improved d-14 feed efficiency at each guar gum inclusion level while 2% guar gum supplementation significantly reduced body weight and increased feed:gain ratio at d 14. In general, water consumption increased as dietary guar gum level increased. In Exp. 2, endo-β-D-mannanase was added at 0, .5, 1, and 1.5% in a corn-soy based diet containing 1% guar gum. Increasing enzyme supplementation did not affect final body weight or body weight gain, but improved feed:gain ratio. The improvement was quadratic and as the enzyme level increased, enzyme efficiency quadratically decreased. Enzyme supplementation either numerically or significantly reduced water:feed ratio. In general, data suggest that endo-β-D-mannanase (Hemicell®) supplementation can improve the utilization of nutrients from diets containing β-mannan.

Key Words: β-mannan, endo-β-D-mannanase, Hemicell®, Guar Gum, Broiler Performance

Introduction

Efficient conversion of feed into broiler tissue is an essential feature of successful poultry production enterprises. Consequently, both the identification and quantification of factors inhibiting and conversely alleviating nutrient utilization are necessary. Among factors reducing nutrient bioavailability are the Non Starch Polysaccharides (NSP), or the presence of anti-nutritional factors (Annison and Choct, 1991; Bedford and Classen, 1993).

NSPs are complex carbohydrates found in the structure of plant cell walls with higher molecular weight (Classen and Bedford, 1991; Annison and Choct, 1991). Beta-mannan (BM) is a NSP, which is found in various feedstuffs and protein concentrates. Studies indicate that the negative effects of BM supplemented to the broiler diets include reduced feed intake, weight gain and feed/gain ratio (Ray et al., 1982; Furuse and Mabayo, 1996). Copra meal, a feedstuff containing 25 to 30% BM, was reported to have increased utilization with bacterial mannanase treatment (Teves et al., 1988).

Consisting mainly of galactose and mannose, guar gum is growth depressing when fed to chicks. The non-starch-polysaccharide (NSP) portion of the guar bean (*Cyamopsis tetragonoloba*), guaran, has a β-D-mannose backbone with α (1-6) linked galactose residues and hydrolysis of guaran yields D-galactose and D-mannose in the ratio of approximately 1:2. It consists of approximately 35% galactose, 63% mannose, and 5 to 7% protein (Horton, 1997). The adverse effects of this ingredient on bird performance has been known for a long time and a lot of enzyme supplementation and/or feed processing techniques have been applied on either guar gum or guar gum meal to improve the digestibility and metabolizable energy content of the diet (Ray et al, 1982; Patel and McGinnis, 1985; Verma and McNab, 1982; Furuse and Mabayo, 1996).

This study investigated the efficacy of endo-β-D-mannanase supplementation in broiler diets varying in guar gum levels.

Materials and Methods

Two experiments were conducted to evaluate efficacy and inclusion level effects of endo-β-D-mannanase (Hemicell®) in broiler diets varying in BM content. Due to its high BM content, guar gum was used as a semi-purified BM source. In both experiments, day-old Cobb x Cobb male chicks were obtained from a commercial hatchery, wing banded, individually weighed, and randomly assigned to metabolic chambers (Figure 1). In all cases, chicks were reared according to the breeder recommendations with *ad libitum* access to feed (Table 1) and water. Starter basal diet was formulated to meet NRC (1994) requirements. Chambers were monitored four times a day for mortality and general conditions. Chick initial and final body weights, feed consumption, and water consumption measurements were recorded. Both trials were terminated on d 14.

Figure 1. Broiler- and turkey-size chambers used in Exp. 1 and Exp. 2, respectively

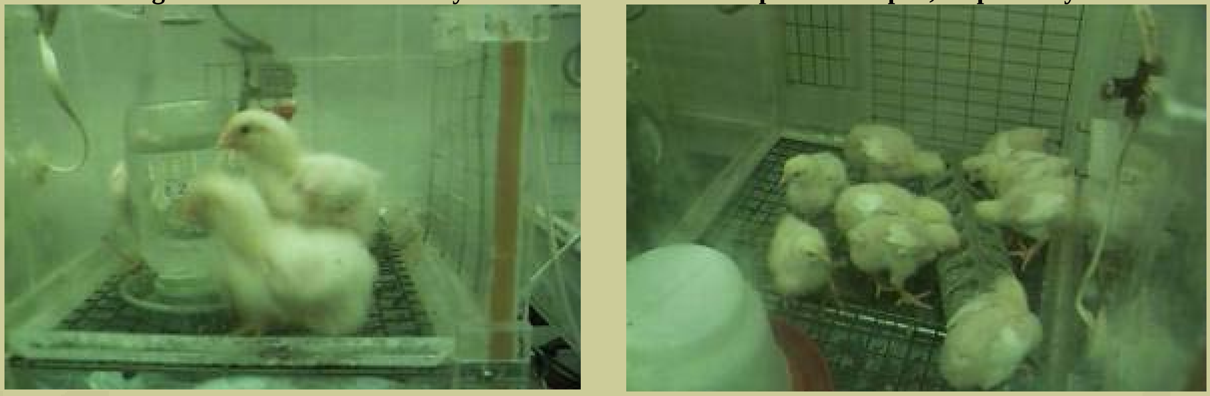

Table 1. Composition of starter basal diet	
Ingredients and composition	Starter diet, %
Ground corn	60.04
Soybean meal	29.00
Pro-pak©[1]	5.05
Vegetable fat	3.15
Dicalcium phosphate	1.20
Calcium carbonate	.81
Salt	.38
Methionine	.13

Vitamin premix[2]	.05
Mineral mix[3]	.05
Choline chloride	.05
Lasalosid	.05
Copper sulphate	.03
Selenium premix	.0015
Calculated analysis	
ME (kcal/kg)	3150
CP	22.67
Methionine	.54
Lysine	1.25
Calcium	.95
Total phosphorus	.72

[1]Propak is an animal protein concentrate with minimum 50% CP, 2% lysine and .8% methionine and maximum 10%moisture and 3% salt.

[2]Supplied per kilogram of diet: vitamin A, 38,500 IU; vitamin D_3, 11,000 IU; vitamin E, 55 IU; vitamin B_{12}, .066 mg; riboflavin, 33 mg; niacin, 165 mg; d-pantothenic acid, 55 mg; menadione, 11 mg; folic acid, 3.3 mg; pyridoxine, 13.75 mg; thiamin, 6.66 mg; d-biotin, .28 mg.

[3]Supplied per kilogram of diet: manganese, 120 mg; zinc, 100 mg, copper, 10 mg, iodine, 2.5 mg; calcium, 135 mg.

Experiment 1. This experiment was conducted to examine the effects of four dietary inclusion levels of guar gum each with and without enzyme supplementation on broiler performance and feed:water ratio. The study utilized 36 broiler-size metabolic chambers and 144 chicks, which were randomly assigned to eight dietary treatments in 4 x 2 factorial treatment arrangement in a randomized block design. Each metabolic chamber contained four birds in it throughout the study. Four guar gum levels (0, .5, 1, and 2%) and two enzyme levels (0 and .05% Hemicell®) were used.

Experiment 2. This experiment was conducted to examine the effects of four dietary enzyme supplementation levels on broiler performance and water consumption. This study utilized 24 turkey-size metabolic chambers and 216 chicks, which were randomly assigned to four dietary enzyme levels (0, .05, .1, and .15%) in a randomized block design. A corn-soy based experimental diet was supplemented with 1% guar gum to increase its BM content. Each metabolic chamber contained nine birds in it throughout the study.

Data Analysis. The data were analyzed using ordinary least squares (PROC GLM, SAS Institute, Inc., Cary, NC). The model included guar gum and enzyme (Hemicell®) as main effects. Interaction between main effects was included in the model. Mean separation was accomplished using Least Significant Difference (Steel and Torrie, 1960).

Results and Discussion

Experiment 1 and 2 results for live weight, water/feed ratio, and feed efficiency for wk 2 are displayed in Tables 2 and 3. In Exp. 1, there was a significant Hemicell® x guar gum interaction on wk-2 body weight, water:feed and feed:gain ratio. Compared to the guar gum free control guar gum inclusion reduced ($P<.05$) live weight gain at all inclusion levels with 2% depressing weight to a greater extent than all other Hemicell® free treatments. As the guar gum level increased, birds on enzyme supplementation had better live weight. These results were in agreement with the findings of Ray et al. (1982). They tested the effectiveness of a guar degrading enzyme fraction of a commercial hemicellulase on chicks fed 2% guar gum and found that the enzyme was effective in eliminating the detrimental effects of guar gum on 14-d-old female broiler performance. Hemicell® addition restored wk-2 live weight to control values for all treatment with the exception of 2% guar gum addition level.

Further, 2-wk Hemicell® fortification improved ($P<.05$) feed efficiency at each guar gum inclusion level, including the negative control in Exp. 1 (Table 2). Increasing dietary endo-β-D-mannanase supplementation quadratically improved feed efficiency in Exp. 2 (Table 3). As the enzyme level increased, efficiency of endo-β-D-mannanase supplementation on feed efficiency decreased. Other studies with guar gum or guar meal concluded similar results. Verma and McNab (1982) observed reduced body weight gain, feed consumption, and gain:feed ratio and enzyme supplementation improved growth on these birds as compared to the control birds. Vohra and Kratzer (1965) suggested that if guar meal is to be used in chicken diets, diets should be supplemented with enzymes capable of hydrolyzing gums and hemicellulose. Studies on rats and chicks showed that partially hydrolyzed guar gum had less detrimental effects as compared to intact guar gum. (Furuse and Mobayo, 1996).

Table 2. Effects of guar gum and endo-β-D-mannanase (Hemicell®) supplementation on 2-wk body weight, water/feed ratio and feed efficiency of broiler chicks in Exp. 1

Treatments		Variables		
Guar gum, %	Hemicell®, %	Weight, g	Water/Feed	Feed/Gain
0	0	394.8[a]	2.446[c]	1.182[d]
0	.05	390.2[a]	2.453[c]	1.149[e]
.5	0	366.2[bc]	2.617[ab]	1.193[d]
.5	.05	396.2[a]	2.398[c]	1.150[e]
1	0	376.2[b]	2.700[a]	1.211[c]
1	.05	390.0[a]	2.615[ab]	1.193[d]
2	0	335.7[d]	2.579[b]	1.417[a]
2	.05	354.0[c]	2.602[ab]	1.337[b]
SEM		4.43	.036	.004
Source of variation		Probabilities		
Hemicell®		.0002	.0182	.0001
Guar gum		.0001	.0001	.0001
Hemicell® x guar gum		.0014	.0064	.0001

[a,b,c,d,e]Means in a column with common superscript do not differ significantly ($P<.05$).

In general, the amount of water consumption per unit feed consumption was increased with increasing guar gum inclusion levels (Table 2) while endo-β-D-mannanase supplementation reduced water consumption per unit feed consumed with the exception of 2% guar gum level (Table 3). This can be explained by the increased gastrointestinal tract viscosity with increasing dietary guar gum levels. Guar gum is a high molecular galactomannan, which cannot be digested in the small intestine and consumption of indigestible NSPs is well known to have an impact on gastrointestinal tract viscosity and digestion and absorption of nutrients. They increase intestinal viscosity (Annison et al., 1995; Almirall et al., 1995), decrease the rate of digestion and absorption (Almirall et al, 1995), and reduce performance.

Table 3. Effects of guar gum and endo-β-D-mannanase (Hemicell®) supplementation on the growth, performance and water/feed ratio of broiler chicks during Exp. 2

Treatments		Variables		
Guar gum, %	Hemicell®, %	Weight, g	Water/Feed	Feed/Gain
1	0	346.5	2.853[a]	1.336[a]
1	.05	346.9	2.752[b]	1.304[b]
1	.1	348.1	2.821[a]	1.291[c]
1	.15	345.5	2.664[c]	1.286[c]
SEM		1.43	.018	.002
Source of variation		Probabilities		
Hemicell®		NS	.0001	.0001

[a,b,c]Means in a column with common superscript do not differ significantly (P<.05).

Implications

Enzyme supplementation (Hemicell®) favorably impacts the feeding efficiency in diets containing BM, including corn-soy based diets with no additional guar gum. These results indicate that Hemicell® supplementation has the potential to improve the use of nutrients from low-cost feed ingredients that have high amounts of BM in it such as guar gum meal, palm kernel meal, and copra meal as well as corn-soy based commercial poultry diets.

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