ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF

POULTRY SCIENCE

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

International Journal of Poultry Science 7 (10): 969-977, 2008
ISSN 1682-8356

Growth Performance and Slaughter Characteristics of Broiler Chickens Fed with Antibiotic, Mannan Oligosaccharide and Dextran Oligosaccharide Supplemented Diets

M. Bozkurt, K. Küçükyilmaz, A.U. Çatli and M. Çinar
Poultry Research Institute, Erbeyli-Aydin 09600, Turkey

Abstract: The aim of the present study was to investigate the effect of dietary supplementation with an antibiotic growth promoter (AGP) and two prebiotics; mannan oligosaccharide (MOS) and dextran oligosaccharide (DOS), respectively, on growth performance and some slaughter characteristics of broilers. One thousand and two hundred day-old broiler chicks (Ross 308) were weighted and randomly assigned to the four treatment groups, each with six replicates. Birds were housed in replicate pens (1.5 x 3.0 m) each containing 50 birds (25 male and 25 female). The four treatments were as follows: 1. Basal diet (Control); 2. Basal diet + antibiotic (10 mg avilamycin/kg diet); 3. Basal diet + mannan oligosaccharide (1 g/kg diet); 4. Basal diet + dextran oligosaccharide (1 g/kg diet). Chicks fed on basal diets were supplemented with an AGP and both of prebiotics were significantly heavier at 21 and 42 days of age than that of control chickens fed with basal diet as control. Besides, body weight of birds given MOS supplemented diet was significantly higher than those birds fed with AGP and DOS added diets ($P < 0.05$). Feed consumption, feed conversion ratio and liveability of birds was not affected by dietary treatments determined both at 0 to 21 d, 22-42 d and 0-42 d periods ($P > 0.05$). Percentage weight of carcass yield, liver, pancreas and abdominal fat pad was not affected by dietary treatments also ($P > 0.05$). The results obtained in the present experiment showed that birds fed with AGP, MOS and DOS supplemented diets exhibited higher body weight gain ($P < 0.05$) and numerically improved feed efficiency than that of the control birds fed on basal diet. In conclusion, either MOS or DOS could replace for AGP as non-antimicrobial performance enhancer feed additives without scarifying any performance goal and carcass yield of broilers.

Key words: Broiler, antibiotic, mannan oligosaccharide, dextran oligosaccharide

Introduction

For the past several decades growth promoter feed additives have been included in poultry diets to promote growth, protect health and maximize the genetic potential of modern broiler, turkey and layer hybrids. Of these, antibiotics have been used at sub therapeutic doses in animal feed, including poultry diets, for over five decades to prevent disease, promote growth and feed conversion efficiency (Eyssen and DeSomer, 1963; Miles *et al*., 1984; Harms *et al*., 1986; Rosen, 1996; Engberg *et al*., 2000). Antibiotics exerted their effect by stabilizing the intestinal microbial flora thereby preventing proliferation of specific intestinal pathogens (Truscott and Al-Sheikhly, 1977; Visek, 1978; Shane, 2005). Today, the non-prescription use of antibiotics in poultry feeds has been eliminated or severely limited in many countries because of concerns related to development of antibiotic-resistant human pathogenic bacteria and legislative action to limit their use in probable in many others. A complete ban on antibiotics in poultry feeds was brought in to force on January 1st by the European Union; thus, all of the antibiotics used at sub-therapeutic levels for growth promotion (antibiotic growth promoters or AGP's) were with drawn (Nollet, 2005; Cervantes, 2006; Michard, 2008). The ban on AGP's has driven and prompted the search and development of alternatives like probiotics, yeast cultures, organic acids, prebiotics, enzymes, botanicals including extracts and essential oils of some herbs and spices (Gill, 1999; Langhout, 2000; Hertrampf, 2001; Hooge, 2006).

Products such as prebiotics also have long been tested for their effects on intestinal health; general health status and zootechnical performance of commercial poultry hybrids. Prebiotics are now being considered in keeping the intestinal tract of poultry healthy and at the same time, safeguarding animal health status and performance (Gill, 2001; Kocher, 2005; Hooge, 2006). Since the early 1980's a series of studies have been conducted to evaluate the effects of different carbohydrates as prebiotic feed additives with the aim of improving animal health and performance. There is a growing interest in use of variety of oligosaccharides to promote human and animal health (Hidaka *et al*., 1991; Orban *et al*., 1997). Among these, mannan oligosaccharides and fructo oligosaccharides have been most extensively studied for their ability to improve animal health and performance (Ammerman *et al*., 1989; Bailey *et al*., 1991; Spring, 1999; Shane, 2001; Iji *et al*., 2001; Hooge, 2003a). Different from fermentable oligosaccharides like FOS and inulin, interest in

mannan oligosaccharides (MOS) being non-fermentable has been steadily on increase. Feed grade MOS showed encouraging results on animal health and animal performance thereby selectively binding capability to the pathogenic bacteria (Hooge, 2003a; Shane, 2005, Kocher, 2005; Nollet, 2005). MOS is derived from the outer cell wall of selected strain of *saccharomyces cerevisia*. Initial researches proved that MOS has the ability to adhere to pathogenic bacteria such as *Salmonella* or *E. coli* (Oyofo *et al.*, 1989; Newman, 1994; Funicane *et al.*, 1999). Subsequent researches showed that MOS has improvement effects on the immune system and intestinal morphology even with improved bird performance, profitability than only the prevention of the colonization of intestinal pathogens (Savage *et al.*, 1996, 1997; Shafey *et al.*, 2001; Iji *et al.*, 2001; Shashidhara and Dewegowda, 2003).

But, on the other hand studies on other oligosaccharide varieties are sparse, even negligible when compared to scientific knowledge regarding to MOS and FOS. During the past decade, limited research activities were applied whether dietary dextran oligosaccharide (DOS) influences health aspects and performance of poultry. Feeding with dextran oligosaccharides (DOS) has been shown to reduce organ invasion of *E. coli* and Salmonella enteritidis (Tellez, 1997), decrease cecal bacterial count (Fukata *et al.*, 1998), improve egg production performance and feed efficiency for egg number and egg output (Mallik *et al.*, 2003). However, no beneficial effect on broiler body weight gain, feed conversion ratio and liveability even DOS was included in diet at three different inclusion rates ranging from 0.05% to 0.15% (Küçükyilmaz *et al.*, 2005).

The aim of the present study reported herein was to compare the working mechanism of AGP and two different oligosaccharides as prebiotics, DOS and MOS, as growth promoters in broiler feeding. So, the substitution dietary MOS or DOS for AGP will be evaluated testing on broilers. Therefore, feed grade AGP, MOS and DOS supplemented into diet to determine their dietary additive effects on growth performance, feed intake, feed conversion ratio, liveability, carcass yield, percentage weight of liver, pancreas and abdominal fat pad. Also, this is the first comparative study in the scientific literature that examined the performance enhancer effects of MOS *versus* DOS on broilers.

Materials and Methods

One thousand and two hundred day-old broiler chicks (Ross-308) were weighted and randomly assigned to the four-treatment group, each with six replicates, using a standard randomization technique. Birds were housed in replicate pens each containing 50 birds (25 male and 25 female). A commercial antibiotic growth promoter and two prebiotic feed additives were supplemented to no additive added basal diet. The four treatments were as follows:

1. basal diet (control)
2. basal diet + antibiotic, avilamycin (AGP[1], l0 mg/kg diet).
3. basal diet + mannan oligosaccharide, Bio-Mos® (MOS[2], 1 g/kg diet).
4. basal diet + dextran oligosaccharide, MHF-Y® (DOS[3], 1 g/kg diet).

The birds were fed a starter diet in crumble form from days 1-21 and a grower diet in pellet form from days 22-42 (Table 1). The diets were isoenergetic and isonitrogeneous and were formulated to meet the minimum nutrient requirements of broilers as recommended by the NRC (1994). All of the dietary feed additives were added at the expense of saw dust. Birds were allowed to free access to feed and water during the 42-d growout period. The birds were kept in 24 pens (1.5 x 3.0 m) on wood shavings as litter material. Each pen was equipped with two hanging feeder and one drinker. Bird density was 11 chicks per square meter. The lighting cycle was 23 h/d maintained. The ambient temperature in experimental house was maintained at 32°C during the first week and gradually decreased by 3°C in the second and third week, and fixed at 22°C thereafter. Chicks were vaccinated against Infectious Bursal Disease, New Castle Disease (HB1) and New Castle Disease (La sota) at day 14, 21, 28, respectively, via drinking water.

Growth performance of broilers was evaluated by recording body weight gain, feed intake, feed conversion ratio and mortality during the 42 d experimental period. Individual body weights of the broiler chicks were recorded at the beginning and on days 21 and 42 of trial. Feed intakes of birds were recorded per pen basis on days 21 and 42 of the experiment. Feed conversion ratio was calculated as the amount of feed consumed per unit of body weight gain on days 21 and 42. FCR was calculated as feed intake consumed per unit of body weight gain and was adjusted for weight of chicks at first day. Mortality was recorded as it occurred and was used to adjust the total number of birds to determine the total feed intake per bird and feed conversion ratio.

At the end of the study, twelve female birds from each treatment were selected, based on the average weight of the group and sacrificed. Carcass yield was calculated by dividing eviscerated weight by live weight. Liver, pancreas and abdominal fat pad were also removed, weighted and as a percentage of live weight was calculated.

The standard techniques of the proximate analysis were

[1]Kavilamycin®, Kartal Kimya Sanayi ve Ticaret AS Gebze-Kocaeli / Turkey
[2]Bio-Mos®, Alltech, Inc., Nicholasville, KY 40356
[3]Meito Healthy Friend (MHF-Y®), Meito Sangyo Co., Ltd. Nagoya / Japan

Table 1: The ingredient and chemical composition of basal starter and grower diets

Ingredients (g/kg)	Starter	Grower	Chemical composition of basal diet (mg/kg)	Starter	Grower
Yellow corn	433.67	496.25	Dry matter	90.65	88.92
Wheat	100.00	100.00	Crude protein	21.72	20.37
Soybean meal	231.43	202.14	Crude fat	7.73	8.32
Full-fat soybean	170.00	138.53	Crude fibre	3.45	3.29
Soy oil	26.03	29.67	Crude ash	5.60	5.52
DCP	19.11	18.44	Starch	35.64	36.96
Limestone	8.27	3.28	Sugar	3.38	3.41
Salt	3.00	3.80	Calcium	1.13	0.86
L-Lysine HCL	0.15	0.00	Total phosphorus	0.65	0.63
DL-methionine	2.34	1.89	Calculated composition (mg/kg)		
Vitamin premix[1]	2.50	2.50	Av.phosphorus	0.45	0.42
Mineral premix[2]	1.00	1.00	Lysine	1.25	1.03
Anticoccidial[3]	0.50	0.50	Methionine	0.57	0.49
Antioxidant[4]	1.00	1.00	Meth.+cysteine	0.92	0.80
Saw dust	1.00	1.00	Linoleic acid	3.58	3.98
TOTAL	1000.00	1000.00	M.energy (kcal/kg)	3163	3219

[1]Provides per kg of diet: vitamin A 12000 IU; vitamin D_3 1500 IU; vitamin E 30 mg; vitamin K_3 5 mg; vitamin B_1 3 mg; vitamin B_2 6 mg; vitamin B_6 5 mg; vitamin B_{12} 0.03 mg; nicotine amid 40 mg; calcium-D-pantothenate 10 mg; folic acid 0.75 mg; D-biotin 0.075 mg; choline chloride 375 mg. [2]Provides per kg of diet :Mn 80 mg; Fe 40 mg; Zn 60 mg; Cu 5 mg; I 0.5 mg; CO 0.2 mg; Se 0.15 mg. [3]Provides 70 mg Narasin per kg of diet. [4]Provides 20 mg BHA, 25 mg Ethoxyquine, 20 mg Citric acid per kg of diet.

used to determine the nutrient concentrations in the diets (Naumann and Bassler, 1993). The experimental diets were analyzed also for starch, sugar, total calcium and phosphorus according to chemical analyses methods of feedstuff by Association of German Agricultural Analysis and Research Institutes (VDLUFA) (Naumann and Bassler, 1993). Metabolizable energy content of the diets was calculated based on chemical composition (Anonymous, 1991). All data were subjected to ANOVA using the General Linear Models procedure of SAS software (SAS Institute, 1991). The mean differences among different treatments were separated by Duncan's multiple range tests. A level of ($P < 0.05$) was used as the criterion for statistical significance.

Results

Performance traits of broiler chickens including body weight, feed intake feed conversion ratio and liveability are presented in Table 2. The results from the trial showed that the substitution of the control by the alternative diets resulted in significantly higher body weight at both 21 and 42 days of age, while there was no major difference in overall feed intake. AGP, MOS and DOS supplementation to diet resulted higher body weight at the level of 3.0, 7.0, 2.3%, respectively, at day 21 ($P < 0.01$) than that control treatment. Similarly, dietary AGP, MOS and DOS additives were superior to a non-supplemented control at the level of 2.2, 5.1, 1.9%, respectively, at day 42 ($P < 0.05$). In a similar pattern, this advantage for additive programs in terms of growth rate was sustained through finisher period from 22-42 d. However, body weight of birds given MOS added diets were significantly higher than those treated with AGP and DOS at both 21 and 42 days of age and 22-42 d period. No significant differences were noticed between AGP and DOS treatments.

Feed intake of broilers was not affected by dietary treatments throughout the experimental period ($P > 0.05$). Indeed, there was a clear tendency that feeding with MOS added diets tended to consume more feed than those other treatments. Broilers on MOS program averaged 116 g, 98 g, 149 g more cumulative feed intake compared to those birds on the control, AGP and DOS programs, respectively, throughout the experimental period. Although feed intake was tended to increase by feeding MOS, the greater increase in weight gain ($P < 0.05$) resulted in an considerable improvement in feed conversion for broilers consuming the MOS added diet compared to broilers consuming no added control diet. On the other hand, DOS-treated broilers exhibited lower feed intake in numerical basis at all stages of the experiment when compared to all other treatments.

Likewise to the feed intake trait, feed conversion ratio was not affected by dietary treatments ($P > 0.05$). However, it is obvious that feed conversion ratio was improved by overall experimental additives in a similar pattern at both 0-21 d and 22-42 d periods and also throughout the entire experimental period in comparison with the control. The numerical improvements on feed conversion ratio in favour of MOS and DOS programs were found as 2.39% and 2.72%, respectively, compared to control treatment for entire test period (0-42d).

The general health status of broiler chickens was excellent for all treatments throughout the entire experimental period, showing liveability more than 97.50%. There was no significant difference between the groups with respect to liveability.

Slaughter characteristics including carcass yield and relative weight of small intestines, pancreas and abdominal fat pad were not influenced ($P > 0.05$) by dietary treatments (Table 3).

Table 2: Body weight, feed intake, feed conversion ratio and liveability of broilers given AGP, MOS or DOS added diets

	Treatments					
Experimental period, d	Control	AGP	MOS	DOS	SEM	P
Body weight (g)						
1 d	38.6	38.7	38.4	38.5	0.24	0.6843
21 d	691^{c}	712^{b}	740^{a}	707^{bc}	5.75	0.0001
42 d	2259^{c}	2309^{b}	2375^{a}	2303^{b}	15.10	0.0481
22-42 d	1568^{b}	1597^{b}	1635^{a}	1596^{b}	14.86	0.0219
Feed intake (g)						
0-21 d	1093	1102	1124	1083	11.70	0.1128
22-42 d	3091	3100	3176	3068	30.64	0.0745
0-42 d	4184	4202	4300	4151	41.07	0.0947
Feed conversion ratio						
0-21 d	1.674	1.637	1.601	1.620	0.02	0.1653
22-42 d	1.971	1.941	1.942	1.922	0.01	0.1523
0-42 d	1.883	1.851	1.839	1.833	0.01	0.1544
Liveability (%)						
0-21 d	98.68	99.33	98.68	99.00	0.66	0.8859
0-42 d	98.68	99.33	97.70	99.00	0.74	0.4618

Means with different superscript in the same row are significantly different from each other (P <0.05)

Discussion

Results from the present study indicated that feeding broilers with AGP, MOS and DOS supplemented diets had beneficial effects on body weight gain and feed conversion ratio without affecting liveability. There was a consistent improvement in growth rate and feed conversion ratio for all experimental additives throughout the experimental period in comparison with unsupplemented control treatment. So that, similar levels of improvements were performed for AGP and DOS treatments in terms of body weight gain and feed conversion efficiency, whereas significantly more benefit was pronounced for MOS program regarding to body weight gain than those DOS and AGP programs.

Clearly, a great number of scientific works, detailed reviews and commercial field observations regarding their use in feed are available and provide useful overviews of the modes of action and performance benefits of antibiotics (Visek, 1978; Miles *et al.*, 1984; Harms *et al.*, 1986; Engberg *et al.*, 2000; Parks *et al.*, 2001; Alçiçek *et al.*, 2003; Bozkurt *et al.*, 2005 a). Consistent with earlier reports, the findings of our study in response to dietary AGP supplementation confirms growth promoter and feed efficacy mechanisms of feed grade antibiotics.

The well established growth promoter effect of dietary MOS was frequently attributed its pathogenic bacteria binding ability described as strongly binding and decoying pathogens away from the intestinal lining (Oyofo, 1989; Newman, 1994; Funicane *et al.*, 1999; Shane, 2001).Thus, more nutrient is available in the intestinal lumen for absorption to convert body mass. The overall main effect of MOS was to increase weight gain at 21 d ($P < 0.01$), 42 d and 21-42 d ($P < 0.05$) when compared to all other treatments. Body weight gain of birds fed with MOS added diets far exceeded the control bird's weight gain over the 21 d and 42 d periods with weight gains of 49 g and 116 g, respectively. However, weight gain of AGP and DOS treatments were intermediate and did not differ significantly at all test periods.

Confirming results to those findings were evidenced in our previous study (Bozkurt *et al.*, 2005a). We also found that body weight of male broilers given MOS added wheat based diets was significantly higher than those AGP and control treatments at both 21 d and 42 d. When compared to the present work, considerably higher benefits for weight gain were determined with 128 g at 21 d and 123 g at 42 d in terms of dietary MOS supplementation than that no added control program. In consistent with our present and earlier findings, Hooge (2004) reported that MOS addition to diet increased body weight gain at 41.8 d at an average of 1.75% evaluating the results of 29 pen trials involving 44 comparisons of negative control diets versus MOS diets. Different from the results of those studies, it was reported that MOS feeding program gave statistically equivalent body weight compared to diets containing subtherapeutic levels of antibiotics (Parks *et al.*, 2001; Hooge *et al.*, 2003b; Ceylan *et al.*, 2003; Waldroup *et al.*, 2003a, b). From a general point of view, numerous scientific results have been reported for growth promoter effect of MOS compared to unsupplemented control program even under different management procedures (Kumprecht *et al.*, 1997; Sims and Sefton, 1999; Shafey *et al.*, 2001; Ceylan *et al.*, 2003; Hooge *et al.*, 2003 b; Bozkurt *et al.*, 2005a, b).

As a consequence, performance enhancer feed additives AGP and MOS verified once again their well established working mechanism via promoting growth and improving feed efficiency in the present study. Obviously, the growth promoter effect was even more outspoken for MOS at both 21 d 42 d, whereas AGP and

Table 3: The effect of dietary inclusion of AGP, MOS and DOS on carcass weight, carcass yield and relative weight of liver, small intestines, pancreas and abdominal fat of female broilers

	Control	AGP	MOS	DOS	SEM	P
Live weight (g)	2142	2150	2150	2157	7.80	0.6065
Carcass weight (g)	1628	1658	1653	1659	11.24	0.1935
Carcass yield (%)	76.00	77.11	76.88	76.91	0.42	0.2784
Liver (%)	1.96	1.95	1.98	1.97	0.05	0.9850
Pancreas (%)	0.29	0.26	0.26	0.27	0.01	0.3814
Abdominal fat (%)	1.85	2.02	2.22	2.18	0.14	0.2316

DOS provided less advantages than that MOS. Moreover, those findings clearly showed that growth performance and feed conversion ratio in diets containing either MOS or DOS was comparable to the performance of commonly used antibiotic growth promoter, avilamycin.

Different from AGP and MOS, scarce scientific knowledge is available for DOS regarding to mode of action and farm animal trials. In a recent scientific work, Küçükyilmaz *et al.* (2005) did not observe any growth promoter and feed efficacy effect of dietary added DOS even supplemented at three different inclusion levels.

Liveability, which ranged from 97.70-99.00% was unaffected by treatments in the present study ($P > 0.05$). Indeed, the mortality rates determined for all treatments were much better when compared to commercial field observations. However, it is obvious that neither AGP nor both oligosaccharide treatments could not provide better liveability than that control program. It appears that well established *in vitro* bacteriostatic and bactericide mode of action of such additives might not implement through practical field applications due to the less stressed environmental conditions and comfortable management procedures. Common pathogens such as *E. coli*, *Salmonella* and *C. Perfringens* have to overcome numerous obstacles in order to colonize in the intestinal tract and cause an infection, consequently diseases mostly in sub clinic form, in poultry under the management conditions of intensive broiler rearing system. However, less stressful housing conditions might have been existed in this study compared to commercial applications; hence, health protective and disease preventing mechanisms of additives could not be exhibited in such a more comfortable pen trial environment.

As indicated in Table 2, there were no differences ($P > 0.05$) in cumulative feed intake and feed conversion ratios between dietary treatments over the experimental periods. Noteworthingly, MOS feeding program was in a tendency of stimulating the feed consumption of birds during the entire experimental phases, whereas absolutely converse pattern was obvious for DOS feeding program. These results are in agreement with that of Küçükyilmaz *et al.* (2005) who reported that the feed intake of birds were linearly decreased as the level of supplemental DOS was increased up to three fold from 500 mg/kg diet to 1500 mg/kg diet. The results of the present study in response to feeding MOS and AGP are contrast to those of other researchers (Ceylan *et al.*, 2003; Sinovec *et al.*, 2005), while confirmed with out former findings (Bozkurt *et al.*, 2005a, b). As a matter of fact, even if the feed intake was considerably increased by feeding MOS, the greater increase in weight gain resulted in an improvement in feed conversion ratio compared to broilers given AGP and DOS added diets and control program also. However, it should be take into consideration that little information is available in the scientific literature still with regard to dietary supplementative effects of oligosaccharides on feed consumption traits of all poultry species.

In agreement with the results of numerous earlier studies for AGP (Miles *et al.*, 1984; Parks *et al.*, 2001; Engberg *et al.*, 2000; Alçiçek *et al.*, 2003; Bozkurt *et al.*, 2005 a) and MOS (Kumprecht *et al.*, 1997; Sims and Sefton, 1999; Parks *et al.*, 2001; Shafey *et al.*, 2001; Hooge, 2003 a, b; Sinovec *et al.*, 2005; Bozkurt *et al.*, 2005 a, b), the present experiment also showed that dietary AGP and MOS treatments improved feed conversion ratio compared with the control. Confirming evidences was arose from another study (Hooge, 2004) who pointed out that MOS feeding programs more benefited (1.99%) than that control program according to the evaluation of 29 broiler pen trials. Contrary to those results, no improvement effect on feed conversion ratio was observed due to the decreased feed intake with depressed body weight in response to DOS supplementation to diet (Küçükyilmaz *et al.*, 2005). Obviously, both AGP and two oligosaccharide treatments achieved to manage better conversion of diet to body mass compared to control treatment. It was clearly seen that such a response is mainly dominated by increased growth rate resulting from dietary supplementation of those additives. However, the most profound effects were attributed to their addition of MOS and DOS.

Naturally, it seems reasonable to assume that antibiotic growth promoters act on the microflora in the proximal end of the small intestine, where most nutrition absorption takes place. Furthermore, the inhibition of certain species of intestinal bacteria that produce toxins or compete with the host for available nutrients and probably depress dietary fat absorption due to bile acid deconcugation may further explain the feed efficacy mechanism of AGPs (Eyssen and DeSomer, 1963; Visek, 1978; Harms *et al.*, 1986; Feighner and

Dashkevisz, 1987; Engberg *et al.*, 2000).

Indeed, the modes of action of growth promoting antibiotics and their alternatives can differ considerably. Subtherapeutic antibiotics results a reduction on the microbial load in gut, thus resulting in more nutrient portioning towards growth and production rather than mechanism of disease resistance (Feighner and Dashkevisz, 1987; Shane, 2005). In contrast, AGP alternative compounds alter the gut microflora profile by limiting the colonization of unfavourable species. Thus, specific pathogens that could attach to the intestinal lumen was forced to move through the gut without colonization; hence, allowing nutrient utilization at much higher levels (Ammerman *et al.*, 1989; Bailey *et al.*, 1991; Parks *et al.*, 2001; Shane, 2001). Eventually, those working mechanisms of AGP and both oligosaccharides appeared to contribute to the improved utilization of dietary nutrients as being reflected to enhanced feed/weight gain ratio compared to control.

In the fact that, similar working mechanism of two experimental oligosaccharides were postulated with similar mode of actions such as resistant to gastric juice, depressing non beneficial bacteria colonization, stabilizing the gut microflora, enhancing immunological activity, preventing against infectious disease and stress, keeping health and safety, eventually improving profitability (Savage *et al.*, 1996; Tellez, 1997; Fukata *et al.*, 1998; Spring *et al.*, 2001; Shane, 2001; Ferket, 2004). But, the principal mechanism in antimicrobial activity differs significantly between AGP and MOS and also DOS. So that, AGP exerts its bactericide effect by destroying the pathogenic bacteria as directly, whereas both MOS and DOS posses indirect mode of action.

Mannan oligosaccharides (MOS), derived from mannans on yeast cell surfaces, act as high affinity ligands, offering a competitive binding site for the bacteria (Ofek *et al.*, 1977). Pathogens with the mannose-specific Type-1 fimbria absorb the MOS instead of attaching to intestinal epithelial cells and, therefore move through the intestine without colonization (Newman, 1994; Shane, 2001). Thus, the presence of dietary MOS in the intestinal tract removed pathogenic bacteria, *S. enteritidis* and *S. typhimurium* with *E. coli* in particular, that could attach to the lumen of the intestine in this manner (Newman, 1994; Spring *et al.*, 2001). Similar pathogen binding mechanism was also demonstrated by Ofek *et al.* (1977) and Oyofo *et al.* (1989) for mannose. Different from the mechanism of MOS, DOS stimulates the organic acid production thereby ensuring as energy sources for lactic acid producing bacteria in the intestinal lumen. It was considered that dietary DOS ensures the proliferation of beneficial intestinal bacteria, *Bifidobacterium* and Lactic acid producing *Lactobacillus* species, in particular. Thus, adding DOS to diet inhibits proliferation of intestinal pathogenic bacteria, particularly the *Salmonella* and *E. coli*, thereby increasing organic acid production with pH reduction (Tellez, 1997; Fukata *et al.*, 1998). Eventually, more acidic intestinal digesta unable to colonization of pathogenic bacteria since the oligosaccharide dextran was used as energy source by those beneficial microorganisms.

As a matter of fact, those assertions were proven with numerous scientific works, animal trials and field experiences in response to dietary MOS supplementation to broiler chicken diets, whereas scarce scientific evidence was obvious for DOS feeding program. Whatever the mode of action is, it was postulated that all of the experimental additives had beneficial effect on growth rate and feed efficiency of broiler chickens via exerting their working mechanisms of own. Furthermore, it was concluded that both of the oligosaccharides, MOS and DOS, could be promising alternatives to AGPs because they improved growth performance and feed conversion ratio of broiler chickens to a similar extent.

Different dietary oligosaccharides and AGP regimens had no significant effect on slaughter characteristics examined in this study (Table 3). It is predictable that better health status of the intestinal mucosa due to feeding AGP, MOS and DOS diets may improve carcass yield of broilers. However, such a pattern was not evident during the current trial. Some workers reported significant improvements in carcass yield and breast yield of broilers fed antibiotic added diets (Izat *et al.*, 1990; Leeson, 1984; Alçiçek *et al.*, 2003). Contrasting to those reports, some other authors failed to observe any differences in overall broiler carcass yield or carcass parts when supplementing diets with antibiotics (Hernandez *et al.*, 2004; Bozkurt *et al.*, 2005 a; Sarica *et al.*, 2005). On the other hand, research pertaining to the effects of dietary MOS on slaughter characteristics and carcass yield is lacking. It was hypothesized that a decrease in intestinal pathogen challenge provided by MOS would result in improvement nutrient utilization and allocation leading to benefits in lean muscle gain (Ferket, 2004). In consistent with that prediction, only one earlier study suggested significantly improvement for breast yield in terms of MOS feeding (Clementino dos Santos *et al.*, 2002), whereas no benefit was determined for carcass yield in other trials (Ceylan *et al.*, 2003; Waldroup *et al.*, 2003a, b; Bozkurt *et al.*, 2005a, b). In a rare recent study (Küçükyilmaz *et al.*, 2005), no benefit for carcass yield was determined in response to dietary DOS supplementation even at three inclusion levels when compared to no treated control. Similarly, the authors could not find any significant effect on relative weight of liver, pancreas and abdominal fat with respect to dietary DOS supplementation.

Unfortunately, little scientific report is available regarding to intestinal organ weights of broilers in terms of feeding with AGP and MOS added diets. The relative weight of

liver, pancreas and abdominal fat were not affected by dietary treatments in agreement with the findings of our two previous works in which we tested the supplementation of MOS (Bozkurt *et al.*, 2005b) and MOS with AGP (Bozkurt *et al.*, 2005a) to broiler diets. Consistent with our results, Hernandez *et al.* (2004) and Sarica *et al.* (2005) found no differences in liver and spancreas weight of broiler chickens fed diets supplemented with an antibiotic. A similar observation was reported by Alçiçek *et al.* (2003) and Waldroup *et al.* (2003a, b). They concluded that abdominal fat pad weight was not affected by antibiotic or antibiotic plus MOS treatment compared to control diet.

As a consequence, it is evident that broilers more benefited from dietary AGP, MOS and DOS additive regimens in terms of weight gain and feed efficiency than that unsupplemented control program. However, the obtained advantageous for weight gain with feeding MOS added diets outperformed both AGP and DOS programs. The results of this study also demonstrated that either MOS or DOS, a non-antibiotic additive, was equivalent to AGP (avilamycin) with respect to technical performance while giving hopeful signs replacing for AGPs. Improved broiler live performance regarding to either AGP or MOS feeding treatments confirms similar results reported formerly in a great deal of study. Consequently, more research is needed in order to bring up mechanism of DOS on broiler growth performance in both animal experimental studies and *in vitro* examinations including microbiological, immunological and intestinal histology works.

References

Alçiçek, A., M. Bozkurt and M. Çabuk, 2003. The effects of an essential oil combination derived from selected herbs growing wild in Turkey on broiler performance. S. Afr. J. Anim. Sci., 33: 89-94.

Ammerman, E., C. Quarles and P.V. Twining, 1989. Evaluation of fructooligosaccharides on performance and carcass yield of male broilers. Poult. Sci., 68: 167.

Anonymous, 1991. Animal feeds-Determination of metabolizable energy (chemical method). Turkish Standards Institute (TSE), Publication No,. 960: 1-3.

Bailey, J.S., L.C. Blackenship and N.A. Cox, 1991. Effect of fructooligosaccharides on Salmonella colonization of the chicken intestine. Poult. Sci., 70: 2433-2438.

Bozkurt, M., K. Küçükyilmaz, A.U. Çatli and M.Çinar, 2005a. Effect of dietary antibiotic, mannan oligosaccharide with or without oregano and hop supplementation on the growth performance and carcass characteristics male of broilers. In: Proceedings of 15th European Symposium on Poult. Nutr., pp: 285-287.

Bozkurt, M., K.Küçükyilmaz, A.U. Çatli and M. Çinar, 2005 b. The effect of dietary supplementation of prebiotic, probiotic and organic acid, either alone or combined, on broiler performance and carcass characteristics. In: Proceedings of 15th European Symposium on Poult. Nutr., pp: 288-290.

Cervantes, H., 2006. Banning antibiotic growth promoters: Learning from the European experience. Poult. Int., 45: 14-15.

Ceylan, N., I. Çiftçi and Z. Ilhan, 2003. The effects of some alternative feed additives for antibiotic growth promoters on the performance and gut miclora of broiler chicks. Turkish J. Vet. and Anim. Sci., 27: 727-733.

Clementino dos Santos, E., A. Soares Teixeira, A. Gilberto Bertechini, R. Tadeu Fonseca de Freitas, P. Borges Rodregues, E. Souza Dias, D.M. Torres, A. Vierra Santos and R.A. Giacometi, 2002. Effects of growth beneficial additives on broiler carcass yield. Federal Agrotech. School of Inconfidentes and Federal University of Lavras, Minas Gerais, Brazil. In: Proceedings of Brazilian Soc. of Anim. Prod. (Sociedade Brasileria de Zootecnia), pp: 5.

Engberg, R.M., M.S. Hedemann, T.D. Leser and B.B. Jensen, 2000. Effect of zinc bacitracin and salinomycin on intestinal microflora and performance of broilers. Poult. Sci., 79: 1311-1319.

Eyssen, H. and P. DeSomer, 1963. The mode of action of antibiotics in stimulating growth of chicks. J. Exp. Med., 117: 127-137.

Feighner, S.D. and M.P. Dashkevicz, 1987. Subtherapeutic levels of antibiotics in poultry feeds and their effects on weight gain, feed efficiency and bacterial cholytaurine hydrolase activity. J. Appl. Enviorn. Microbio., 53 :331-336.

Ferket, P.R., 2004. Alternatives to antibiotics in poultry production: Responses, practical experience and recommendations. In: Proceedings of Alltech's 20th Annual Symposium. (Lyons TP and K.A. Jacques eds). pp: 57-67. Nottingham Univ. Press, Nottingham.

Fukata, T., K. Sasai, T. Miyamoto and E. Baba, 1998. Effect of Mixed Feed Containing Dextran on Salmonella Colonization in Chicks. J. Japon. Vet. Med. Assoc., 52: 125-128.

Funicane, M.C., K.A. Dawson, P. Spring and K.E. Newman, 1999. Effects of mannanoligosaccharide on composition of the gut microflora of turkey poults. Poult. Sci., 78: 77.

Gill, C., 1999. Herbs and plant extracts as growth enhancers. Feed Int., 20 : 20-23.

Gill, C., 2001. Safe and sustainable feed ingredients. Feed Int., 22: 40-45.

Harms, R.H., N. Ruiz and R.D. Miles, 1986. Influence of virginiamycin on broilers fed four levels of energy. Poult. Sci., 65: 1984-1986.

Hernandez, F., J. Madrid, V. Garcia, J. Orengo and M.D. Megias, 2004. Influence of two plant extracts on broiler performance, digestibility, and digestive organ size. Poult. Sci., 83: 169-174.

Hertrampf, J.W., 2001. Alternative antibacterial performance promoters. Poult. Int., 40: 50-52.

Hidaka, H., M. Hirayama and K. Yamada, 1991. Fructooligosaccharides enzymatic preparation and biofunctions. J. Carb. Chem., 10: 509-522.

Hooge, D.M., 2003a. Dietary Mannan Oligosaccharide improves broiler performance. World Poult., 19: 14-15.

Hooge, D.M., M.D. Sims, A.E. Sefton, A. Connoly and P.S. Spring, 2003b. Effect of dietary mannan oligosaccharide, with or without bacitracin or virginiamycin on live performance of broiler chickens at relatively high stocking density on new litter. J. Appl. Poult. Res., 12: 461-467.

Hooge, D.M., 2004. Meta-analysis of broiler chicken pen trials evaluating dietary mannan oligosaccharide, 1993-2003. Int. J. Poult. Sci., 3: 163-174.

Hooge, D.M., 2006. Dietary alternatives for improving live performance of antibiotic-free poultry. Zootecnica Int., March: 42-51.

Iji, P.A., A.A. Saki and D.R. Tivey, 2001.Intestinal structure and function of broiler chickens on diets supplemented with a mannan oligosaccharide. J. Sci. Food Agric., 81: 1186-1192.

Izat, A.L., M.A. Colberg, M.H. Reiber, J.T. Adams, J.T. Skinner, M.C. Cabel, H.L. Stilborn and P.L. Waldroup, 1990. Effects of different antibiotics on performance, processing charecreristics, and parts yield of broiler chickens. Poult. Sci., 69: 1787-1791.

Kocher, A., 2005. AGP alternatives-part IV. Poultry production without AGPs- Challenges and solutions. World Poult., 21: 32-33.

Kumprecht, I., P. Zobac, V. Siske, A.E. Sefton and P. Spring, 1997. Effect of dietary mannan oligosaccharide level on performance and nutrient utilization of broilers. Poult. Sci., 76: 132.

Küçükyilmaz, K., M. Bozkurt, A.U. Çatli and M. Çinar, 2005. Growth performance and carcass characteristics of broiler chickens fed with different level of dextranoligosaccharide supplemented diets. In: Proceedings of 3rd Nat.ional Anim. Nutri. Congress, pp: 48-52.

Langhout, P., 2000. New additives for broiler chickens. World Poult., 16: 22-27.

Leeson, S., 1984.Growth and carcass characteristics of chicken and turkey broilers fed flavomycin. Canadian J. Anim. Sci., 64: 971-976.

Mallik, B.K., N.P. Bangar and M. Ahmad, 2003. Effect of "MHF-Y" on Egg Production in Desi Egg Type Rhode White Chicken. In: Proceedings of Xth Annual Conference of IAAVR and National Symposium, P4, pp: 33.

Michard, J., 2008. Seeking new broiler growth promoters. Poult. Int., 47: 28-30.

Miles, R.D., D.M., Janky and R.H. Harms, 1984. Virginiamycin and broiler performance. Poult. Sci., 63: 1218-1221.

National Research Council (NRC), 1994. Nutrient Requirements of Poultry. 9th rev. ed. National Academy Press, Washington, DC.

Naumann, C. and R. Bassler, 1993. Chemical analyses of feedstuff. Method book III. 3rd ed. VDLUFA-Press, Darmstadt, Germany.

Newman, K., 1994. Mannan-oligosaccharides: Natural polymers with significant impact on the gastrointestinal microflora and the immune system. In: Proceedings of Alltech's 10th Annual Symposium. (Lyons T.P. and K.A. Jacques eds). pp: 167-174. Nottingham Univ. Press, Nottingham.

Nollet, L., 2005. AGP alternatives-part I. EU close to a future without antibiotic growth promoters. World Poult., 21: 14-15.

Ofek, I., D. Mirelman and N. Sharon, 1977. Adherence of *Escherichia coli* to human mucosal cells mediated by mannosa receptors. Nature, 265: 623-625.

Orban, J.I., J.A. Patterson, A.L. Sutton and G.N. Richards, 1997. Effect of thermal oligosaccharide caramel, dietary vitamin-mineral level and brooding temperature on growth and intestinal bacterial populations of broiler chickens. Poult. Sci., 76: 482-490.

Oyofo, B.A., J.R. DeLoach, D.E. Corrier, J.O. Norman, R.L. Ziprin and H.H. Molenhauer, 1989. Prevention of Salmonella typhimurium colonization of broilers with D-mannose. Poult. Sci., 68: 1357-1360.

Parks, C.W., J.L. Grimes, P.R. Ferket and A.S. Fairchild, 2001. The effect of mannanoligosaccaharides, bambermycins and virginiamycin on performance of large white male market turkeys, Poult. Sci., 80: 718-723.

Rosen, G.D., 1996. Pronutrient antibiotic replacement standarts discussed. Feedstuffs, 75: 11-13.

Sarica, S., A. Ciftci, E. Demir, K. Kilinc and Y. Yildirim, 2005. Use of an antibiotic growth promoter and two herbal natural feed additives with and without exogenous enzymes in wheat based broiler diets. S. Afr. J. Anim. Sci., 35: 61-72.

SAS Institute, 1991. SAS® User's Guide: Statistics. Version 6.03 edition. SAS Institute Inc., Cary, North Caroline.

Savage, T.F., P.F. Cotter and E.I. Zakrzewska, 1996. The effect of feeding a mannan oligosaccharide on immunoglobulin plasma IgA and bile IgA of Wrolstad MW male turkeys. Poult. Sci., 73: 310.

Savage, T.F., E.I. Zakrzewska and J.R. Andreasen, 1997. The effect of feeding mannan oligosaccharide supplemented diets to poults on performance and the morphology of the small intestine. Poult. Sci., 76: 139.

Shafey, T.M., S. Al-Mufarej, M.I. Shalaby and A.J. Jarlenabi, 2001. The effect of feeding mannan-oligosaccharides (Bio-Mos) on the performance of meat chickens under two different vaccination programs. Asian-Austr. J. Anim. Sci., 14: 559-563.

Shane, M.S., 2001. Mannan oligosaccharides in poultry nutrition: mechanism and benefits. In: Proceedings of Alltech's 17th Annual Symposium. (Lyons T.P. and K.A. Jacques eds). pp: 65-77. Nottingham Univ. Press, Nottingham.

Shane, S., 2005. Antibiotic alternatives in turkey production. World Poult., 19: 14-15.

Shashidhara, R.G. and G. Dewegowda, 2003. Effect of dietary mannan oligosaccharide on broiler breeder production traits and Immunity. Poult. Sci., 82: 1319-1325.

Sims, M.D. and A.E. Sefton, 1999. Comparative effects of mannan oligosaccharide and an antibiotic growth promoter on performance of commercial broilers. In: Proceedings of the 50th North Central Avivan Disease Conference.

Sinovec, Z., R. Markovic and D. Gledic., 2005. Influence of Bio-Mos on broiler performances and gut morphology. In: Proceedings of 15th European Symposium on Poult. Nutr., pp: 339-341.

Spring, P., 1999. Modes of action of dietary mannan oligosaccharide as a growth enhancer. Zootecnica Int., 22: 34-36.

Spring, P., C. Wenk, K.A. Dawson and K.E. Newman, 2001. The effects of dietary mannanoligosaccharides on cecal paremetres and the concentrations of enteric bacteria in the ceca of Salmonella-challenged broiler chicks. Poult. Sci., 79: 205-211.

Tellez, G., 1997. Effect of dietary Meito Healthy Friend® on cecal morphology, cecal pH, *Escherichia coli* and Salmonella enteritidis organ invasion in broiler chicks (Research report). Avian Med. Depart. Of the College of Vet. Med. National Autonomus Univ. of Mexico, Mexico city.

Truscott, R.B. and F. Al-Sheikhly, 1977. The production and treatment necrotic enteritis in broilers. Am. J. Vet. Res., 38: 857-861.

Visek, W.J., 1978. The mode of growth promotion by antibiotics. J. Anim. Sci., 46: 1447-1469.

Waldroup, P.W., O. Edgar, Oviedo-Rondon and C.A. Fritts, 2003a. Comparison of Bio-Mos® and antibiotic feeding program in broiler diets containing copper sulphate. Int. J. Poult. Sci, 2: 28-31.

Waldroup, P.W., C.A. Fritts and Fenglan Yan, 2003b. Utilization of Bio-Mos® mannan oligosaccharide and Bioplex® copper in broiler diets. Int. J. Poult. Sci., 2: 44-52.