The Effect of Feeding Mannan-Oligosaccharides (Bio-MOS) on the Performance of Meat Chickens under Two Different Vaccination Programs

T. M. Shafey*, S. Al-Mufarej, M. I. Shalaby and A. J. Jarelnabi
Department of Animal Production, College of Agriculture, King Saud University
PO Box 2460, Riyadh 11451, Saudi Arabia

ABSTRACT : The effects of feeding a mannan oligosaccharide (Bio-Mos) from 0 to 3 g/kg diet and vaccination program on 1- to 35-day performance (growth and feed efficiency), metabolizable energy, nitrogen utilization and carcass composition of meat chickens were investigated. A general vaccination program was used against IB, IBD and ND with half of the birds per diet receiving a booster dose of IB and ND vaccines at 12 days of age. Dietary supplementation of Bio-Mos (BM) did not influence body weight gain, feed efficiency and nutrient utilization. The highest dietary BM (3 versus 1.5 or 0 g/kg) increased carcass abdominal fat and reduced the proportion of drumstick in the carcass of meat chickens. The booster dose reduced the performance of birds. It was concluded that the addition of BM to the diet of chickens did not significantly influence the performance and nutrient utilization of meat chickens. ***(Asian-Aust. J. Anim. Sci. 2001. Vol. 14, No. 4 : 559-563)***

Key Words : Bio-Mos, Mannan Oligosaccharide, Vaccination Program, Meat Chickens, Body Weight Gain, Feed Conversion Ratio, Nutrient Utilization, Carcass Composition

INTRODUCTION

Oligosaccharides are a natural constituent of feed ingredients. Bio-Mos (BM, Alltech, USA) is a mannan-based oligosaccharides derived from the cell wall of yeast strain *Saccharomyces cerevisiae*. These complex polysaccharides are resistance to enzymatic hydrolysis and therefore are able to provide their response in the lower gastrointestinal tract and interact with intestinal microbial flora. BM has been used to manipulate gut microbiology with the goal of lessening the impact of pathogenic challenge (Newman, 1994). The addition of BM to diets of turkey increased body weight gain and the efficiency of feed conversion (Savage and Zakrzewska, 1995; Savage et al., 1996) and enhanced the health status of the chickens (MacDonald, 1995). BM provides an alternative approach to the usage of antibiotics for manipulation of intestinal flora of poultry. This can provide more favorable environment for nutrient utilization by chickens without any residual effect in their meat products. Feeding antibiotics to poultry have been shown to be associated with causing residues in their meat products.

Scientists examining effects of yeast cell wall fractions have noted that reduction in disease incidence due to stimulation of non-specific immunity in chickens (MacDonald, 1995). The development of effective strategy for enhancing the immunity of poultry has become a major goal of many research groups. The inclusion of BM in poultry production in a proper way without a change in vaccination schedules may provide economic benefits to the industry, especially in situation where standard control measures provide incomplete protection against economic loss due to bird disease. The objectives of this study were to investigate the effects of BM on the performance, nutrient utilization and carcass composition of meat chickens under two different vaccination programs.

METERIALS AND METHODS

A total of 288, day-old unsexed commercial meat chickens (Cobb) were wing banded, individually weighed and randomly assigned into 48 replicates of 6 chickens each. They were housed in electrically heated battery brooders. Lighting was incandescent and continuous throughout the experiment period. The experiment was a 3×2 factorial, with factors of dietary BM level (0 g, 1.5 g or 3 g/kg diet, respectively) and vaccination program (without or with a booster dose). Sixteen replicates were randomly assigned to either one of the three starter diets to 21 days, followed by the finisher diets to 35 days of age. The composition of the basal diet is shown in table 1. Feed and water were available *ad libtium*.

A general vaccination program was used against IB, ND and IBD. The birds were vaccinated at day one against IB (H120, Vaccine Laboratories, Saudi Arabia) and ND (HB1, Vaccine Laboratories, Saudi Arabia). Live (HB1) and inactivated oil-emulsion (HB1) vaccines against ND were given at day one by spraying and subcutaneous route, respectively. Chickens were also vaccinated against IBD (D78, Invert) by oral route at 21 days of age. Eight replicates from each

* Corresponding Author: T. M. Shafey. Tel: +966-1-467 8785, Fax: +966-1-4678474, E-mail: tmshafey@ksu.edu.sa.
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diet were given a booster dose of IB (H120) and ND (HB1) by oral route at 12 days of age. Whilst, the other eight replicates per diet were not given a booster dose and kept as a control group. Chickens receiving the booster dose were maintained in separate batteries for the duration of the experiment. At the end of the experiment, birds were sexed and three birds per diet per vaccination program per sex were randomly selected and processed at King Saud University Plant to determine processing yields and carcass quality.

Excreta samples were collected every 12 h in the last 2 days of the experiment and acidified by 0.5M sulfuric acid (the acid prevented microbial action and voided loss of ammonia). Excreta samples were not collected from birds given the booster dose. Feed and excreta samples were oven dried at 100℃ and finely ground prior to analysis. Nitrogen in both feed and excreta was determined by Kjeldahl procedure (AOAC, 1990), gross energy by using an adiabatic bomb calorimeter, and chromic oxide by AOAC (1990). Faecal nitrogen was separated by uranyle acetate precipitation method of Ekman et al. (1949). The calculations of nutrient utilization as described by Scott et al. (1982) were as follows:

$$\text{N digestibility (\%)} = 100\ [1 - \frac{\text{Fecal N (mg/g)}}{\text{N in diet (mg/g)}} \times F^*]$$

N retention (mg/g diet)=N in diet (mg/g)-N in excreta (mg/g)×F*

Classical metabolizable energy (kJ/g diet)-Energy in excerta (kJ/g)×F*

$$F^* = \frac{Cr_2O_3 \text{ in diet (\%)}}{Cr_2O_3 \text{ in excreta (\%)}}$$

ME_n (kJ/g diet)=Classical ME (kJ/g diet)-F**×N retention (mg/g diet)

F**=0.03439 (kJ/mg N retention)

Measurements were made of body weight gain, feed intake, feed conversion ratio, N digestibility, ME_n for each diet and carcass composition. Data collected were subjected to analysis of variance for factorial design using GLM procedures (SAS, 1988). Where significant variance ratios were detected, differences between treatment means were tested using the least significant difference (LSD) procedures.

Table 1. The composition of the basal diets

Ingedient (g/kg)	Starter diet	Finisher diet
Ground corn	200.00	200.00
Soy bean meal (48% protein)	262.50	180.00
Ground wheat	425.50	487.50
Wheat mill run	25.00	27.00
Fish meal (65% protein)	25.00	35.00
Palm oil	30.00	36.00
DL-Methionine	1.80	1.00
Limestone	12.00	15.00
Dicalcium phosphate	10.20	8.00
Sodium chloride	2.00	2.00
Chromic oxide	-	3.00
Premix[1]	6.00	5.00
Analysis:		
Crude protein (N%×6.25)	22.8	19.9
Fat (%)	2.94	7.01
Calcium (%)	1.22	1.24
Total phosphorus (%)	0.68	0.72
Calculated available phosphorus (%)[2]	0.50	0.48
Calculated metabolizable energy (kj/g)[2]	12.4	12.7

[1] The composition of vitamins and minerals in the premix (per ton of diet) : vitamin A, 6000,000 IU; vitamin D, 1500,000 IU; vitamin E, 20,000 IU; vitamin K 1,000 mg; vitamin B_1, 1 mg; vitamin B2, 300 0mg; vitamin B_6, 2000 mg; vitamin B_{12}, 10 mg; niacin, 20,000 mg; folic acid, 500 mg; pantothenic acid 5,000 g; biotin, 50 mg; antioxidant, 60.000 mg; cobalt, 100 ppm; copper, 5,000 ppm; iodine, 500 ppm; iron, 20,000 ppm; manganese, 40,000 ppm; selenium, 100 ppm; zinc, 30.000.

[2] Available phosphorus was calculated on the basis of 30% availability of phosphorus in plant products.

[3] Metabolizable energy was calculated from Evan (1985).

RESULTS

Dietary supplementation of BM did not significantly influenced body weight gain (BWG), feed conversion ratio (FCR) (table 2), nitrogen digestibility and retention and nitrogen corrected metabolizable energy (table 3) and carcass composition of edible offal (liver+heart+gizzard), neck and eviscerated carcass as expressed as g/kg live body weight (table 4). Vaccination program significantly influenced the performance of birds. Birds given the booster dose at 12 days of age had significantly ($p<0.05$) lower BWG and higher FCR than those of the unvaccinated control group between 21 and 35 days of age. BWG was significantly ($p<0.05$) reduced by the booster dose at 35 days of age. Whilst, FCR was not significantly influenced at 35 days of age by the booster dose (table 2).

Birds fed 3 g BM/kg diet had a significantly ($p<0.05$) higher proportion of abdominal fat (g/kg live body weight) and lower carcass proportion of

Table 2. The effects of dietary BM supplementation and vaccination program on body weight gain and feed conversion ratio of meat chickens between 1 and 35 days of age

Treatment	Age					
	1-21 day		22-35 day		1-35 day	
	BWG[1] (g)	FCR[2] (feed/gain)	BWG[1] (g)	FCR[2] (feed/gain)	BWG[1] (g)	FCR[2] (feed/gain)
Dietary BM (DBM)						
Control	657.6	1.60	905.4	1.98	1563.0	1.82
Control+0.15BM	657.6	1.67	939.7	1.92	1596.3	1.81
Control+0.30BM	668.3	1.64	923.9	1.94	1594.2	1.80
SEM[4]	9.4	0.03	13.0	0.03	19.4	0.03
Vaccination program (VP)[3]						
VP1	658.1	1.60	951.8[a]	1.92[b]	1609.9[a]	1.80
VP2	664.3	1.63	893.4[b]	1.98[a]	1558.4[b]	1.82
SEM[4]	7.6	0.02	10.6	0.02	16.2	0.01
Probability (p):						
DBM	0.6428	0.1752	0.2694	0.3982	0.5546	0.9811
VP	0.3485	0.6333	0.2058	0.1368	0.1839	0.2266
DBM × VP	0.1431	0.5298	0.3419	0.9809	0.2616	0.8721

[1] Body weight gain (g).
[2] Feed conversion ratio (feed intake/weight gain).
[3] VP1=Birds were not given the booster dose of IB and ND vaccines at 12 days of age.
VP2=Birds were given the booster dose of IB and ND vaccines at 12 days of age.
[4] Standard error of means.
[a,b] Means within raw followed by different superscripts are significantly different ($p<0.05$).

drumstick (g/kg eviscerated carcass) than those fed the other diets. Male chickens had significantly ($p<0.01$) higher body weight and carcass proportion of drumstick (g/kg eviscerated carcass) ($p<0.05$) and lower carcass proportion of breast (g/kg eviscerated carcass) than female chickens. Carcass composition was not significantly influenced by the booster dose (table 4).

DISCUSSION

Results from this experiment showed that dietary supplementation of BM caused a non-significant improvement in BWG and efficiency of feed conversion (EFC) of chickens over the 5 week-experimental period. There was no significant difference in BWG and FCR at 21 and 35 days of age. However, BM had a more pronounced effect on chicken performance during the finishing period (22-35 days of age) when compared with the performance of chickens during the starter period (1-21 days of age). The addition of 1.5 g BM/kg diet increased BWG and EFC by 2.1% and 0.6%, respectively, with almost 100% of the increase in BWG occurred in the finishing period. Whilst, dietary supplementation of 3 g BM/kg diet increased BWG and EFC by 2% and 1.1%, respectively, with almost 60% of the increase in BWG occurred in the finishing period. In this trial, birds were kept in a clean environment by daily cleaning their batteries. It appears that BM has a very little effect on performance when birds are kept in hygienic conditions. However, in intensive systems of housing, meat chickens are reared on litter systems, where they are more prone to certain diseases, particularly those passed from bird to bird via the faeces. MacDonald (1995) found that dietary supplementation of BM (1 g BM/kg diet) significantly improved the performance and reduced the mortality of chickens at 49 days of age. These chickens were reared in a house with a history of performance and

Table 3. Nutrient utilization of meat chickens fed diets supplemented with BM between 1 and 35 days of age

Nutrient Utilization	Dietary treatment			LSD[1] ($p<0.05$)
	Control	Control+ 0.15BM	Control+ 0.30BM	
Nitrogen digestibility (%)	72.2	72.1	71.8	1.00
Nitrogen retention (mg N/g of feed)	16.5	17.2	16.2	2.1
ME_n (MJ/kg)[2]	12.6	12.8	12.2	0.9

[1] Least significant difference ($p<0.05$).
[2] Nitrogen corrected metabolizable energy.

Table 4. Body composition of meat chickens fed diets supplemented with BM under two different vaccination programs between 1 and 35 days of age

Treatment	Body composition									
	Live body weight (g)	g/kg live body weight[1]				g/kg eviscerated carcass				
		AF	EO	Neck	EC	T	D	W	B1	B2
DBM[3]										
Control	1521.9	11.8[b]	40.08	51.9	663.2	174.1	154.2[a]	130.7	303.7	237.2
Control+0.15BM	1539.2	12.2[b]	39.3	54.4	667.4	176.5	155.3[a]	126.7	303.8	237.7
Control+0.30BM	1537.7	15.9[a]	39.9	54.2	672.7	176.2	148.6[b]	130.1	308.9	236.1
SEM[4]	30.7	1.1	0.8	1.4	3.7	3.3	1.9	3.5	5.5	3.9
VP[5]										
VP1	1572.3[a]	13.8	40.2	54.6	665.5	179.1	151.9	129.3	306.8	232.9
VP2	1493.6[b]	12.7	39.8	52.4	670.0	172.1	153.6	129.0	304.2	241.1
SEM[4]	22.8	0.9	0.6	1.1	3.0	2.6	1.6	2.3	4.5	3.2
SEX										
Male	1567.0[a]	12.9	40.0	53.2	666.7	175.9	156.6[a]	129.5	300.5[b]	237.6
Female	1456.8[b]	14.0	40.0	54.2	670.2	175.1	144.1[b]	128.3	316.7[a]	235.8
SEM[4]	22.8	0.9	0.6	1.1	3.0	2.6	1.6	2.3	4.5	3.2
Probability (p):										
DBM	0.5478	0.0494	0.1960	0.7226	0.3917	0.8699	0.1927	0.8059	0.7869	0.7786
VP	0.0501	0.4967	0.6535	0.0806	0.4953	0.1533	0.2400	0.6390	0.7013	0.1418
S	0.0071	0.4969	0.8490	0.6412	0.6252	0.8592	0.0001	0.7483	0.0527	0.9396
DBM × VP	0.1711	0.3626	0.8452	0.3407	0.8166	0.2910	0.5567	0.3283	0.8180	0.1216
DBM × S	0.5384	0.7317	0.2621	0.8552	0.8353	0.8939	0.8476	0.6862	0.5133	0.4216
VP × S	0.7416	0.6912	0.9450	0.2084	0.5937	0.5585	0.4575	0.2937	0.9759	0.9038

[1] AF=Abdominal fat; EO=Edible offal=liver + heart + gizzard. EC=Eviscerated carcass.
[2] T=Thigh; D=Drums; W=Wings; B1= Breast; B2=Back.
[3] Dietary BM.
[4] Standard error of mean.
[5] VP1= Birds were not given the booster dose of IB and ND vaccines at 12 days of age.
VP2=Birds were given the booster dose of IB and ND vaccines at 12 days of age.
[a,b] Means within column followed by different superscripts are significantly different ($p<0.05$).

mortality problems. It seems that the improvement was greatest in conditions of poor hygiene where growth was sub-optimal (MacDonald, 1995) and least in clean, where birds were already exhibiting a good growth performance as in this experiment. Similar results were obtained from feeding antibiotics under different experimental conditions. Chicks hatched and reared in environment free of any microorganisms grew significantly better than their counterparts and their growth performance was not improved by including antibiotics in the diets (Forbes and Park, 1959; Coates et al., 1963). Superior growth in clean environment, hygienic premises, also observed in other laboratory animals (Dubos and Schaedler, 1960; Seravalli and Dubos, 1967). It seems in some cases where a beneficial nutritional effect has been demonstrated the values of performance or production in the control groups themselves are frequently usually low. Whether this indicates purely biological variation between the control and treated groups or a real improvement under poor management or other conditions is unclear. This may be significant because one of the areas where BM may be of real value is where poor management or other adverse conditions result in poor performance. Perhaps more studies should be carried out in this area.

It is unfortunate that the mechanism of action of BM is not fully understood. The growth promoting action of BM forms the subject of many papers (Newman, 1994; Savage and Zakrzewska, 1995; Savage et al., 1996). The most likely explanation is that BM inhabits or eliminates gut microorganisms that cause a depression in bird's performance. Micro-organisms perform a variety of metabolic actions on the content of the gastrointestinal tract. The increase in these microorganisms would also cause an increase in intestinal wall thickness and impairment of intestinal absorption (Lev et al., 1957; Salter, 1973).

Vaccination of growing chickens with a booster dose of IB and ND at 12 days of age reduced BWG and increased FCR between 21 and 35 days of age. The birds did not overcome the growth depression caused by the stress of vaccination. Hentges et al. (1984) found that vaccination stress reduced protein synthesis and consequently protein production. However, this reduction in body weight gain did not bring about any significant changes in body composition. Dietary BM increased abdominal fat composition. There was a significant increase in the abdominal fat (g/kg live weight) and a reduction in drumstick (g/kg eviscerated carcass) of bird fed the highest BM dietary level. The changes in body composition brought about by dietary BM have not been accomplished by alteration in efficiency of nutrient utilization. Carcass compositional differences between sexes suggest that carcass composition of males and females is not entirely controlled by the same genes. There are probably genes common to both sexes and gene specific for each sex. Male birds had higher drumstick and lower breast meat than those of female.

It was concluded that BM did not significantly influenced performance, nutrient utilization, body composition of meat chickens when birds were kept under hygienic experimental conditions. However, results in favor of BM may be achieved under field conditions, with the highest improvement in performance of chickens may be obtained with the lowest sanitation.

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