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THE EFFECT OF PROBIOTIC ON HEMATOLOGICAL PARAMETERS AND CHEMICAL CONTENT OF BROILER CHICKENS MEAT

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Abstract

A study of morphological and biochemical indexes of blood of chickens-broilers is undertaken for the use of the investigated addition of probiotic Entero-active on the basis of lactics of sort of Lactobacillus and Enterococcus.

The experiment was conducted to examine the influence of probiotic preparation on the mineral contents of the broiler chicken muscles. It is proved that additional feeding of probiotic Entero-activ to broiler chickens increases retention of mineral elements of the fodder. To study the effect of probiotic on chicken meat the contents 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 contents 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.

Keywords: broiler chickens, probiotic, feeding, hematological parameters, muscles, mineral elements.

INTRODUCTION

The supplying of people with qualitative foodstuffs is one of the most actual problems nowadays. Prohibition of antibiotics use as growth stimulators on the territory of EU countries concerning livestock was accepted as an answer for appearing of antibiotic-resistant microorganisms both to animals and people who consumed different animal products. So, fitobiotics, enzymes, probiotics and prebiotics, and other dietary supplements replaced antibiotics [2, 5, 6, 9, 11].

Nowadays the efforts of many scientists and practices are concentrated on the usage of such additives that are not accumulated in the tissues and livestock products and they are safe as people`s food [4, 16, 18, 20].

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 [1, 7, 8, 15].

The mechanism of action of probiotic 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. 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 [2, 10].

The poultry meat contains a lot of nutrients, bioactive and minerals; their ratio is constant, that's why poultry meat has high nutritional value. Nutritive muscles value is evaluated by its quality, protein content and its full value. The proteins of muscle tissues are of full value, because they contain all essential amino acids. That's why we have researched the amino acid of broiler chicken pectoral muscles. Similar researches were conducted by other scientists; they have studied the effect of feed additives on the meat quality, the mineral and amino acid composition of animal muscles [19, 21].

The research objective was to investigate the influence of probiotic supplement «Entero-active» on hematological parameters and chemical contents of broiler chicken meat.

METHODS AND MATERIALS

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 [12-14]; 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).

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

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 [14].

Biometric data processing was performed on a computer. The results of the average values were considered statistically significant at *P<0.05;**P < 0.01; ***P<0.001 [17].

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.

The producer of preparation Entero-active is BTU "Tsentr" (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% (29-56 days). In order to find the optimal dose of probiotic Entero-active for feeding modern crosses of broiler chickens we have investigated minimum, average and maximum dose of the researched supplement.

RESULTS AND DISCUSSIONS

A study of morphological and biochemical indexes of blood of chickens-broilers is undertaken for the use of the investigated addition of probiotic Entero-active on the basis of lactics of sort of Lactobacillus and Enterococcus.

The additional use of middle dose of feed addition in feeding of chickens-broilers assists a tendency to the increase of content general a squirrel on the 3,5%. For the consumption of addition of probiotic broilers with the mixed fodder are fix the increase of level of alanine aminotransferase (ALT) and aspartate aminotransferase (AST).

Use in broiler diets minimum dose of probiotics increases levels of bilirubin in 44.8%, 12,5% cholesterol, glucose 17,3% and creatinine 36,8%. Under act of probiotic content of haemoglobin increases for a bird on the 14,0% amount of leucocytes of 16,0% action of probiotic a positive tendency is set to the increase of content of segmented neutrophils and lymphocytes for broilers on by the 1,3% (table 2).

The study found that probiotic supplement improves metabolism by strengthening the respiratory function of blood and increases the protective functions of the body. Thus, the general picture of blood found that broiler chickens, which in addition to the feed consumed probiotic supplements, significant changes in the morphological and biochemical indices of blood and the negative impact of probiotic organism birds were observed. It was established that the optimum dose administration in broiler complete feed probiotic supplements are in amount: 0,25% in 1-10 days age, 0,1% at 11-28 days age, 0,05% in the 29-42 age daily weight feed for broiler chickens.

Table 2

Biochemical parameters of blood (M ± m, n = 4)

Indicator	Group			
	1– control	2 – research	3 – research	4 – research
Total protein, g / l	34.0 ± 4.05	29.5 ± 1.37	35.2 ± 3.03	32.5 ± 3.41
Albumins, g / l	16.2 ± 1.59	12.7 ± 0.55	16.5 ± 1.52	15.5 ± 2.02
Globulins, g / l	17.7 ± 2.51	16,7 ± 0.86	18.7 ± 1.52	17.0 ± 1.41
ALAT, units / l	4.7 ± 1.72	4.0 ± 1.94	8.2 ± 1.44	5.0 ± 2.45
AsAT, units / l	198.5 ± 24.85	190.5±18.11	214.0±9.82	221.2±34.88
Bilirubin, μmol / l	2.9 ± 0.32	4.2 ± 0.33*	3.1 ± 0.60	3.6 ± 0.78
Alkaline phosphatase, units / l	1383.0 ± 222.3	1808.2 ± 82.0	1534.2 ± 149.8	1571.7 ± 344.6
Cholesterol, mmol / l	2.4 ± 0.20	2.7 ± 0.26	2.5 ± 0.27	2.5 ± 0.26
Triglycerides, mmol / l	0.69 ± 0.20	1.04 ± 0.24	0.95 ± 0.095	1,05 ± 0.07
Glucose, mmol / l	7.5 ± 0.76	8.8 ± 1.14	7.7 ± 0.45	7.9 ± 1.01
Creatinine, μmol / l	9.5 ± 1.37	13.0 ± 3.80	10.7 ± 2.68	10.5 ± 5.61
Urea, mmol / l	1.3 ± 0.28	1.4 ± 0.28	1.6 ± 0.51	1.4 ± 0.44
Calcium, mmol / l	2.7 ± 0.21	2,7 ± 0,22	2.5 ± 0.26	2.5 ± 0.30
Phosphorus, mmol / l	2.3 ± 0.11	2.3 ± 0.16	2.2 ± 0.25	2.2 ± 0.22

The feeding by probiotics also influenced the nutrient contents in pectoral and thigh muscles of broiler chickens (table 3).

The broiler chickens dry matter contents of the second poultry group white meat increases by 0.2% (P<0.01); the broiler chickens dry matter contents of the fourth poultry group red meat increases by 0.1% (P<0.05) under the action of probiotics than in control group.

Table 3

The chemical composition of broiler chickens meat, % (M ± m, n = 4)
(in air-dry matter)

Indicator	Group			
	1– control	2 – research	3 – research	4 – research
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±0,031	4,21±0,082	4,43±0,032***	4,87±0,009***
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

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).

The protein contents 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.

The research of minerals in meat of researched poultry was conducted in order to investigate the influence of probiotic supplement on the broilers meat (table 4).

The additional usage of probiotics as a component of mixed fodder for broiler chickens facilitated the increasing of phosphorus contents 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 contents 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 4

Mineral contents of broiler chicken pectoral muscles (M ± m, n=4)
(in 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±0.006***	0.36±0.001***	0.39±0.003**
Mg, g/kg	0.427±0.0002	0.444±0.0020***	0.426±0.0016	0.431±0.0009**
Fe, mg/ kg	379.1 ± 1.68	230.1±1.74***	555.4±6.90***	291.5±3.56***
Zn, mg/ kg	29.3 ± 0.11	25.5±0.09***	28.5±0.06***	27.9 ±0.20**
Mn, mg/ kg	6.7 ± 0.86	4.5 ± 0.77	7.6 ± 0.31	4.3 ± 0.32*
Cu, mg/ kg	1.1 ± 0.05	0.3 ± 0.02***	0.6 ± 0.07**	1.2 ± 0.02

The contents 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 contents 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 contents has 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 contents of this trace element by 35.9% (P<0.05) than the control group has.

The usage of probiotic supplement has positive influence on the mineral contents of white meat, but it causes the decreasing of copper contents 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 contents 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 contents 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 5).

Table 5

The mineral content of 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±0.0027	1.011±0.0050***	0.296±0.0005***	0.419±0.0032***
Mg, g/kg	0.363±0.0011	0.351±0.0015***	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 contents 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. 6).

Table 6

Amino acid composition of the pectoral muscles of broiler chickens

Amino acid	Group			
	Control	Experimental II	Experimental III	Experimental IV
Lysine	7.62 ± 0.038	8.42 ± 0.036***	7.81 ± 0.030**	9.28 ± 0.067***
Histidine	3.83 ± 0.014	3.86 ± 0.020	3.50 ± 0.019***	3.73 ± 0.082*
Arginine	7.53 ± 0.027	7.91 ± 0.035***	7.60 ± 0.066	4.82 ± 0.106***
Threonine	5.11 ± 0.012	5.13 ± 0.023	5.16 ± 0.031	5.18 ± 0.079
Valine	5.50 ± 0.22	5.65 ± 0.30**	5.66 ± 0.026**	5.52 ± 0.072
Methionine	3.15 ± 0.022	3.26 ± 0.023*	3.48 ± 0.016***	3.32 ± 0.083
isoleucine	5.53 ± 0.015	5.32 ± 0.014***	5.24 ± 0.022***	4.83 ± 0.048***
Leucine	9.40 ± 0.065	9.39 ± 0.030	9.50 ± 0.061	9.04 ± 0.132*
Phenylalanine	4.52 ± 0.023	4.68 ± 0.023**	4.69 ± 0.035**	4.63 ± 0.045

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 contents were 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 contents of poultry pectoral muscle were 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 7).

Table 7

Amino acid composition in thigh muscle of broiler chickens

Amino acid	Group			
	Control	Experimental II	Experimental III	Experimental IV
Lysine	8.82 ± 0.007	8.53 ± 0.017***	8.78 ± 0.004**	8.87 ± 0.019*
Histidine	2.95 ± 0.008	2.83 ± 0.017***	2.85 ± 0.015**	3.03 ± 0.019**
Arginine	7.06 ± 0.010	6.65 ± 0.029***	7.04 ± 0.011	7.06 ± 0.026
Valine	5.23 ± 0.009	5.10 ± 0.019***	5.05 ± 0.017***	5.13 ± 0.012***
Methionine	3.00 ± 0.003	2.81 ± 0.020***	2.89 ± 0.005***	2.97 ± 0.005**
Isoleucine	4.83 ± 0.011	4.74 ± 0.008***	4.74 ± 0.002***	4.81 ± 0.008
Leucine	8.49 ± 0.017	8.28 ± 0.028***	8.29 ± 0.005***	8.48 ± 0.008
Phenylalanine	4.41 ± 0.004	4.40 ± 0.120	4.34 ± 0.008***	4.39 ± 0.005*

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 contents 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:

1. Use in broiler diets minimum dose of probiotics increases levels of bilirubin in 44.8%, 12,5% cholesterol, glucose 17,3% and creatinine 36,8%.

2. 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 contents is 0.1 % higher in the thigh muscles than in control group.

3. The feeding of minimal dose of probiotic supplement increases the Mg contents 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.

4. 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.

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THE STATE OF PROTEIN AND MINERAL METABOLISM OF CROSSBRED PIGS FOR THE ACTION OF BETAINE

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Abstract

The effect of feed additive betaine on the content of macro- and microelements, as well as the number of amino acids in the liver of piglets is studied experimentally. It has been found that the additional consumption of feed additive betaine by crossbred piglets keeping for fattening has a positive effect on amino acid composition of the liver.

Using betaine we observe the highest content of arginine by 0.96% ($p<0.01$), methionine by 1.08% ($p\leq0.001$), threonine by 0.52% ($p\leq0.001$) and phenylalanine by 0.85% ($p\leq0.001$) in the liver of animals of the 3rd group compared to the control group. It is recorded the highest level of histidine in the liver of animals of the 4th group, it is by 0.13% ($p\leq0.001$) more than in the control group.

It is established that the consumption of feed additive by animals of the 2nd group increases the amount of calcium in the liver by 4.3% ($p\leq0.001$) compared to the control group. It is found that the feeding factor in the diet of crossbred piglets increases the amount of zinc by 17.9% ($p\leq0.001$) and of manganese by 16.7% ($p\leq0.001$) in the liver of animals of the 4th group compared to the control one.

Keywords: feed additive betaine, feeding, fattening, crossbred piglets, liver, complete feed.

Topicality. Improving the consumption, increasing the efficiency of feed application, and obtaining maximum livestock productivity is ensured by a high level of balanced feeding with various feed additives application.

Feed additives are used to improve the nutritional value of basic feed. Nowadays the list of feed additives includes hundreds of different feeds, it is constantly updated. Betaine (Betafin) occupies an important place among the protein supplements; it is a substance from sugar beet molasses [4].

Betaine is a natural sugar beet extract used in animal nutrition to improve performance. It maintains water balance in cells, the function of ion pumps and improves liver function by promoting homeostasis [1, 6].

The liver is the largest internal organ performing a metabolic function; it is involved in the metabolism of proteins, carbohydrates, fats, hormones, and vitamins; it is also involved in neutralization and detoxification of many endogenous and exogenous substances.

The liver is involved in the regulation of all types of metabolism due to anatomical and biochemical features. Participating in protein metabolism, the liver destroys and rebuilds blood proteins, it converts amino acids into a reserve source of energy and material for the synthesis of its own proteins in the body [2, 7].

The aim of these studies was to determine the amino acid and mineral content of the liver of crossbred piglets fed by betaine supplement in different proportions; we also researched the optimal amount of betaine in the diet.

Materials and methods of research. We have conducted a scientific experiment with crossbred piglets F1 (Big White x Landrace) at a nucleus farm Servolux Genetic LLC in Orativ district of Vinnytsia region to achieve the goal of research. The experiment was performed on four groups of young pigs selected by the principle of analogous groups according to the following scheme [5] (table 1).

We took into account sex, age, origin, live weight and growth intensity for the previous period (growth) forming analogous groups for scientific experiment. All animals were clinically healthy and suitable for research. 68 piglets were selected for the equalization period of the experiment, four 12 head groups were formed. During the equalization and the main periods, the control group received the basic ration (BR), i.e. complete ration feed TM Trouw Nutrition International (the Netherlands). Experimental groups were also fed by betaine feed additive according to the experimental scheme.

The duration of the equalization and main research periods was 15 and 72 days.

Biometric processing of digital material is processed by the method of M. Plokhinskyi [3].