Ukrainian Journal of Ecology

Ukrainian Journal of Ecology, 2017, 7(1), 61–65, doi: 10.15421/201707

ORIGINAL ARTICLE *UDC 636.5:637.5:637.04*

Effect of probiotics on the chemical, mineral, and amino acid composition of broiler chicken meat

Ju.N. Podolian

Vinnytsia National Agrarian University
Email: Julia.p@i.ua
Submitted: 08.01.2017. Accepted: 21.03.2017

The experiment was conducted to examine the influence of probiotic preparation on the mineral contamination of the broiler chicken muscles. Investigational product contains probiotic lactic acid bacteria of genus Lactobacillus and Enterococcus. It is proved that additional feeding of probiotic "Entero-active" to broiler chickens increases retention of mineral elements of the fodder. To study the effect of probiotic on chicken meat the contamination of minerals in the experimental poultry meat was researched. The studies proved that the additional use of the studied probiotic supplements with food of broiler chickens allowed increasing phosphorus contamination by 4.7%, magnesium by 3.9% and iron by 46.5% in the pectoral muscles compared with the control group. The use of probiotic for broilers feeding has increased phosphorus by 4.7%, calcium by 4.1 times, iron by 70.5%, zinc by 5.4%, magnesium by 31.5% and copper in 4.2 times in thigh muscles of poultry. Thus, consumption of probiotic preparation by broilers in various doses improves the mineral compound of meat carcasses this meat is also considered as free range food. It was proved that probiotic increases the synthesis of such essential amino acids in the pectoral muscles as lysine by 1.66%, histidine by 0.03%, arginine by 0.38%, threonine by 0.07%, valine by 0.16%, methionine by 0.33%, leucine by 0.1% and phenylalanine by 0.17%. The increasing of level of lysine and histidine respectively by 0.05 and 0.08% is observed in the thigh muscles of broilers under the influence of probiotic. We have proved that the optimal dose for broiler chickens is 0.25% for the age of 1-10 days, 0.1% for the age of 11-28 days, 0.05 % for the age of 29-42 days, the percentage is for broiler chickens feed weight.
Key words: broiler chickens, probiotic, feeding, muscles, mineral elements.

It is known that probiotics form the intestine microbiocenosis, manufacture biologically active matters and creates unfavorable conditions for the development of pathogenic microflora, positively influence on forage nutrients digestibility, nitrogen balance and increases metabolism and decreases the forage consumption (Al-Ghazzewi et al., 2012; Ezema, 2012; Brzóska, 2012; Hryhoryev, 2011; Mookiah et al., 2014; Park et al., 2014; Podobed, 2011; Xiaolu et al., 2012). The scientific research and gained practical experience proved the efficiency of probiotics usage in poultry production. The percentage of digestive system diseases decreases, the survival and growth rates of poultry live weight increase if poultry is fed probiotics preparations. The ecological aspects of probiotics usage are also very important, because the products are free from antimicrobial agents (Alavi et al., 2012; Chudak et al., 2014; Gupa et al., 2013; Świątkiewicz, 2012; Fallah et al., 2013; Salim et al., 2013).

The research objective was to investigate the influence of probiotic supplement Entero-active on chemical and mineral contamination of broiler chicken meat.

Methods

The experiment was conducted at the research farm of Vinnytsia National Agrarian University. The four groups of broiler chickens of cross "Ross-308" were selected by the method of analog groups (Kononenko et al., 2000); each group had 50 heads. The research has lasted for 42 days. The researched poultry was kept at group cages of one circle; the hygiene requirements were met. The control group consumed the basic diet (BD) in the form of complete feed. The researched groups were additionally fed by different doses of probiotics supplement (Table 1).

In order to research the probiotic supplement effect on the chemical, mineral and amino acid effect meat composition of the researched poultry the control slaughter was done at the end of the experiment; we took four chicken from each group; their

pectoral and thigh muscles were researched according to the standard methods (Kozyr, 2002). The results of the average values were considered statistically significant at *P<0.05; **P < 0.01; ***P < 0.001 (Plokhinskiy, 1969).
The researched probiotic supplement Entero-active contains lactic acid bacteria of Lactobacillus bulgaricus – 2,0*10^{10} CCU / kg (colonies of conventional units / kg) and Enterococcus faecium – 2.0*10^{10} CCU / kg. The mechanism of action of probiotic Entero-active is the formation of the lactic and acetic acids; they are unfavorable pH environment for pathogenic and opportunistic pathogenic microorganisms, stimulate growth and biological activity of intestinal flora, it positively influences microbiota composition, besides probiotic microorganisms produce biologically active substances, enzymes and amino acids.

Table 1 Chart of experience

Group	Duration, days	Feeding traits Age, days		
		1 - 10	11 - 28	29 – 42
Control	42		OR (complete feed)	
Experimental II	42	OP+0.062% Entero-active	OP+0.025% Entero-active	OP+0.0125 % Entero-active
Experimental III	42	OP+0.125% Entero-active	OP+0.05% Entero-active	OP+0.025% Entero-active
Experimental IV	42	OP+0.25% Entero-active	OP+0.1% Entero-active	OP+0.05% Entero-active

The producer of Entero-active is BTU-Tsentr (Biotechnology of Ukraine; Ladyzhyn, Vinnytsia region); the recommended dose of probiotic as a part of poultry complete feed is 0.125% (1-10 days), 0.05% (11-28 days), 0.025% (29-42 days). We investigated minimum, average, and maximum dose of this supplement to find the optimal dose of probiotic Entero-active for feeding modern crosses of broiler chickens.

Results and discussions

The feeding by probiotics also influenced the nutrient contamination in pectoral and thigh muscles of broiler chickens (Table 2).

Table 2 The chemical composition of broiler chicken meat, % (M ± m, n = 4; air-dry matter)

Indicator	Group			
	Control	Experimental II	Experimental III	Experimental IV
		White meat		
Dry matter	92.4 ± 0.03	92.6 ± 0.02**	91.7 ± 0.10**	92.3 ± 0.01*
Protein	73.1 ± 0.87	73.5 ± 0.07	73.6 ± 0.21	73.3 ± 0.10
Fat	5.5 ± 0.04	6.7 ± 0.04***	5.8 ± 0.01***	5.6 ± 0.02
Ash	4.12 ± 0.03	4.21 ± 0.08	4.43 ± 0.03***	4.87±0.01***
		Red meat		
Dry matter	92.6 ± 0.01	92.6 ± 0.06	92.5 ± 0.02**	92.7 ± 0.02**
Protein	60.8 ± 0.30	55.4 ± 0.19***	58.8 ± 0.18**	58.9 ± 0.16**
Fat	22.1 ± 0.05	25.0 ± 0.05***	26.0 ± 0.05***	24.9 ± 0.07***
Ash	3.6 ± 0.02	4.0 ± 0.04***	3.4 ± 0.02***	3.6 ± 0.01

*, **, *** - see Methods for explanation

Broiler chickens dry matter contamination of the second poultry group white meat increases by 0.2% (P<0.01); the broiler chickens dry matter contamination of the fourth poultry group red meat increases by 0.1% (P<0.05) under the action of probiotics than in control group. However, the poultry of the third group has the lower level of dry matter in pectoral muscles by 0.7 % and in thigh muscles by 0.1% (P<0.01). Protein contamination in pectoral muscles don’t change considerably, but this thigh muscles indicator is lower for poultry of the second group by 5.4% (P<0.001), the third group by 2.0% and the fourth group by 1.9% than in control group.
The consumption of probiotic Entero-active facilitates the fat percentage in white and red poultry meat; it is 1.2 and 2.9% (P<0.001) for the second group, 0.3 and 3.9% (P<0.01) for the third group; the forth group has the increasing of fat percentage only in pectoral muscles by 2.8% (P<0.001) than in control group. The white meat of the forth group has the highest ash level, it is higher by 0.75% (P<0.001) than in control group; the red meat of the second group has the highest ash level; it is higher by 0.4% (P<0.001) than in control group; it is observed under the action of probiotic.
Minerals research in meat of researched poultry was conducted to investigate the influence of probiotic supplement on the broilers meat (Table 3). Additional usage of probiotics as a component of mixed fodder for broiler chickens facilitated the increasing of phosphorus contamination by 2.3% (P<0.05) for the third group and by 4.7% (P<0.001) for the fourth group than

in control group. The decreasing of calcium contamination was observed; it was lower by 19.6 (P<0.001), 12.2 (P<0.001) and 4.9% (P<0.01) in the second, third and fourth group.

Table 3 Contamination of minerals in broiler chicken pectoral muscles (M ± m, n=4; absolutely dry matter)

Element	Group			
	Control	Experimental II	Experimental III	Experimental IV
P, g/kg	12.6 ± 0.08	12.4 ± 0.08	12.9 ± 0.04*	13.2 ± 0.04***
Ca, g/kg	0.41 ± 0.003	0.33 ± 0.01***	0.36 ± 0.001***	0.39 ± 0.003**
Mg, g/kg	0.43±0.0002	0.44 ± 0.002***	0.43 ± 0.002	0.43 ± 0.001**
Fe, mg/ kg	379.10 ± 1.68	230.10 ± 1.74***	555.49 ± 6.90***	291.50 ± 3.56***
Zn, mg/ kg	29.30 ± 0.11	25.50 ±0 .09***	28.50 ± 0.06***	27.90 ±0.20**
Mn, mg/ kg	6.70 ± 0.86	4.50 ± 0.77	7.60 ± 0.31	4.30 ± 0.32*
Cu, mg/ kg	1.10 ± 0.05	0.30 ± 0.02***	0.60 ± 0.07**	1.20 ± 0.02

The contamination of magnesium in the pectoral muscles of broiler chickens fed by feed additive significantly increased in the second group by 3.9% (P <0.001) and fourth group by 0.9% (P <0.01) than in control group. It is interesting to note that usage of probiotic supplement average dose increases the iron contamination in the white meat by 46.5% (P<0.001), this rate decreases by 39.4% (P <0.001) and 23.2% (P <0.001) respectively under minimal and maximum dose than the control sample. The highest manganese content had the white meat of the third group; it is higher by 13.4%, although significant difference with the control group wasn't observed. The fourth group has the lower content of this trace element by 35.9% (P<0.05) than the control group. The usage of probiotic supplement has positive influence on the mineral contamination of white meat, but it causes the decreasing of copper contamination in the second and third groups by 72.8 and 45.5% (P<0.001 and P<0.001) than in the control group.

It should be mentioned that poultry fed by probiotics has the lower zinc contamination in pectoral muscles; it was lower by 13.0% (P<0.001) in the second group, by 2.8% (P<0.001) in the third group and by 4.8% (P<0.01) in the fourth group than in control group. The research of mineral contamination of red meat of researched poultry has given an opportunity to prove that the level of macro- and microelements was different under the action of probiotic (Table 4). The largest quantity of phosphorus was registered in the fourth group, it was larger by 4.7% (P<0.01); the smallest quantity was in the second and third groups, it was smaller respectively by 14.3% (P<0.01) and 11.5% (P<0.001) than in control group. It should be mentioned that the calcium contamination of broiler chicken thigh muscles increase under the action of probiotic; it is increased 4.1 times (P<0.001) in the second group, by 21.3% (P<0.001) in the third group, and by 71.7% (P<0.001) in the forth group in comparison with the control group.

Table 4 The contamination of minerals in broiler chicken thigh muscles (M ± m, n=4)

Element	Group			
	Control	Experimental II	Experimental III	Experimental IV
P, g/kg	10.5 ± 0.07	9.0 ± 0.28**	9.3 ± 0.08***	11.0 ± 0.10**
Ca, g/kg	0.244 ± 0.003	1.011 ± 0.01***	0.296 ± 0.001***	0.419 ± 0.003***
Mg, g/kg	0.363 ± 0.001	0.351 ± 0.002***	0.324 ± 0.0004***	0.360 ± 0.001*
Fe, mg/ kg	492.0 ± 4.15	560.3 ± 4.73***	839.1 ± 8.39***	826.3 ± 6.36***
Zn, mg/ kg	66.4 ± 0.41	65.6 ± 0.27	70.0 ± 0.06***	69.4 ± 0.08***
Mn, mg/ kg	7.3 ± 1.34	6.1 ± 0.25	9.6 ± 0.54	8.6 ± 0.50
Cu, mg/ kg	0.73 ± 0.01	3,1 ± 0.39***	0.94 ± 0.04**	2.1 ± 0.03***

It was proved that probiotic supplements causes reducing red meat magnesium in the second, third and fourth groups, respectively by 3.4 (P<0.001), 10.8 (P<0.001) and 0.9% (P<0.05) in comparison with the first group. The iron content of the thigh muscle was higher than benchmark in all experimental groups fed by probiotic; it was higher by 13.8% (P<0.001) in the second group, by 70.5% (P<0.001) in the third group and by 67.9% (P<0.001) in the fourth group. The researched additive also had a notable positive effect on the zinc level in the red meat. The third and the forth group had the largest portion of this trace element; it was higher by 5.4 % (P<0.001) in the third group and by 4.5 % (P<0.001) in the fourth group than the control sample. The highest amount of manganese was found in the third group at 31.5%, but significant difference from the control group was not found. It should be mentioned that the copper level increases in thigh muscles of broilers of the second group in 4.2 times (P<0.001), the third group by 28.7% (P<0.01) and the fourth group in 2.8 times (P<0.001) than in control group. The increase of this microelement is within physiological norms.

It was proved that poultry fed by researched additive had the higher lysine contamination in the white meat that the control sample has; the second group had by 0.8 % (P<0.001), the third one had by 0.19% (P<0.01) and the fourth had by 1.66% (P<0.001) than the control group has (Table 5).

Table 5 Amino acid composition of the pectoral muscles of broiler chickens

Amino acid	Group			
	Control	Experimental II	Experimental III	Experimental IV
Lysine	7.62 ± 0.04	8.42 ± 0.04***	7.81 ± 0.03**	9.28 ± 0.07***
Histidine	3.83 ± 0.01	3.86 ± 0.02	3.50 ± 0.02***	3.73 ± 0.08*
Arginine	7.53 ± 0.03	7.91 ± 0.04***	7.60 ± 0.07	4.82 ± 0.11***
Threonine	5.11 ± 0.01	5.13 ± 0.02	5.16 ± 0.03	5.18 ± 0.08
Valine	5.50 ± 0.22	5.65 ± 0.30**	5.66 ± 0.03**	5.52 ± 0.07
Methionine	3.15 ± 0.02	3.26 ± 0.02*	3.48 ± 0.02***	3.32 ± 0.08
isoleucine	5.53 ± 0.02	5.32 ± 0.01***	5.24 ± 0.02***	4.83 ± 0.05***
Leucine	9.40 ± 0.07	9.39 ± 0.03	9.50 ± 0.06	9.04 ± 0.13*
Phenylalanine	4.52 ± 0.02	4.68 ± 0.02**	4.69 ± 0.04**	4.63 ± 0.05

The histidine decreases in the pectoral muscles of broilers if they are fed by average or maximum dose of probiotic; it decreases by 0.33% (P<0.001) and 0.1% (P<0.05) than in control group. However, the second group has a slight increase of this indicator by 0.03%; but significant differences weren't found. The highest arginine contamination was found in the meat of broilers from the second group; it was by 0.38% (P<0,001) higher than in control one; the fourth group has the lowest its level; it was lower by 2.71% (P<0.001) than in control group.
The additional consumption of feed additive by broilers facilitates the increasing of valine and methionine in the white meat; it was higher by 0.15 % (P<0.01) it the second group, by 0.11% (P<0.05) in the third one, and by 0.33% (P<0.001) in the fourth one than on control group. The isoleucine contamination of poultry pectoral muscle was lower in the second, third and fourth groups than in control one by 0.21% (P<0.001), 0.29% (P<0.001) and 0.7% (P<0.001) respectively.
In addition, the decrease of leucine proportion was observed in the fourth group under the action of probiotic, it was by 0.36% (P<0.05) lower than in control one. Meanwhile, its highest level was in the third group (by 0.1%), but significant differences with control group weren't found. There are also quantitative amino acid changes in the thigh muscle of broiler chickens under the influence of probiotic (Table 6).

Table 6 Amino acid composition in thigh muscle of broiler chickens

Amino acid	Group			
	Control	Experimental II	Experimental III	Experimental IV
Lysine	8.82 ± 0.01	8.53 ± 0.02***	8.78 ± 0.004**	8.87 ± 0.02*
Histidine	2.95 ± 0.01	2.83 ± 0.02***	2.85 ± 0.02**	3.03 ± 0.02**
Arginine	7.06 ± 0.01	6.65 ± 0.03***	7.04 ± 0.01	7.06 ± 0.03
Valine	5.23 ± 0.01	5.10 ± 0.02***	5.05 ± 0.02***	5.13 ± 0.01***
Methionine	3.00 ± 0.003	2.81 ± 0.02***	2.89 ± 0.01***	2.97 ± 0.01**
Isoleucine	4.83 ± 0.01	4.74 ± 0.01***	4.74 ± 0.002***	4.81 ± 0.01
Leucine	8.49 ± 0.02	8.28 ± 0.03***	8.29 ± 0.01***	8.48 ± 0.01
Phenylalanine	4.41 ± 0.004	4.40 ± 0.12	4.34 ± 0.01***	4.39 ± 0.01*

The level of essential amino acids such as lysine and histidine has increased in the broilers red meat under the action of researched preparation; it has increased in the fourth group by 0.05 and 0.08% (P<0.05 and P<0.01) respectively. However, the meat of the second group poultry has lower indicator of amino acids mentioned above, it is lower by 0.29 and 0.12% (P<0.001) respectively. The arginine amount in the red meat decreases by 0.41% (P<0.001) in the second group, however the fourth group has this indicator at the control level. It should be mentioned that threonine amount decreases in the red meat by 0.48% (P<0.001) in the second group and by 0.29% (P<0.001) in the third group, however the fourth group has this indicator at the control level. The usage of researched additive as a part of broilers diet influences on the decreasing of valine and methionine level in the thigh muscles by 0.13 and 0.19% (P<0.001) in the second group, by 0.18 and 0.11% (P<0.001) in the third group, by 0.1 and 0.03% (P<0.001 and P<0.01) in the fourth group than in control one. The contamination of isoleucine and leucine in the thigh muscles of the poultry from the second group is by 0.09 and 0.21% (P < 0.001) lower; from the third group is by 0.09 and 0.2% (P < 0.001) lower than in similar samples of the first group. It should be mentioned that amino acids amount does not differ considerably from the meat of the fourth group.

Conclusions

The adding of minimal dose of probiotic supplement to the broiler chickens diet increases the dry matter by 0.2%, fat by 1.2% in the pectoral muscles, the ash by 0.4% in the thigh muscles; the feeding of average dose of supplement increases the fat level in muscles by 3,9%; the usage of maximum probiotic dose increases the ash by 0.75% in the pectoral muscles, the dry matter contamination is 0.1 % higher in the thigh muscles than in control group.
The feeding of minimal dose of probiotic supplement increases the Mg contamination by 3.9 % in the pectoral muscles, the level of Ca by 4.1 times and Cu by 4.2 times in the thigh muscles. The usage of the average level of probiotic increases the level

of Fe by 46.5% in the pectoral muscles and by 70.5% in the thigh muscles, the Zn level increases by 5.4% in the thigh muscles. The maximum dose of probiotic increases the P level by 4.7% both in the thigh and pectoral muscles.

It was proved that feeding of maximum dose (0.25% for the age of 1-10 days, 0.1% for the age of 11-28 days, 0.05% for the age of 29-42 days, daily to feed the masses) of probiotic supplement "Entero-active" to the broiler chickens stimulates the synthesis of such essential amino acids in the pectoral muscles as lysine by 1.66% and threonine by 0.07% than in control group. The consumption of average dose of supplement (0.125% for the age of 1-10 days, 0.05% for the age of 11-28 days, 0.025% for the age of 29-42 days, daily to feed the masses) increases the level of valine by 0.16%, methionine by 0.33%, leucine by 0.1% and phenylalanine by 0.17% than in control group. The usage of minimal dose (0.062% for the age of 1-10 days, 0.025% for the age of 11-28 days, 0.0125% for the age of 29-42 days, daily to feed the masses) increases the histidine by 0.03% and arginine by 0.38% than in control group. In addition, the maximum dose of probiotic increase the level of lysine and histidine by 0.05% and 0.08% action in the thigh muscles of broilers, compared with the control.

Acknowledgments

The author extent deep gratitude to the administration of Vinnytsia National Agrarian University and supervisor Prof. Chudak R.A. for their generous assistance in research conduct.

References

Alavi, S.A.N., Zakeri, A., Kamrani, B., Pourakbari, Y. (2012). Effect of prebiotics, probiotics, acidfier, growth promoter antibiotics and synbiotics on humural immunity of broiler chickens. Global Vet., 8, 612–617.

Al-Ghazzewi, F.H., Tester, R.F. (2012). Efficacy of cellulose and manganese hydrolysates of konjac glucomannan to promote the growth of lactic acid bacteria. J. Sci. Food Agric., 92, 2394–2396.

Brzóska, F., Śliwiński, B., Stecka, K. (2012). Effect of Lactococcus lactis vs. Lactobacillus Spp. bacteria on chicken body weight, mortality, feed conversion and carcass quality. Ann. Anim. Sci., 12, 549–559.

Chudak, R.A., Smetanska, I.M., Vozniuk, O.I. (2014). Egg and slaughter performance indicators quail hens feeding on white Echinacea extract. Collection of articles of Vinnitsa National Agrarian University, 2(86), 65–96. (in Ukrainian).

Ezema, M.C. (2012). Probiotic Effects of Saccharomyces cerevisiae on Laying Chicken Fed Palm Kernel Cake–Based Diets. PhD Thesis, Department of Animal Health and Production, Faculty of Veterinary Medicine, University of Nigeria, Nsukka.

Fallah, R., Kiani, A., Azarfar, A. (2013). A review of the role of five kinds of alternatives to in–feed antibiotics in broiler production. J. Vet. Med. Anim. Health, 5, 317–321.

Gupta, A.R., Das, S. (2013). The benefits of probiotics in poultry production: An overview. Int. J. Livestock Res., 3, 18–22.

Hryhoryev, D. (2011). Use the right probiotics. Poultry Production, 1, 41–42 (in Ukrainian).

Kononenko, V.K., Patrov, V.S. (2000). Workshop on the basics of research in animal husbandry. Kiev (in Ukrainian).

Kozyr, V.S., Svezhentsov, A.I. (2002). Practical methods of research in animal husbandry. DA: Art – Press (in Ukrainian).

Mookiah, S., Sieo, C.C., Ramasamy, K., Abdullah, N., Ho, Y.W. (2014). Effects of dietary prebiotics, probiotic and synbiotics on performance, caecal bacterial populations and caecal fermentation concentrations of broiler chickens. J. Sci. Food Agric., 94, 341–348.

Park, J.H., Kim, I.H. (2014). Supplemental effect of probiotic Bacillus subtilis B2A on productivity, organ weight, intestinal Salmonella microflora, and breast meat quality of growing broiler chicks. Poult Sci, 93(8), 2054–2059.

Podobed, L.I. (2011). How to choose the enzyme preparation to improve the digestibility of the diet of nutrients in poultry? Effective feeds and feeding, 1, 9–13 (in Ukrainian).

Plokhinskiy, N.A. (1969). Rukovodstvo po biometrii dlya zootekhnikov. Moscow: Kolos (in Russian).

Salim, H.M., Kang, H.K., Akter, N., Kim, D.W., Kim, J.H. (2013). Supplementation of Direct–fed microbials as an alternative to antibiotic on growth performance, immune response, cecal microbial population and ileal morphology of broiler chickens. Poult. Sci., 92, 2084–2090.

Świątkiewicz, S., Arczewska–Włosek, A. (2012). Prebiotic fructans and organic acids as feed additives improving mineral availability. World's Poult. Sci. J., 68(2), 269–279.

Xiaolu Liu, Hai Yan, Le Lv, Qianqian Xu, Chunhua Yin, Keyi Zhang, Pei Wang, Jiye Hu (2012). Growth Performance and Meat Quality of Broiler Chickens Supplemented with Bacillus licheniformis in Drinking Water. Asian–Australas J Anim Sci. May; 25(5), 682–689.

Citation:
Podolian, Ju.N. (2017). Effect of probiotics on the chemical, mineral, and amino acid composition of broiler chicken meat.
Ukrainian Journal of Ecology, 7(1), 61–65.