Asian-Aust. J. Anim. Sci.
Vol. 22, No. 4 : 550 - 556
April 2009

www.ajas.info

Effects of Mannan-oligosaccharides and Live Yeast in Diets on the Carcass, Cut Yields, Meat Composition and Colour of Finishing Turkeys

Yusuf Konca*, Figen Kirkpinar[2] and Selim Mert[2]

Ege University, Ödemiş Vocational School, Department of Animal Science, İzmir, Turkey

ABSTRACT : This study was designed to evaluate the effects of dietary prebiotic (mannan oligosaccharide = MOS) and probiotic (*Saccharomyces cerevisiae* = SC) in finishing turkey diets on carcass, cut yield, meat composition and colour. A total of 72 ten-weeks-old Big6 male turkey poults were used in the trial. There were eight replicate floor pens per floor with three birds in each. The experiment lasted up to 20 wks of age. The trial was set up as a completely randomized design with 3 dietary treatments. The treatments were: i) negative control (C, no additive); ii) MOS 1 g per kg of diet and iii) SC 1 g per kg of diet (strain SC47, 300×10^{10} CFU/kg). Body weight (BW) and feed intake were determined for each of the two week intervals. Twenty-four birds were slaughtered and eviscerated to determine carcass, carcass parts and internal organ weights at 20 wks of age. Meat colour and pH levels were measured 24 h after slaughter. The dietary treatments did not affect BW and average daily gain during the trial ($p>0.05$). The average daily feed intake and feed conversion ratio of turkey toms fed with MOS were higher than those of control and SC groups during the overall period ($p<0.05$). The dietary treatments did not affect carcass yield, breast meat, thigh, wing, liver, heart, empty gizzard, intestine, and abdominal fat pad proportions and meat pH, composition and pigmentation ($p>0.05$). These results suggest that the addition of MOS and SC is not likely to produce any performance or carcass characteristics in finishing turkeys at 10 to 20 wks of age. (**Key Words :** Mannan Oligosaccharide, Live Yeast, Turkey, Carcass, Meat Composition)

INTRODUCTION

The ban against using antibiotics as feed additives in poultry diets of many countries has led to an increase in research regarding alternative feed additives, including prebiotics such as mannan oligosaccharide (MOS) and probiotics like *Saccharomyces cerevisiae* (SC). MOS is derived from mannans on yeast cell surfaces. The benefits of MOS are based on specific properties, including modification of the intestinal micro-flora, reduction in turnover rate of the intestinal mucosa, and modulation of the immune system in the intestinal lumen. These properties have the potential to enhance growth rate, feed efficiency, and livability in poultry species (Parks et al., 2001). Probiotics, such as *Saccharomyces cerevisiae*, are defined as non-digestible ingredients, and they have several modes of action: beneficial changes in gut flora with reductions in the population of pathogenic bacteria, lactate production with subsequent changes in intestinal pH, production of antibiotic-type substances, production of enzymes, competition for adhesion receptors in the intestine, competition for nutrients, reduction of toxin release, and immuno-stimulation (Montes and Pugh, 1993; Leeson and Summers, 1997; Sohn et al., 2000; Han et al., 2007; Yin et al., 2008).

There are many reports concerning the effects of using prebiotics (Fairchild et al., 2001; Parks et al., 2001; Sims et al., 2004; Deng et al., 2008) and probiotics (Midilli and Tuncer, 2001; Zhang et al., 2005) on the performance of poultry. However, there are many questions and inconsistencies about the use of such additives in relation to meat quality. Some authors have determined that feeding poultry both prebiotics and probiotics has been advantageous in the improvement of carcass and meat quality in bronze turkeys from 49 to 147 d of age (Cömert, 2004), as well as in broilers during the overall period (Zhang et al., 2005; Brzóska et al., 2007). However, others have not obtained any positive results regarding carcass traits in turkeys from 0 to 126 d of age (Blair et al., 2004) or broilers from 0 to 42 d of age (Ceylan et al., 2003; Waldroup et al., 2003; Pelicano et al., 2005). Carcass colour

* Corresponding Author: Y. Konca. Tel: +90-232-5453272, Fax: +90-232-5444356, E-mail: yusuf.konca@ege.edu.tr

[2] Faculty of Agriculture, Department of Animal Science, İzmir-Turkey.

Received June 20, 2008; Accepted October 9, 2008

Table 1. Composition of experimental diets[1]

Ingredients (kg)	Age (week)		
	10 to12	12 to 16	16 to 20
Yellow maize	460.00	500.00	550.00
Wheat	148.30	186.37	199.54
Soybean meal	345.07	264.12	198.31
Vegetable oil	12.39	18.55	25.35
Limestone	11.56	13.05	11.66
Monocalcium phosphate	14.63	10.82	8.76
Anticoccidial	1.00	1.00	1.00
Methionine	0.62	0.50	-
Lysine	1.43	0.59	0.38
Sodium chloride	2.50	2.50	2.50
Premix[2]	2.50	2.50	2.50
Chemical analysis*			
Dry matter (%)	89.23	89.48	90.54
Crude protein (%)	21.32	18.33	15.91
Crude fiber (%)	3.39	3.08	2.78
Crude ash (%)	5.50	4.92	4.27
ME (kcal/kg)	2,915.0	3,032.3	3,146.5
Lysine (%)	1.12	0.92	0.76
Methionine (%)	0.38	0.33	0.26
Calcium (%)	0.89	0.81	0.72
Available phosphorus (%)	0.40	0.34	0.29

[1] Rations of the experiment was consisted of periodical contained without and with 1 g/kg mannan oligosaccharide (MOS) and live yeast (Biosaf, *Saccharomyces cerevisiae,* SC).

[2] Supplied per kg of the feed: Vitamin A, 15,000 I.U; Vitamin D_3, 2,000 IU; Vitamin E, 40.0 mg; Vitamin K, 5.0 mg; Vitamin B_1 (thiamin), 3.0 mg; Vitamin B_2 (riboflavin) 6.0 mg; Vitamin B_6, 5.0 mg; Vitamin B_{12}, 0.03 mg; Niacin, 30.0 mg; Biotin, 0.1 mg; Calcium D-pantothenate, 12 mg; Folic acid, 1.0 mg; Colin chloride, 400 mg; Manganese, 80.0 mg; Iron, 35.0 mg; Zinc, 50.0 mg; Copper, 5.0 mg; Iodine, 2.0 mg; Cobalt, 0.4 mg; Selenium, 0.15 mg.

* The ME, lysine, methionine, Ca and available P contents of feeds were calculated according to NRC (1994).

is an important component of quality, which affects consumer selection and acceptability of foods (Karaoğlu and Durdağ, 2005); likewise, meat composition is considered for the processing of different products (Aksu et al., 2005). Breast muscle contains the greatest portion of edible meat in turkeys, depending upon market conditions, and is generally the most valuable part of the carcass. However, abdominal and visceral fat are waste products to the poultry processor. The yield of cut-parts changes as a bird grows and is of considerable importance in deciding the optimal weight for slaughter, estimating accurate nutrient requirements, and evaluating nutritional effects (Gous et al., 1999). On the other hand, we are unaware of any literature that concerns the effects of dietary MOS and SC supplementation on carcass colour and meat composition in turkeys. The magnitude of carcass and meat traits that promote the effects of MOS and SC, and the mechanism responsible for these effects, are difficult to assess because of the lack of relevant literature. Therefore, how dietary MOS and SC supplementations influence carcass and meat quality characteristics should be clarified. The aim of this study was to determine the effects of dietary MOS and SC supplementation on the carcass, cut yields, meat colour, and composition in finishing turkey toms.

MATERIALS AND METHODS

Animals and diets

A total of 72 ten-weeks-old Big6 male turkey poults were used in the trial. The turkey chicks were obtained from a local hatchery and they had been reared to 10 wks of age without any treatment. The birds were fed diets with a nutrient composition based on recommendations from NRC (1994) relevant to poultry aged from 0 to 10 wks. The birds were weighed individually, ranked for minimal differences, and allocated into three groups in week 10. There were three treatment groups, including 8 replicates per treatment with 3 birds in each. The treatments were: i) basal diet (negative control = C, no additive); ii) basal diet supplemented with mannan oligosaccharide (Bio-Mos: Alltech Inc., Finland) at 1 g per kg of diet; iii) basal diet supplemented with *Saccharomyces cerevisiae* (Kavimix Biosaf®, each kg of premix contained 300×10^{10} CFU strain SC47, Kartal Kimya, İstanbul-Turkey) at 1 g per kg of diet. Basal feed nutrient contents were formulated according to age intervals (10 to 12; 12 to 16; 16 to 20 wks) (NRC, 1994). Feed and water were provided *ad libitum*. The ingredients and composition of the diets are shown in Table 1.

The birds were housed in wire-separated pens (2 birds/m^2) with floors which were covered with dry wood shavings. The lighting schedule was 16 L:8 D (darkness from 10:30 pm to 06:30 am). The tests lasted from 10 wks to 20 wks, from July to September. The room temperature (°C) averages were recorded as 28.1±0.6, 31.2±0.3 and 31.6±0.3, with humidity levels of 50.8±1.22, 38.2±0.9 and 36.59±0.7 at 08:00, 14:30, and 19:00 h, respectively.

Measurements

Individual body weight (BW) was measured at wks 10, 12, 14, 16, 18 and 20. Feed intake was measured in each pen on the same days and corrected for mortality. Average daily weight gain (ADG) and average daily feed intake (DFI) from 10 to 20 wks was calculated for each chick. The feed conversion ratio (FCR) was calculated as the ratio between DFI to ADG of all birds in each pen.

At the end of the experiment, two birds from each pen were humanely slaughtered by cervical dislocation. Their feathers were plucked mechanically, and they were eviscerated by hand. The weights of the whole carcass,

Table 2. Effect of mannan oligosaccharide and *Saccharomyces cerevisiae* on body weight (BW), average daily weight gain (ADG), daily feed intake (DFI) and feed conversion ratio (FCR)

Item	Age (week)	Dietary treatment			SEM	Probability
		Control	MOS	SC		
BW (kg)	10	7.00	7.12	7.04	0.11	NS
	20	15.67	16.02	15.77	0.23	NS
ADG (g/day/bird)	10 to 20	155.0	159.7	156.7	2.74	NS
DFI (g/day/bird)	10 to 20	427.2 [b]	471.8[a]	435.4[b]	9.20	**
FCR (feed/gain)	10 to 20	3.03[b]	3.21[a]	2.96[b]	0.10	*

MOS = Mannan oligosaccharide; SC = *Saccharomyces cerevisae*; SEM = Standard error of means.
[a, b] Means in row with no common superscript differ significantly (* $p<0.05$; ** $p<0.01$); NS = Non significant ($p>0.05$).

breast meat, thighs, wings, liver, heart, empty gizzard, intestines, and abdominal fat pad were recorded individually. The left breast meat, containing only pectoralis muscles, and thigh portions were separated from the carcass and weighed. Individual part yields were reorded as part weight: carcass weight ratio. The cold carcass weight was recorded after the carcasses were kept at +4°C for 18 h.

The color of the breasts and thighs were measured 24 h after slaughter using a Minolta colorimeter (CM508d) in order to determine CIE Lab values (L* measures relative lightness, a* relative redness and b* relative yellowness). The pH value of the sample was determined 24 h after slaughter with a pH meter (Hanna Instruments-8413) and measured by direct probe thrust into the breast and thigh meat.

Eight breast and thigh samples from each group (a total of 48 samples) were collected in plastic trays, weighed, and stored in air tight plastic bags in a freezer until they were required for analysis. They were then homogenized using a blender and analyzed for dry matter, nitrogen, ether extract, and crude ash. The dry matter contents of feed, breast, and thigh samples were determined by oven-drying at 105°C for 18 h. The ether extract content of breast and thigh samples was obtained by the Soxhlet extraction method, using anhydrous diethyl ether. The Kjeldahl method was used for the analysis of the total nitrogen content of feed, breast, and thigh samples, and crude protein was expressed as nitrogen×6.25 (AOAC, 1980). The crude ash content was determined after heating the samples in a muffle furnace at 550°C for 16 h. The crude fibre content of the feed was determined using 12.5% H_2SO_4 and 12.5% NaOH solutions (Nauman and Bassler, 1993).

Statistical analysis

The current data were analyzed using the General Linear Models (GLM) procedure of the Statistical Analysis System (SAS, 1996). The models included control, MOS and SC. Means were separated using Duncan's multiple range tests. The results of statistical analyses were expressed as mean values and standard error of the means (SEM).

RESULTS AND DISCUSSION

Performance traits

The results presented in Table 2 show the effects of dietary treatments on BW, average ADG, DFI, and FCR of turkey toms. The dietary MOS and SC supplementation did not affect BW and ADG during the trial ($p>0.05$). From similar research, Cömert (2004) reported that BW and ADG were not significantly affected by the addition of dietary MOS and probiotic (*Enterococcus faecium*) in bronze turkeys from 7 to 21 wks of age. Also, it was reported that dietary MOS (Shafey et al., 2001; Waldroup et al., 2003; Batista et al., 2007; Yalçınkaya et al., 2008) and probiotic (Denli et al., 2003; Gunal et al., 2006; Batista et al., 2007) supplementation did not affect BW in broilers or turkeys (Bradley and Savage, 1995). Contrary to other findings on BW and BWG, some studies have shown that dietary MOS supplementation in turkeys actually caused an improvement (Fairchild et al., 2001; Parks et al., 2001; Sims et al., 2004).

DFI and FCR in the MOS group were higher than those of the control and SC groups ($p<0.05$), but DFI and FCR in the SC groups were similar to the control group. Significantly higher DFI in the MOS group may be a result of the changing status of the digestive system. For example, the intestinal bacterial flora of domestic animals has an important role in the digestion and absorption of feed. There is substantial evidence that dietary MOS modifies the morphology and structure of the intestinal mucosa and may change digestive enzyme activities and amino acid transport in the digestive system (Iji et al., 2001). Juśkiewicz et al. (2006) reported that dietary MOS changed caecal metabolism more markedly at early ages. These researchers also reported some positive effects of adding MOS to the diet, such as lowering ammonia concentration and decreasing β-glucuronidase activity in the caeca, as well as some negative effects, including decreased bacterial glycolytic activity and raised pH of digesta. However, lower pH of digesta is probably responsible for the proliferation of beneficial species of bacteria and the depression of pathogenic species in the lower gut of animals (Zentek et al., 2002). Hence dietary MOS supplementation might be harmful in part to disjoin of gastrointestinal system. On the

Table 3. Effects of mannan oligosaccharide and *Saccharomyces cerevisiae* on carcass parts and gastrointestinal tracts

Item	Dietary treatment			SEM	Probability
	Control	MOS	SC		
Slaughter weight (kg)	15.80	15.48	15.42	0.36	NS
Carcass yield (%)	82.72	81.40	80.93	7.72	NS
Breast meat (%)	11.71	11.27	11.35	0.33	NS
Thigh (%)	11.60	11.64	11.75	0.19	NS
Wing (%)	4.68	4.79	4.86	0.12	NS
Liver (%)	1.04	1.13	1.04	0.06	NS
Heart (%)	1.13	1.04	1.04	0.01	NS
Empy gizzard (%)	1.02	1.05	1.05	0.04	NS
Empty intestine (%)	1.84	1.96	1.95	0.09	NS
Abdominal fat pad (%)	0.53	0.47	0.55	0.09	NS

MOS = Mannan oligosaccharide; SC = *Saccharomyces cerevisae*; SEM = Standard error of means; NS = Non significant (p>0.05).

other hand, Iji et al. (2001) found that dietary MOS supplementation (1 g/kg) led to increased cumulative feed intake and FCR compared to the control group, but differences were not significant in broilers at 7 to 28 days of age. Contrary to our results, it was reported that feed intake was not significantly affected by dietary MOS and probiotic addition in bronze turkeys from 7 to 21 wks of age (Cömert, 2004), and young turkeys from 0 to 8 wks of age (Zduńczyk et al., 2004; Stanczuk et al., 2005), or broilers (Shafey et al., 2001; Sarica et al., 2005; Yalçınkaya et al., 2008).

Carcass and cut yields

Turkey carcasses have been marketed as cut-up carcass products such as breast, drumstick, and wing, instead of as a whole carcass. The effects of dietary treatments on carcass traits are presented in Table 3. Neither MOS nor SC had any significant effect on carcass and cut-part yields (breast, thigh, wing), liver, heart, gizzard, intestinal system or abdominal fat (p>0.05). In this experiment, turkeys were fed a diet supplemented with MOS and SC at the level (1 g per kg of diet) recommended by the companies. Also, the recommended level of MOS in a diet for turkeys was estimated at 0.5-1.0 g/kg to 6 wks then 0.5 g/kg, according to Alltech Inc., Finland). On the other hand, Juśkiewicz et al. (2006) found that the addition of mannan-oligosaccharide to a diet was the most effective when MOS was applied for a long-term feeding period (16 weeks of feeding) and at a higher dose than 0.1%. Therefore, the level of MOS and SC generally recommended by the companies could be too low to be efficient in finishing turkey diets.

Our results concerning MOS are in agreement with Waldroup et al. (2003) and Blair et al. (2004), who reported that MOS and probiotic supplementation did not affect carcass and part yields, as well as abdominal fat in turkeys and broilers (Pelicano et al., 2005). Similarly, probiotic supplementation to broiler diets had no significant effect on carcass traits in broilers (Loddi et al., 2000; Pelicano et al., 2003; Alçiçek et al., 2004; Karaoğlu and Durdağ, 2005; An et al., 2008). Similar results indicated that MOS and probiotics may be effective in providing lean meat by decreasing abdominal fat (Santoso et al., 1995; Kalavathy et al., 2003; Samarasinghe et al., 2003; Pelícia et al., 2004; Kannan et al., 2005). In this study, however, dietary MOS and SC supplementation had no significant effect on the abdominal fat pad (p>0.05). Similarly, previous studies have reported that the abdominal fat pad was not significantly influenced by dietary supplemental prebiotics and probiotics in turkeys (Waldroup et al., 2003; Blair et al., 2004; Cömert et al., 2004) and broilers (Denli et al., 2003; Pelicano et al., 2003; Karaoğlu and Durdağ 2005; Pelicano et al., 2005). In contrast to others, Shafey et al. (2001) and Brzóska et al. (2007) reported that MOS and probiotic supplementation increased the abdominal fat pad in broilers.

Internal organ traits

The results of this study showed that MOS and SC supplementation did not affect empty gizzard and intestinal weights of birds (Table 3, p>0.05). Our results concerning intestinal weight are consistent with Denli et al. (2003), who reported that mixed probiotic supplementation did not affect intestinal traits. Also, it was previously reported that dietary MOS and probiotic (lactobacillus) had no effect on gizzard weights of broilers (Karaoğlu and Durdağ, 2005; Brzóska et al., 2007; Owens and McCracken, 2007). In the current study, internal organ weights and proportions, as percentages of carcass weight, were not influenced by dietary MOS and SC. These results confirmed those of Karaoğlu and Durdağ (2005), Denli et al. (2003), Pelicano et al. (2004) and Loddi et al. (2000). In contrast, Yang et al. (2007) reported that dietary MOS supplementation decreased intestine and liver weight in broilers.

Meat pigmentation

Color variation is an important component of quality which affects consumer selection and acceptability of foods. In the current study, average breast and thigh colour were not influenced by dietary MOS and SC supplementation (Table 4, p>0.05). These results are in agreement with some

Table 4. Effects of mannan oligosaccharide and *Saccharomyces cerevisiae* on breast meat colour

Parameters	Dietary treatment			SEM	Probability
	Control	MOS	SC		
L*	48.84	49.91	49.15	0.77	NS
a*	4.31	4.06	4.77	0.74	NS
b*	13.15	13.40	13.52	0.51	NS

L*: lightness, a*: redness, b*: yellowness.
MOS = Mannan oligosaccharide; SC = *Saccharomyces cerevisae*; SEM = Standard error of means; NS = Non significant (p>0.05).

Table 5. The effects of mannan oligosaccharide and *Saccharomyces cerevisiae* on breast and thigh meat composition and pH levels

Item	Dietary treatment			SEM	Probability
	Control	MOS	SC		
Breast meat					
Dry matter (%)	26.97	27.87	26.52	0.54	NS
Crude ash (%)	1.12	1.15	1.16	0.03	NS
Crude protein (%)	24.46	24.74	23.46	0.63	NS
Ether extract (%)	1.53	1.53	1.63	0.22	NS
pH	5.73	5.80	5.69	0.06	NS
Thigh meat					
Dry matter (%)	25.69	26.37	26.10	0.48	NS
Crude ash (%)	1.06	1.06	1.09	0.02	NS
Crude protein (%)	22.81	23.62	23.29	0.57	NS
Ether extract (%)	1.82	1.69	1.73	0.41	NS
pH	5.90	5.92	5.86	0.08	NS

MOS = Mannan oligosaccharide; SC = *Saccharomyces cerevisae*; SEM = Standard error of means; NS = Non significant (p>0.05).

previous studies which investigated the same effect in broilers (Loddi et al., 2000; Pelicano et al., 2003; Karaoğlu et al., 2004; Pelicano et al., 2005). However, Karaoğlu et al. (2004) revealed that dietary SC supplementation decreased L* and a* values but increased b* values in broilers. Similarly Pelicano et al. (2003), in the latter of two experiments, showed that dietary probiotic addition increased L* value but did not influence a* and b* values.

Meat composition

In the present study, the dietary treatments did not affect dry matter, crude protein, ether extract, crude ash, or pH of breast and thigh meats of turkey toms (Table 5, p>0.05). We could not locate any literature concerning the effects of dietary MOS and probiotics supplementation on meat composition in turkeys and broilers; therefore, this subject should be considered in new investigations. These results are in agreement with Brzóska et al. (2007), who reported that MOS and probiotic supplementation did not affect dry matter, crude protein, or ether extract in chickens. Also, previous studies have shown that MOS and probiotic supplementation did not affect pH of meat in broilers (Loddi et al., 2000; Pelicano et al., 2003; Pelicanao et al., 2005) and turkeys (Cömert, 2004). Contrary to these findings, there are inconsistencies among the published results. It is reported that dietary probiotic supplementation can cause an increase in pH levels of breast and drumstick meat (Karaoğlu et al., 2004; Aksu et al., 2005), but also Brzóska et al. (2007) reported that dietary MOS and probiotic supplementation decreased pH levels of breast meat at 24 h in broilers.

In conclusion, dietary MOS and SC supplementation did not affect BW and BWG, but MOS supplementation increased DFI and FCR of turkey toms. Carcass and part weights and yields, meat colour and composition were not influenced by the dietary MOS and SC supplementation. There is a possibility that the level of MOS and SC generally recommended in finishing turkey diets by the companies could be too low to be effective on carcasses, cut yields and meat composition of turkeys. However, there is a lack of data concerning dietary MOS and SC in turkeys and their effect on carcass traits and composition. Therefore, further experiments need to be conducted in order to determine whether MOS and SC supplementation affects turkeys according to different circumstances.

REFERENCES

Aksu, M. I., M. Karaoğlu, N. Esenbuga, M. Kaya, M. Macit and H. W. Ockerman. 2005. Effect of a dietary probiotic on some quality characteristics of raw broiler drumsticks and breast meat. J. Muscle Foods. 16:306-317.

Alçiçek, A., M. Bozkurt and M. Çabuk. 2004. The effect of a mixture of herbal essential oils, an organic acid or a probiotic on broiler performance. S. Afr. J. Anim. Sci. 34:217-222.

An, B. K., B. L. Cho, S. J. You, H. D. Paik, H. I. Chang, S. W. Kim, C. W. Yun and C. W. Kang. 2008. Growth performance and antibody response of broiler chicks fed yeast derived β-glucan and single-strain probiotics. Asian-Aust. J. Anim. Sci. 21:1027-1032.

AOAC. 1980. Official methods of analysis. 13th edn. Association of Official Analytical Chemist. Washington, DC.

Batista, L. S., E. A. Garcia and A. B. G. Faitarone. 2007. Flavonoids and mannan oligosaccharides in broiler diets. Brazilian J. Poult. Sci. 9:33-37.

Blair, E. C., H. M. Allen, S. E. Brooks, J. D. Firman, D. H. Robbins, K. Nishimura and H. Ishimaru. 2004. Effects of Calsporin® on Turkey Performance, Carcass Yield and Nitrogen Reduction. Int. J. Poult. Sci. 3:75-79.

Bradley, G. L. and T. F. Savage. 1995. The effect of autoclaving a yeast culture of *Saccharomyces cerevisiae* on turkey poult performance and the retention of gross energy, and selected minerals. Anim. Feed Sci. Technol. 55:1-7.

Brzóska, F., S. Buluchevskij, K. Stecka and B. Śliwiński. 2007. The effects of lactic acid bacteria and manan oligosaccharide, with or without fumaric acid, on chicken performance, slaughter yield and digestive tract microflora. J. Anim. Feed Sci. 16:241-251.

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

Cömert, N. 2004. The effects of avilamycin, bio-moss, cylactin and yucca schidigera extract added to the corn-soybean meal based diets on fattening performance, slaughter results and some blood and intestinal parameters of male broiler turkey. Ankara University Graduate School Naturel and Applied Sciences Department of Animal Science, PhD Thesis, p. 57.

Deng, X., X. Li, P. Liu, S. Yuan, J. Zang, S. Li and X. Piao. 2008. Effect of chito-oligosaccharide supplementation on immunity in broiler chickens. Asian-Aust. J. Anim. Sci. 21:1651-1658.

Denli, M., F. Okan and K. Çelik. 2003. Effect of dietary probiotic, organic acid and antibiotic supplementation to diets on broiler performance and carcass yield. Pakistan J. Nutr. 2:89-91.

Fairchild, A. S., J. L. Grimes, F.T. Jones, M. J. Wineland, F. W. Edens and A. E. Sefton. 2001. Effects of hen age, bio-mos and flavomycin, on poult susceptibility to oral *Escherichia coli* challenge. Poult. Sci. 80:562-571.

Gous, R. M., E. T. Moran, Jr., H. R. Stilborn, G. D. Bradford and G. C. Emmans. 1999. Evaluation of the parameters needed to describe the overall growth, the chemical growth, and the growth of feathers and breast muscles of broilers. Poult. Sci. 78:812-821.

Gunal, M. G. Yayli, O. Kaya, N. Karahan and O. Sulak. 2006. The effects of antibiotic growth promoter, probiotic or organic acid supplementation on performance, intestinal microflora and tissue of broilers. Int. J. Poult. Sci. 5:149-155.

Han, K. N., I. K. Kwon, J. D. Lohakare, S. Heo and B. J. Chae 2007. Chito-oligosaccharides as an alternative to antimicrobials in improving performance, digestibility and microbial ecology of the gut in weanling pigs. Asian-Aust. J. Anim. Sci. 20:556-562.

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.

Juśkiewicz, J., Z. Zduńczyk and J. Jankowski. 2006. Growth performance and metabolic response of the gastrointestinal tract of turkeys to diets with different levels of mannan-oligosaccharide. W. Poult. Sci. J. 62:612-625.

Kalavathy, R., N. Abdullah, S. Jalaludin and Y. W. Ho. 2003. Effects of Lactobacillus cultures on growth performance, abdominal fat deposition, serum lipids and weight of organs of broiler chickens. Br. Poult. Sci. 44:139-144.

Kannan, M., R. Karunakaran, V. Balakrishnan and T. G. Prabhakar. 2005. Influence of prebiotics supplementation on lipid profile of broilers. Int. J. Poult. Sci. 4:994-997.

Karaoğlu, M., M. I. Aksu, N. Esenbuga, M. Kaya, M. Macit and H. Durdag. 2004. Effect of dietary probiotic on the pH and colour characteristics of carcasses, breast fillets and drumsticks of broilers. Anim. Sci. 78:253-259.

Karaoğlu, M. and H. Durdağ. 2005. The Influence of Dietary Probiotic (*Saccharomyces cerevisiae*) Supplementation and different slaughter age on the performance, slaughter and carcass properties of broilers. Int. J. Poult. Sci. 4:309-316.

Leeson, S. and J. D. Summers. 1997. Commercial poultry nutrition. 2nd ed., University Books, Guelph, Ontario.

Loddi, M. M., E. Gonzales, T. S. Takita, A. A. Mendes and R. O. Roca. 2000. Effect of the use of probiotic and antibiotic on the performance, yield and carcass quality of broilers. Brazilian J. Poult. Sci. 29:1124-1131.

Midilli, M. and S. D. Tuncer. 2001. The effects of enzyme and probiotic supplementation to diets on broiler performance. Turk. J. Vet. Anim. Sci. 25:895-903.

Montes, A. J. and D. G. Pugh. 1993. The use of probiotics in food - Animal practice. Vet. Med. 88:282-289.

Naumann, C. and R. Bassler. 1993. Methodenbuch, Band III. Die chemische untersuchung von futtermitteln. VDLUFA-Verlag, Darmstadt, Germany.

NRC (National Research Council). 1994. Nutrient requirements of poultry: 9th revised edn., National Academy Press. Washington, DC. pp. 62-68.

Owens, B. and K. J. McCracken. 2007. A comparison of the effects of different yeast products and antibiotic on broiler performance. Br. Poult. Sci. 48:49-54.

Parks, C. W., J. L. Grimes, P. R. Ferket and A. S. Fairchild. 2001. The effects of mannan oligosaccharide, bambermycin and virginiamycin on performance of large white male turkeys toms. Poult. Sci. 80:718-723.

Pelicano, E. R. L., P. A. Souza, H. B. A. Souza, A. Oba, E. A. Norkus, L. M. Kodawara and T. M. A. Lima. 2003. Effect of different probiotics on broiler carcass and meat quality. Brazilian J. Poult. Sci. 5:207-214.

Pelicano, E. R. L., P. A. Souza, H. B. A. Souza, F. R. Leonel, N. M. B. L. Zeola and M. M. Boiago. 2004. Productive traits of broiler chickens fed diets containing different growth promoters. Brazilian J. Poult. Sci. 6:177-182.

Pelicano, E. R. L., P. A Souza, H. B. A. Souza, A. Oba, M. M. Boiago, N. M. B. L. Zeola, A. M. Scatolini, V. A. Bertanha and T. M. A. Lima. 2005. Carcass and cut yields and meat qualitative traits of broilers fed diets containing probiotics and prebiotics. Brazilian J. Poult. Sci. 7:169-175.

Pelícia, K., A. A. Mendes, E. S. P. B. Saldanha, C. C. Pizzolante, S. E. Takahashi, J. Moreira, R. G. Garcia, R. R. Quinteiro, I. Clapaz and C. M. Komiyama. 2004. Use of prebiotics and probiotics of bacterial and yeast origin for freerange broiler chickens. Brazilian J. Poult. Sci. 6:163-169.

Samarasinghe, K., C. Wenk, K. F. S. T. Silva and J. M. D. M. Gunasekera. 2003. Turmeric (*Curcuma longa*) root powder and

mannanoligosaccharides as alternatives to antibiotics in broiler chicken diets. Asian-Aust. J. Anim. Sci. 16:1495-1500.

Santoso, U., K. Tanaka and S. Ohtani. 1995. Effect of dried Bacillus subtilis culture on growth, body composition and hepatic lipogenic enzyme activity in female broiler chicks. Br. J. Nutr. 74:523-529.

Sarica, S., S. Erdogan, A. Koc and Z. Erdogan. 2005. Addition of avilamycin, mannan oligosaccharide and organic acids mixture to corn-soybean meal based broiler diets. Indian J. Anim. Sci. 75:961-964.

SAS. 1996. SAS Institute., SAS User's Guide: Statistics. Cary, NC.

Shafey, T. M., S. Al-Mufarej, M. I. Shalaby and A. J. Jarelnabi. 2001. The effect of feeding mannan-oligosaccharides (biomos) on the performance of meat chickens under two different vaccination programs. Asian-Aust. J. Anim. Sci. 14(4):559-567.

Sims, M. D., K. A. Dawson, K. E. Newman, P. Spring and D. M. Hooge. 2004. Effects of dietary mannan oligosaccharide, bacitracin methylene disalicylate, or both on the live performance and intestinal microbiology of turkeys. Poult. Sci. 83:1148-1154.

Sohn, K. S., M. K. Kim, J. D. Kim and In K. Han. 2000. The role of immunostimulants in monogastric animal and fish-Review. Asian-Aust. J. Anim. Sci. 13:1178-1186.

Stanczuk, J., Z. Zduńczyk, J. Juśkiewicz and J. Jankowski. 2005. Indices of response of young turkeys to diets containing mannan oligosaccharide or inulin. Veterinar. Zootech. T. 31: 98-101.

Waldroup, P. W., C. A. Fritts and F. Yan. 2003. Utilization of biomos mannan oligosaccharide and Bioplex1 cooper in broiler diets. Int. J. Poult. Sci. 2:44-52.

Yalcinkaya, I., T. Gungor, M. Basalan and E. Erdem. 2008. Mannan oligosaccharides (MOS) from *Saccharomyces cerevisiae* in broilers: Effects on performance and blood biochemistry. Turk. J. Vet. Anim. Sci. 32:1-6.

Yang, Y., P. A. Iji and M. Choct. 2007. Effects of different dietary levels of mannanoligosaccharide on growth performance and gut development of broiler chickens. Asian-Aust. J. Anim. Sci. 20:1084-1091.

Yin, Y. L., Z. R. Tang, Z. H. Sun, Z. Q. Liu, T. J. Li, R. L. Huang, Z. Ruan, Z. Y. Deng, B. Gao, L. X. Chen, G. Y. Wu and S. W. Kim 2008. Effect of galacto-mannan-oligosaccharides or chitosan supplementation on cytoimmunity and humoral immunity in early-weaned piglets. Asian-Aust. J. Anim. Sci. 21:723-731.

Zduńczyk, Z., J. Juśkiewicz, J. Jankowski and A. Koncicki. 2004. Performance and caecal adaptation of turkeys to diets without or with antibiotic and with different levels of mannan-oligosaccharide. Arch. Anim. Nutr. 58:367-378.

Zhang, A. W., B. D. Lee, K. W. Lee, K. B. Song, G. H. An and C. H. Lee. 2005. Effects of graded levels of dietary *Saccharomyces cerevisiae* on growth performance and meat quality in broiler chickens. Asian-Aust. J. Anim. Sci. 18:699-703.