Mannan oligosaccharide (Bio-Mos®) supplementation of wheat-based diets for broilers

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A series of four consecutive studies were conducted on built-up litter to compare efficacy of a commercial mannan oligosaccharide (Bio-Mos, Alltech) and BMD when broilers were fed a wheat-based diet. In each trial a total of 1500 broiler chicks (750 males and 750 females) were obtained (Ross X Ross). Built-up litter was used throughout with one flock reared on the litter prior to trial initiation and experimental groups were maintained on litter from the same treatments with no top dressing between flocks. Broilers were subjected to three treatments: control (CON), 50 ppm Bacitracin Methylene Disalycilate (BMD) or mannan oligosaccharide (MOS). MOS levels were 2.0 kg/T starter; 1.5kg/T grower; and 0.5 kg/T withdrawal. Ten replicate pens/trt with 50 birds (male or female) placed in each pen corresponded to a 3 x 2 (treatment x sex) design. Birds were fed starter (21.5% CP, 3142 kcal/kg ME), grower (20.0% CP, 3153 kcal/kg ME) and finisher (17.0% CP, 3197 kcal/kg ME) at 0.82 kg, 1.59 kg and c.a. 1.68 kg (to 2.2 kg bodyweight) per bird, respectively. Diets were corn-wheat-soybean meal based to include 30% wheat and 600 units/ton xylanase (Allzyme PT, Alltech). Coban was used in starter and grower diets. Diets and water were *ad libitum* and light was 23D:1L. Birds and feed were weighed at 14, 28 d and at a target weight of 2.2 kg (c.a. 37 d). Results from combined data analysis (Trials 1-4) indicate highly significant ($P < 0.0009$) improvements in BW with MOS and BMD over CON at 14 d. These differences diminished by 28 and 37 d, but MOS and BMD showed numerically greater (sometimes significant) improvements in bodyweight. Feed consumption at 14 d was greatest for BMD ($P < 0.026$ over CON) intermediate for MOS and lowest for CON, after which no differences in FCR were noted. Feed efficiency effects indicated that after 14 d there was a tendency for the treatments to differ in efficiency, and by day 37 overall FCR was lowest in CON, intermediate in MOS and highest for BMD ($P < 0.09$ over CON). Results indicate that the addition of Bio-Mos to the diet had an influence in promoting bodyweight increases over the control diet early in the growing period, typically from the 0-14 d period. The combination of continued use and long-term effects indicate that cumulative improvements in performance may be attributed to the use of specific feed additives such as Bio-Mos.

Keywords: mannan oligosaccharides, bacitracin methylene disalycilate, broilers, wheat

Introduction

Use of antibiotics in the poultry industry has come under scrutiny in recent years. Concern for development of resistant strains of bacteria to antibiotics that are commonly used for treatment of both human and animal infections has contributed to the need to find alternatives that will maintain animal health and well-being. There has been greater scrutiny placed on the poultry industry to find alternatives to the use of sub therapeutic levels of antibiotics and growth promotants in commercial production of poultry. Alternatives may include use of probiotics and enzymes, which may also contribute to the bird's health and performance, but do not promote development of resistant strains of microorganisms. Adoption of probiotic and enzyme-based feed additives will contribute to a decrease in antibiotic and growth promoting compounds currently in use.

Mannan oligosaccharides are yeast cell wall derivatives and are applied commercially in the feed industry. Based on the scientific literature mannan oligosaccharides have been shown to inhibit colonization of enteric pathogens by blocking bacterial adhesion to the intestinal lining (Lyons, 1994; Oyofo *et al*., 1989; Spring *et al*., 2000), interfere with bacterial conjugation (Newman, 2006), enhance immunity (Savage *et al*., 1996; Moran, 2004), modify microflora fermentation to favor nutrient availability (Kumprecht *et al*., 1997), and enhance the brush border mucin barrier and integrity of the intestinal lining (Loddi *et al*., 2002).

Broilers reared on litter are continually exposed to increasing levels of microorganisms contained in litter that accumulates from successive growout cycles. Commercially, six or more consecutive growouts are reared on bedding material prior to total cleanout of the broiler house. As a result, litter can be used for up to a one-year period. In the present protocol a series of four consecutive studies were conducted on built-up litter to compare the efficacy of Bio-Mos and BMD under these conditions to improve body weight, feed efficiency, and livability when broilers were fed a wheat-based diet.

Materials and methods

In each of four consecutive trials a total of 1500 broiler chicks (750 males and 750 females) were obtained from a commercial hatchery (Ross X Ross) and 50 birds were randomly assigned to each of 30 pens, each being 1.98 x 2.29 m in dimension. Pens were separated by wire partitions and floor and aisles were concrete. Electric brooders and forced-air furnaces supplied heat. Natural curtain and fan ventilation was typical of that found in the commercial broiler industry. Tube-type feeders and a nipple water system were provided in each pen. Five centimeters of pine shavings were supplied as the bedding material in each pen. Standard husbandry and good management practices were followed that met or exceeded industry guidelines.

Birds were fed a starter (0.82 kg/bird), grower (1.59 kg/bird), and a finisher (to 2.2 kg bodyweight) to meet or exceed National Research Council (NRC, 1994) recommendations (Table 1). Diets were comprised of corn-wheat-soybean meal with 30% wheat inclusion. All diets were pelletized or crumbled where appropriate. Allzyme PT was used in all diets at a rate of 600 xylanase units/ton. Coban was the coccidiostat used in the starter and grower diets. Diets and water were available *ad libitum*. Lighting was 23D:1L.

Dietary treatments for the trials were as follows:

Treatment	Product	Starter	Grower	Finisher
		----------------------g/T----------------------		
CON	No additive (Control)	None	None	None
BMD	BMD	55.00	55.00	55.00
MOS	Bio-Mos Plus	2,000.	1,000.	500.

There were ten replicate pens per dietary treatment with 50 birds (male or female) placed in each pen corresponding to a 3 x 2 (treatment x sex) design. Live performance (weight gain, feed consumption and daily mortality) was determined. Birds and feed were weighed at 14 and 28 days and when the birds reached an average target weight of 2.2 kg at c.a. 37 d.

Litter management

Built-up litter was used throughout the experimental periods. One flock was reared on the litter prior to initiation of these experimental trials. Top dressing was not done between flocks. Litter was stirred between experiments.

Table 1. Composition and calculated analyses of experimental diets

Ingredient	Starter	Grower	Finisher
	----------------------------%------------------------------		
Ground yellow corn	26.94	34.03	41.22
Ground wheat	30.00	30.00	30.00
Soybean meal (48%)	28.52	23.22	17.00
Poultry by-product meal (60%)	5.00	5.00	5.00
Poultry oil	5.46	4.24	3.63
Limestone	1.06	0.93	0.83
Dicalcium phosphate[1]	1.34	1.21	1.03
Salt	0.41	0.41	0.41
DL-methionine	0.24	0.21	0.21
L-lysine	0.15	0.12	0.12
Vitamin premix[2]	0.50	0.25	0.25
Trace mineral premix[3]	0.25	0.25	0.25
Coban-60[4]	0.08	0.08	--------
Allzyme PT[5]	0.05	0.05	0.05
Test additive[6]	--------	--------	--------
Total	100.00	100.00	100.00
Calculated analyses (%)			
Crude protein	21.50	20.00	17.00
ME (kcal/kg)	3142.00	3153.00	3197.00
Methionine	0.51	0.47	0.44
Methionine + Cystine	0.95	0.86	0.80
Lysine	1.27	1.10	0.93
Calcium	0.93	0.84	0.75
Nonphytate phosphorus	0.45	0.42	0.38

[1] Contains 18.5% phosphorus and 24.1% calcium.
[2] Supplied the following per kg of complete feed: vitamin A, 8,000 IU (retinyl palmitate); cholecalciferol, 2,000 IU; vitamin E, 8 IU (di-tocopheryl acetate); menadione, 2 mg; riboflavin, 5.5 mg; pantothenic acid, 13 mg; niacin, 36 mg; choline, 500 mg; vitamin B_{12}, 0.02 mg; folic acid, 5 mg; thiamin, 1 mg; pyridoxine, 2.2 mg; biotin, 0.05 mg; ethoxyquin, 125 mg.
[3] Supplied the following per kg of complete feed: manganese, 125 mg; iodine, 1 mg; iron, 55 mg; copper, 6 mg; zinc, 55 mg, selenium, 0.3 mg.
[4] Monensin Sodium; Elanco Animal Health, Inc., Indianapolis, IN 46285.
[5] Used in all diets at a rate of 600 xylanase units/ton, Alltech, Inc., Nicholasville, KY 40356.
[6] Feed additives Bio-Mos Plus and BMD were added to the diet at the expense of corn.
Bacitracin methylene disalycilate; Alpharma, Inc., Fort Lee, NJ 0702.
Bio-Mos Plus; Alltech, Inc., Nicholasville, KY 40356.

Statistical analysis

Data from this experiment was analyzed by analysis of variance using General Linear Models procedure of Statistical Analysis System (SAS Institute, 1985; Cary, NC). Replicate pens were used as the error term to test main effects of dietary treatments. All percentage data were subjected to arc sine transformation prior to analysis; however, actual data are reported. When significant ($P \leq 0.10$), means were separated by Tukey's studentized multiple comparison procedure.

Results and discussion

The data were combined from four trials and results of the statistical analysis appear in Table 1. Results from the combined data indicate that there were significant ($P<0.0009$) improvements in BW with MOS and BMD over CON at 14 d (Table 1). These differences diminished at 28 and 37 d, but MOS and BMD treatments show numerically greater improvements in bodyweight. Feed consumption at 14 d was greatest for BMD (P<0.026 over CON) intermediate for MOS and lowest for CON, after which no differences in FC were noted due to treatment. Feed efficiency effects indicated that after 14 d there was a tendency for the treatments to differ in FE, and by day 37 overall FE was lowest in CON with intermediate in MOS and highest for BMD (P<0.09 over CON). Results indicate that the addition of BMD or MOS to the diet had an influence in promoting bodyweight increases over the control diet early in the growing period, typically from the 0-14 d period. A significant (P<0.10) effect on growth performance may or may not be carried beyond this early growth period. The combination of continued use and long-term effects indicate that cumulative improvements in performance may be attributed to the use of specific feed additives such as Bio-Mos.

Table 1. Bodyweight, bodyweight gain, feed consumption, feed efficiency, and mortality of sexed broilers fed BioMos or BMD in a wheat-based diet (Combined Trials).

By Variable	Initial Weight[1] (g/bird)	14-d Body Weight (g/bird)	14-d Feed Consumed (g/bird)	14-d FE (g/g)	14-d Mortality[2] (%)	28-d Body Weight (kg/bird)	14-28 d BW Gain (g/bird)	14-28 d Feed Consumed (kg/bird)	0-28 d Feed Consumed (kg/bird)	14-28 d FE (g/g)[3]
Treatment										
Control	40.39	367.1^{b}	480.0^{b}	1.318	1.35^{b}	1.278^{b}	922.9	1.493	1.973	1.626^{b}
BMD	40.13	387.6^{a}	509.4^{a}	1.323	2.10^{a}	1.324^{a}	936.4	1.509	2.006	1.609^{b}
BioMos	40.25	382.9^{a}	483.8^{ab}	1.300	1.30^{b}	1.304^{ab}	921.2	1.515	2.010	1.657^{a}
SEM[4]	0.129	3.90	8.21	0.014		0.011	6.35	0.001	0.013	0.009
Sex										
Male	40.54^{a}	389.6^{a}	515.5^{a}	1.336^{a}	1.82	1.383^{a}	1.000^{a}	1.614^{a}	2.122^{a}	1.615^{a}
Female	39.98^{b}	368.8^{b}	466.7^{b}	1.291^{b}	1.78	1.221^{b}	0.852^{b}	1.398^{b}	1.872^{b}	1.646^{b}
SEM[4]	0.105	3.19	6.70	0.011		0.020	0.006	0.008	0.010	0.007
Probability										
Treatment	NS	0.0009	0.026	NS	0.075	0.017	NS	NS	0.073	0.001
Sex	0.0003	0.0001	0.0001	0.005	NS	0.0001	0.0001	0.0001	0.0001	0.004
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.011

Table 1. Continued

Treatment	0-28 d FE (g/g)	14-28 d Mortality (%)	37-d Body Weight (kg/bird)	28-37 d BW Gain (g/bird)	28-37 d Feed Consumed (g/bird)	0-37 d Feed Consumed (kg/bird)	28-37 d FE (g/g)	0-37 d FE (g/g)	28-37 d Mortality (%)	0-37 d Mortality (%)	37 d Body Weight CV
Treatment											
Control	1.525^{ab}	1.67	1.953^{b}	661.9	1.349	3.322^{b}	2.043^{b}	1.702	2.18	5.05	9.495
BMD	1.513^{b}	0.97	1.978^{a}	654.1	1.386	3.392^{a}	2.150^{a}	1.715	1.55	4.45	9.484
BioMos	1.539^{a}	1.06	1.963^{ab}	659.8	1.339	3.350^{ab}	2.046^{b}	1.707	2.16	4.40	9.664
SEM[4]	0.007		0.008	6.87	0.019	0.023	0.034	0.010			0.191
Sex											
Male	1.520	2.09^{a}	2.118^{a}	727.1^{a}	1.467^{a}	3.588^{a}	2.038^{b}	1.697^{b}	2.33	6.10	10.154^{a}
Female	1.532	2.95^{b}	1.812^{b}	590.2^{b}	1.249^{b}	3.121^{b}	2.122^{a}	1.719^{a}	2.03	4.63	8.942^{b}
SEM[4]	0.006		0.006	5.61	0.016	0.018	0.028	0.009			0.337
Probability											
Treatment	0.056	NS	0.075	NS	NS	0.09	0.044	NS	NS	NS	NS
Sex	NS	0.0003	0.0001	0.0001	0.0001	0.0001	0.035	0.077	NS	NS	0.0001
Interaction	0.023	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[1]Values are grand means involving 10 pens each with 50 chicks at placement.
[2]Total mortality percentages were transformed to the arcsine √ for GLM, whereas there is no valid SEM since data were transformed and subject to analysis.
[3]Feed efficiency calculated as amount of feed consumed per gram of bodyweight gain, corrected for mortality.
[4]Pooled standard error of mean.
[ab]Means within the same column and variable with no common superscripts are significantly different.
NS=Not significant P>0.10.

The Meta-analysis of numerous broiler (Hooge, 2004a) and turkey (Hooge, 2004b) studies indicated that MOS improved market weights and feed efficiency by approximately 2% and reduced mortality by over 20% relative to non-medicated controls. From analysis of broiler data obtained from 50 pen trials the results indicated that relative improvements of MOS compared to a control diet with no additional supplementation were 1.61% in body weight, 1.99% decrease in feed efficiency, and 21.4% decrease in mortality. All improvements were significant at the P=0.02 level). When compared to a control diet supplemented with an antibiotic the relative improvements using MOS yielded a 0.36% decrease for bodyweight and a 0.11% improvement for feed efficiency, but were not significant (P=0.473). The MOS diets significantly (P<0.008) decreased mortality by 18.10% as compared to the antibiotic supplemented diet. Any advantages in performance were attributed to a positive effect on gut health.

In the data presented from four consecutive trials there appears to be a relationship whereby the long-term accumulated use of MOS as a dietary supplement may contribute to improvements in performance. In these trials, the greatest impact occurred during the early growing period from 0 – 14 days where MOS elicited a response of 4.13 and 1.37% improvement in bodyweight (P<0.0009) and feed efficiency (nonsignificant), respectively. Results suggest that a combination of continued use and long-term effects of specific feed additives such as MOS may contribute to cumulative improvements in performance by influencing body weight gain, feed efficiency or livability of the broiler.

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