ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS

Volume LVIII 1 Number 2, 2010

SOME PARAMETERS OF MEAT AND BONE CHEMICAL CONTENT OF BROILERS FED DIETS CONTAINING *Lactobacillus species* BASED ON DRIED YOGURT

A. Abdulwahab, E. Horniaková

Received: November 12, 2009

Abstract

ABDULWAHAB, A., HORNIAKOVÁ, E.: *Some parameters of meat and bone chemical content of broilers fed diets containing Lactobacillus species based on dried yogurt.* Acta univ. agric. et silvic. Mendel. Brun., 2010, LVIII, No. 2, pp. 13–18

The effect of dried yogurt (Kashik) based on *Lactobacillus plantarum* and *Lactobacillus acidophilus* on broiler meat crude protein and fat content and tibial bone mineral composition was studied. The birds were fed diets including probiotics only during the first 21 days of age. The trial groups T1, T2 and T3 were supplied with 1, 3 and 5 % Yoghurt, respectively. The control group was fed with a commercial feed mixture. Breast muscules nutrition quality was not significantly affected ($P > 0.05$) with Kashik up to day 21. The highest difference was 0.25% (C and T3) in crude protein content and 0.15% in crude fat (C and T2). Also, leg muscles crude protein and fat percentages were not affected by probiotics up to day 21 of age. The values varied from 18.76 to 19.24% and from 5.77 to 6.54% respectively. However, significant differences ($P < 0.05$) in legs' muscles crude protein (19.05 and 19.92% in C and TI group) and fat contents (4.82 and 6.33%) were observed between the T1 and T3 group up to 40 days of age. No significant effects of probiotics were observed on breast muscles mineral content up to 21 days and 40 days of age. Leg muscles mineral contents were not affected with probiotics up to 21 days, whereas up to 40 days only leg muscles P and Mg content was affected (1.80 and 1.61 $g.kg^{-1}$ of P in C and T3 group and 0,42 and 0,44 $g.kg^{-1}$ in C and T1, in Mg, resp.). There were no significant effects of treatments on tibial bone Ca and Mg contents up to day 21. However, tibial bone P content was significantly affected. The addition of 3 and 5 percents of Kashik increased tibial bone P content significantly (98.5$g.kg^{-1}$ in T2, 97.0$g.kg^{-1}$ in T3) above the value of the control group (80.5$g.kg^{-1}$) up to 21 days of age. There were no significant differences between treatment groups and the control group in tibial bone P and Mg composition at day 40 of age. The values varied from 86.00 to 93.12% in C and T1 in P and 4.10 to 4.23$g.kg^{-1}$ in Mg content. Some significant differences were observed between the treatment group which was supplemented with 1% of Kashik and the control group in tibial bone Ca composition at day 40 of age (213.62 and 229.06$g.kg^{-1}$, resp.).

dried yogurt, protein, fat, muscles, and bone mineral composition, broilers

Probiotics are viable, defined microorganisms in sufficient numbers, which alter the microflora in a compartment of the host and exert beneficial health effects in this host (Schrezenmeir and Vrese, 2001). Using probiotic organisms in order to sustain appropriate homeostasis of the digestive tract and protect it against pathogenic microflora is a common practice in poultry production in some parts of the world (Verstegen and Williams, 2002). Mahmood *et al.* (2005) reported that the analysis of variance showed no significant difference in crude protein percentage of meat of broiler chicks between the control group and the treatment groups. The chemical analyses of breast meat indicated that moisture, protein, fat and ash percentages were not significantly influenced ($P > 0.05$) by feed addi-

tives supplementation in all the experimental diets (Abaza, *et al*., 2008). *Lactobacillus* bacteria did not adversely affect the breast chemical composition of the breast meat (Brzośka *et al*., 2007). The skeleton not only provides structural support for the bird but also is an important mineral source for metabolic needs. Bone tissue is complex and composed of inorganic substances such as Ca and P, which provide hardness and strength, and organic substances, which give elasticity to the bones (Mutus et al., 2006). These authors also reported, that there has been no well-established link between microbial probiotics and mineral absorption, on bone development. It was reported that probiotic yogurt containing strains of Lactobacillus casei, Lactobacillus reuteri, and Lactobacillus gasseri increased apparent calcium absorption (Ghanem et al., 2004). The aim of this study was to investigate the effects of dried yogurt (Kashik) containing *Lactobacillus plantarum*, *Lactobacillus acidophilus* on Chemical analyses of breast and legs and tibial bone characteristics in broilers.

This work was financially supported by the Grant Agency of the Slovak Ministry of Education and the Slovak Academy of Sciences (Project N. 1/0610/08).

MATERIALS AND METHODS

The experiment was conducted on 320 day-old broiler chicks of hybrid combination ROSS 308. They were randomly divided without sexing into four groups (C, T1, T2 and T3) with four replicates of twenty birds each and reared for 40 days (Table I). This experiment was conducted at the Zvolen Research Centre in Slovakia. Feed and water were offered *ad libitum*. During the first experimental period (1–21 days of age), the feed for group T1 contained 4.10^6 CFU.g^{-1}, the feed for the group T2 contained $1.2.10^7$ CFU.g^{-1} and for group T3 it contained 2.10^7 CFU.g^{-1} of *L. plantarum* and *L. acidophilus*, which represents 1%, 3%, and 5% Kashik of the total amount of diet respectively (Table I). The group C was considered as the control group (Table I). Kashik (dry Yogurt) is a Kurdish natural dairy product, naturally dried. Our sample contained an appropriate number of microorganisms and 56.0% of crude protein in dry matter.

In the experiment a 4-stages (periods) feeding program was used; first a pre-starter for the first week, second: a starter for the 2nd and 3rd week of age. During these stages treatment groups were supplied with probiotics (Table II). While during the grower (22–35 days of age), and the finisher (36–40 days of age) periods, all diets were not supplemented with probiotics (Table I and II). On 21 day of life, to study characteristics demanded to be performed at the end of the first phase of the experiment, sixteen birds three weeks old (4 from each group) were slaughtered, and the same number of birds were slaughtered at the end of the second experimental period. After having slaughtered the broiler chicken, breast and legs muscules without skin were submitted to a chemical analysis. After having mechanically discharged the bones from muscles and tendons, they were boiled, extracted (to remove fat and cartilage), burned and transferred to an analysis of minerals. The space was 1.95 m^2 per 20 birds (1.3 m × 1.5 m). All data from the experiments were subjected to a one-way ANOVA analysis (SPSS, 1997) and the Duncan Multiple Range test (Duncan, 1955) was used to study the differences between the mean values (X ±SE) of 16 chicks related to meat end bone of some chemical parameters. In addition, (a, b, c) indices with different superscripts within rows indicate significant differences ($P< 0.05$).

RESULTS AND DISCUSSION

Chemical analyses of breast and legs muscles

Breast

The results of chemical organic composition of breasts muscles as shown in Table III indicated that the probiotic increased the percentage of crude protein of breast muscles compared to the control group, but the differences were not significant ($P > 0.05$). The results of the crude fat percentage in the chemical breast composition showed a non-significant effect ($P > 0.05$) among the five groups at day 21 (Table III). This is in contrast with other findings (Mahmood *et al*., 2005). The insignificant effects of probiotics on the chemical composition of the breast muscles may be due to the short period of probiotic supplementation. Results of chemical breast meat analysis indicated that dry matter, crude protein, crude fat and ash percentages were not significantly influenced ($P > 0.05$) by probiotics (Table III and IV). There was no significant effect ($P > 0.05$) of ages for breast muscles chemical composition at day 21 and day 40. Similar results (except for crude protein %) were found by De Marchi *et al*. (2005). The average values of the breast meat crude fat content showed the significant highest value ($P < 0.05$) in group T3 compared with group T2, but the differences were insignificant as compared to the control group. This is in agreement with findings by Abaza, *et al*., 2008.

Legs

The leg muscles crude protein and crude fat and dry matter percents were higher than in the control group on day 21 of age, however the differences were not significant (Table III and V). May be the short period of probiotics supplementation during first 21 days of age was not enough to induce a significant effect on the chemical composition of the leg muscles. Furthermore, probiotic supplementation significantly affected the legs' muscles crude fat percentage in the treatment groups (Table III). The positive effect of feeding probiotic on the legs muscles crude protein percentage is in agreement with the findings of Kroliczewska *et al*., 2008. May be the effects

I: *Design of the experiment*

Treatments	Replications	Birds	Total
Control	4	20	80
T1 (4.10^6.g^{-1} *L. plantarum* and *L. acidophilus*)	4	20	80
T2 ($1.2.10^7$.g^{-1} *L. plantarum* and *L. acidophilus*)	4	20	80
T3 (2.10^7.g^{-1} *L. plantarum* and *L. acidophilus*)	4	20	80
Total (Birds)		320	

II: *Rations and calculated content of nutrients in pre-starter, starter, grower and finisher rations*

Components (%)		Pre-starter				Starter				Grower	Finisher
		C	T1	T2	T3	C	T1	T2	T3		
Corn		41.50	41.50	41.50	41.75	43.50	43.50	43.50	43.80	43.00	44.80
Soybean meal (46%)		33.50	32.50	30.50	28.50	31.00	30.00	28.00	26.00	30.00	26.00
Wheat		12.50	12.50	12.50	12.50	17.00	17.00	17.00	17.00	20.00	23.00
Fish meal		4.50	4.50	4.50	4.50	2.70	2.70	2.70	2.70	-	-
Rapseed oil		4.50	4.50	4.50	4.50	2.50	2.50	2.50	2.50	3.20	2.55
$CaCO_3$		0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	1.45	1.10
Monocalcium phosphate		1.20	1.20	1.20	1.20	1.10	1.10	1.10	1.10	1.00	1.00
Vitamin- mineral premix (BR1) 1.0 %		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-	-
Vitamin- mineral premix (BR2) 1.0 %		-	-	-	-	-	-	-	-	1.00	-
Vitamin- mineral premix (BR3) 1.0 %		-	-	-	-	-	-	-	-	-	1.00
Salt		0.25	0.25	0.25	-	0.30	0.30	0.30	-	0.30	0.33
Methionine 99%		0.15	0.15	0.15	0.15	-	-	-	-	0.05	0.12
Lysine78		-	-	-	-	-	-	-	-	-	0.10
Kashik %		-	1.00	3.00	5.00	-	1.00	3.00	5.00	-	-
Crude Protein	**g.kg^{-1}**	235.6	236.6	238.5	240.7	217.2	218.1	220.1	222.3	196.8	184.5
Metabolizable energy	**MJ.kg^{-1}**	13.0	13.0	13.1	13.1	12.6	12.6	12.6	12.7	12.6	12.6
Ash	**g.kg^{-1}**	63.5	64.4	66.2	65.5	58.6	59.5	61.3	60.2	57.3	52.2
Crude Fiber	**g.kg^{-1}**	27.0	26.6	25.8	25.0	27.4	27.0	26.2	25.4	27.5	26.9
L – lysine	**g.kg^{-1}**	15.0	15.1	15.5	15.8	13.4	13.6	13.9	14.3	12.1	10.1
Methionine + Cystine	**g.kg^{-1}**	11.7	11.7	11.8	11.9	9.7	9.7	9.8	9.9	9.4	9.4
Ca	**g.kg^{-1}**	10.2	10.2	10.3	10.4	9.1	9.2	9.2	9.3	7.7	7.9
Phosphorus	**g.kg^{-1}**	7.7	7.7	7.8	7.8	7.0	7.0	7.1	7.1	6.0	5.9
Na	**g.kg^{-1}**	1.7	2.3	3.2	3.4	1.7	2.2	3.2	3.0	1.3	1.4

III: *Chemical composition of breast and legs muscles*

Treatments	Breast		Legs	
	C. protein %	C. fat %	C. protein %	C. fat %
		in 21-day old broilers		
C	22.81 ± 0.463	1.40 ± 0.444	18.88 ± 0.223	5.96 ± 0.519
T1	22.40 ± 0.463	1.27 ± 0.157	18.76 ± 0.096	6.54 ± 0.401
T2	22.46 ± 0.135	1.55 ± 0.400	18.96 ± 0.080	6.04 ± 0.288
T3	23.06 ± 0.259	1.46 ± 0.202	19.24 ± 0.160	6.54 ± 0.304
		in 40-day old broilers		
C	22.32 ± 0.238	1.43 ± 0.235^{ab}	19.05 ± 0.243^{a}	6.03 ± 0.354^{ab}
T1	22.90 ± 0.200	1.30 ± 0.081^{ab}	19.92 ± 0.085^{b}	4.82 ± 0.542^{a}
T2	22.78 ± 0.146	1.08 ± 0.167^{a}	19.48 ± 0.341^{ab}	5.07 ± 0.456^{ab}
T3	22.71 ± 0.227	1.7 ± 0.148^{b}	19.55 ± 0.090^{ab}	6.33 ± 0.385^{b}

mean values (X ±SE of 16 chicks)
(a, b, c) means: different superscripts within rows are significantly different ($P < 0.05$).

of probiotics fed at the first period continued into the second period, in addition to the best quality of the Kashik crude protein and high levels of some essential amino acids (arginine and lysine). The lower crude fat percentage of the leg muscles of broilers was observed in group T1 and the highest percentage was in group T3 at day 40 (Table III) in real dry mather (Table V). That means that there were insignificant and variable effects of different levels (*Lactobacillus* sp.) on crude fat percentage.

Breast and legs muscles mineral content

Breast Ca and Mg contents were higher in treatment groups compared with the control group in both periods of age (Table IV), but the differences were not significant (P>0.05). This is in agreement with those of Ghanem et al., 2004. No significant differences were observed among all groups regarding P. During the second period there were significant differences among treatment groups (Table IV). There were significant effects from dietary treatments on the breast P content at day 42. Groups T1 and T3 had a higher P content compared to T2 (Table IV).

There were non-significant effects (P>0.05) from dietary treatments on the leg muscles Ca, P and Mg content on day 21 (Table V). This is in contrast to findings by Ghanem et al., 2004. In addition, no significant differences (P > 0.05) among all groups were observed at day 40 of age (Table V). However, the leg muscles P content was significantly higher (P < 0.05) in the control group compared with the group T3 (Table V) at day 40 of age. There were no significant differences (P > 0.05) between control and treatment groups except group T1 in leg muscles Mg content at day 40 of age (Table V).

Tibial bone mineral content in original dry matter

Probiotics significantly affected tibial bone P content and insignificantly Ca and Mg content of tibial bones at day 21 of age. However, probiotic supplementation had significant effects on groups T2 and T3 compared with the control group C at day 21 (Table VI). There were significant differences between T1 and C at day 40 regarding the Ca bone content. No significant differences were observed in tibial bone P and Mg content at day 40 of age (Table VI).

IV: *Effects of treatments on mineral composition of breast muscules at day 21 and day 40 of age*

Treatments	At day 21				At day 40			
	Dry Matter %	Ca	P	Mg	Dry Matter %	Ca	P	Mg
		g.kg^{-1}				g.kg^{-1}		
C	25.57±0.463	0.07±0.010	2.38±0.039	0.30±0.013	25.43±0.160	0.09±0.016	2.23±0.022^{ab}	0.24±0.005
T1	25.34±0.368	0.08±0.007	2.36±0.047	0.31±0.016	25.53±0.078	0.09±0.007	2.28±0.065^{b}	0.25±0.002
T2	25.65±0.344	0.07±0.015	2.34±0.010	0.31±0.012	25.38±0.102	0.10±0.008	2.11±0.035^{a}	0.25±0.005
T3	26.06±0.168	0.11±0.008	2.31±0.052	0.33±0.004	25.57±0.206	0.10±0.004	2.28±0.059^{b}	0.26±0.008

V: *Effects of treatments on mineral composition of legs muscules at day 21 and day 40 of age*

Treatments	At day 21				At day 40			
	Dry Matter %	Ca	P	Mg	Dry Matter %	Ca	P	Mg
		g.kg^{-1}				g.kg^{-1}		
C	26.06 ± 0.523	0.10 ± 0.013	1.96 ± 0.051	0.23 ± 0.017	26.38 ± 0.223^{ab}	0.13 ± 0.005	1.80 ± 0.035^{a}	0.42 ± 0.008^{a}
T1	26.55 ± 0.342	0.08 ± 0.004	1.95. ± 0.078	0.23 ± 0.005	25.99 ± 0.440^{a}	0.11 ± 0.007	1.73 ± 0.053^{ab}	0.44 ± 0.006^{b}
T2	26.17 ± 0.362	0.08 ± 0.007	2.02 ± 0.039	0.23 ± 0.001	26.03 ± 0.293^{a}	0.13 ± 0.010	1.71 ± 0.039^{ab}	0.43 ± 0.010^{ab}
T3	26.15 ± 0.245	0.09 ± 0.007	2.04 ± 0.076	0.23 ± 0.004	27.14 ± 0.312^{b}	0.12 ± 0.004	1.61 ± 0.047^{b}	0.43 ± 0.011^{ab}

VI: *Effects of treatments on mineral composition of tibial bone at day 21 and day 40 of age*

Treatments	At day 21				At day 40			
	Dry Matter %	Ca	P	Mg	Dry Matter %	Ca	P	Mg
		g.kg^{-1}				g.kg^{-1}		
C	95.54 ± 0.167^{b}	209.62 ± 13.264	80.50 ± 4.770^{a}	4.40 ± 0.117	94.91 ± 0.095	213.62 ± 4.196^{a}	86.00 ± 3.142	4.10 ± 0.119
T1	94.84 ± 0.185^{a}	211.05 ± 1.796	85.00 ± 5.212^{ab}	4.25 ± 0.160	94.88 ± 0.309	229.06 ± 5.877^{b}	93.12 ± 3.363	4.18 ± 0.083
T2	94.97 ± 0.064^{a}	224.84 ± 13.473	98.50 ± 3.862^{b}	4.45 ± 0.042	94.85 ± 0.083	218.70 ± 4.060^{ab}	88.13 ± 3.085	4.23 ± 0.073
T3	94.78 ± 0.138^{a}	212.80 ± 3.626	97.00 ± 5.730^{b}	4.25 ± 0.090	95.05 ± 0.168	227.25 ± 2.707^{ab}	87.75 ± 2.594	4.17 ± 0.037

SUMMARY

The goal of this study was to investigate the effects of dried yogurt (Kashik) containing *Lactobacillus plantarum*, *Lactobacillus acidophilus* on the nutrition quality of breast and legs meat and tibial bone characteristics in broilers. Experiments performed on 320 ROSS broilers kept until 40 days of age, showed the effect of *Lactobacillus plantarum* and *Lactobacillus acidophilus* on some parameters of meat quality and bone mineral composition. The birds were fed diets including probiotics only during the first 21 days of age. All data from the experiments were analyzed using a one-way ANOVA (SPSS, 1997) and the Duncan Multiple Range test (Duncan, 1955). They were used to study the differences between the mean values (X ±SE) of 16 chicks related to meat and bone organic and mineral parameters. In addition, the (a, b, c) indices with different superscripts indicate rows which are significantly different ($P < 0.05$).

Breast muscles nutrition quality was not significantly affected ($P > 0.05$) with Kashik on day 21, crude protein and fat percentages in the legs muscles were not affected by probiotics on day 21 of age. However, on day 40, crude protein and fat percentages of the legs muscles with significant differences were observed between the control group and the treatment groups. There were no significant effects ($P>0.05$) of probiotics on breast muscles mineral content at days 21 and 40 of age. Leg muscles' mineral content was not affected with probiotics at day 21, whereas at day 40 only leg muscles P and Mg content was affected. There were no significant effects of treatments on tibial bone Ca and Mg content at day 21. However tibial bone P content was significantly affected. The addition of 3 and 5 percents of Kashik increased tibial bone P content significantly above the control group values at day 21 of age. There were no significant differences between treatment groups and the control group in tibial bone P and Mg composition at day 40 of age. Significant differences in tibial bone Ca composition at day 40 of age were observed between the treatment group which was supplemented with 1% of Kashik and the control group.

SÚHRN

Niektoré ukazovatele obsahu chemických látok v mäse a kostiach brojlerov kŕmených dietou obsahujúcou *Lactobacillus species* zo sušeného jogurtu

Cieľom tejto štúdie bolo zistiť vplyv sušeného jogurtu (Kashik) obsahujúceho *Lactobacillus plantarum*, *Lactobacillus acidophilus* na nutričnú kvalitu prsného svalu, svalov nôh a minerálnu charakteristiku holennej kosti u brojlerov. Experimenty boli vykonané na 320 brojlerov typu ROSS chovaných do 40 dní veku. Brojlery sa kŕmili s rozdielnym podielom probiotického prídavku (1,3 a 5%) v pokusných skupinach len počas prvých 21 dní veku. Všetky výsledky z pokusov boli analyzované pomocou jednofaktorovej analýzy rozptylu ANOVA (SPSS, 1997) a Duncan testom pre zistenie (Duncan, 1955) štatisticky preukazných rozdielov medzi priemernými hodnotami. Hodnoty označené písmenami (a, b, c) v riadku sú štatisticky preukazne rozdielne ($P < 0,05$).

Chemické zloženie prsnej svaloviny nebolo ovplyvnené ($P > 0,05$) probiotikom Kashik v 21 dni veku na obsah dusíkatých látok a percentuálneho obsahu tuku. Vo veku 40 dni u brojlerových kurčiat, obsah dusíkatých látok a obsah celkového tuku vo svalovine nôh bol štatisticky prekazne rozdielny v experimentálnych skupinách v porovnaní s kontrolnou skupinou. Probiotikum nemalo vplyv na obsah minerálnych látok v prsnej svalovine v 21 dni ani v 40 dni veku brojlerových kurčiat. V 21 dni veku kurčiat, obsah minerálnych látok v svalovine nôh nebol ovplyvnený probiotikom, kým vo veku 40 dní bol zaznamenaný zvýšený obsah fosforu v skupine s 5% obsahom probiotika a horčíka v experimentálnej skupine s 1% obsahom probiotika. Probiotikum štatiskticky preukazne ovplyvnilo aj obsah fosforu v holennej kosti kurčiat, obsah vápnika a horčíka nebol ovplyvnený v 21 dni veku brojlerových kurčiat. Prídavok 3 a 5 % Kashik zvýšil obsah fosforu v holennej kosti analyzovanej v 21 dni veku. Taktiež boli zistené štatisticky nepreukazné zmeny medzi kontrolnou a pokusnými skupinami v obsahu fosforu a horčíka v 40 dni veku kurčiat. Avšak štatisticky preukazné zmeny v obsahu vápnika holennej kosti boli pozorované medzi pokusnou (prídavok 1% Kashik) a kontrolnou skupinou v 40 dni veku brojlerových kurčiat.

sušený jogurt, protein, tuk, minerálne zloženie kostí a svalstva, brojlerové kurčatá

REFERENCES

ABAZA, I. M., SHEHATA, M. A., SHOIEB, M. S. and HASSAN, I. I., 2008: Evaluation of some natural feed additives in growing chicks' diets. *International Journal of Poultry Science*, 7, 9: 872–879. ISSN 1682-8356.

BRZOŚKA, F., BULUCHEVSKIJ, S., STECKA, K. and ŚLIWIŃSKI, B., 2007: The effects of lactic acid bacteria and mannan oligosaccharides, with or without fumaric acid, on chicken performance, slaughter yield and digestive tract microflora. *Journal of Animal and Feed Sciences*, 16: 241–251. ISSN 1230-1388.

DE MARCHI, M., CASSANDRO, M., LUNARDI, E., BALDAN, G., SIEGEL, P. B., 2005: Carcass characteristics and qualitative meat traits of the padovana breed of chicken. *International Journal of Poultry Science*, 4, 4: 233–238. ISSN 1682-8356.

DUNCAN, D. B., 1955: The new multiple rank and F test, In: Biometrics, vol. 11, 1955, p. 1–42.

GHANEM, K. Z., BADAWY, I. H., ABDEL-SAMAM, A. M., 2004: Influence of yoghurt and probiotic yoghurt on the absorption of calcium, magnesium, iron and bone mineralization in rats. *Milchwissenschaft*, 59: 472–475. ISSN 0026-3788.

KROLICZEWSKA, B., SKIBA, W. Z. T., KOPEC, W. and KROLICZEWSKI, J., 2008: The influence of baical skullcap roots (*Scutellaria baicalensis radix*) in the diet of broiler chickens on the chemical composition of the muscles, selected performance traits of the animals and the sensory characteristics of the meat. *Veterinarni Medicina*, 53, 7: 373–380. ISSN 0375-8427.

MAHMOOD, TARIQ, ANJUM, M. S., HUSSAIN, I. and PERVEEN, R., 2005: Effect of probiotic and growth promoters on chemical composition of broiler carcass. *International Journal of Agriculture and Biology*, 7, 6: 1036–1037. ISSN 1560-8530.

MUTUS¸ R., KOCABAG, N., ALP, M., ACAR, N., EREN, M. and GEZEN, S., 2006: The effect of dietary probiotic supplementation on tibial bone characteristics and strength in broilers. Poultry Science, 85: 1621–1625, ISSN 0032-5791.

SCHREZENMEIR, J., VRESE, M., 2001: Probiotics, prebiotics, and synbiotics–approaching a definition. *American Journal of Clinical Nutrition*, 73, 2 Suppl: 361S–4S. ISSN 0002-9165.

SPSS. 1997: SPSS Advanced Statistics. SPSS, Inc., Chicago, IL. 1997.

VERSTEGEN, M. W. A. and WILLIAMS, B. A., 2002: Alternatives to the use of antibiotics as growth promoters for monogastric animals. *Animal Biotechnology*, 13: 113–127. ISSN 1532-2378.

Address

doc. Ing. Erika Horniaková, Ph.D., Katedra výživy zvierat, Slovenská poľnohospodárska univerzita v Nitre, Tr. A. Hlinku 2, 949 76, Nitra, Slovenská republika, e-mail: erika.horniakova@uniag.sk, MSc. Amjad Arshad Abdulwahab, Ph.D., Mantikawa 89, Erbil, Irak, amjedhawizy@yahoo.com