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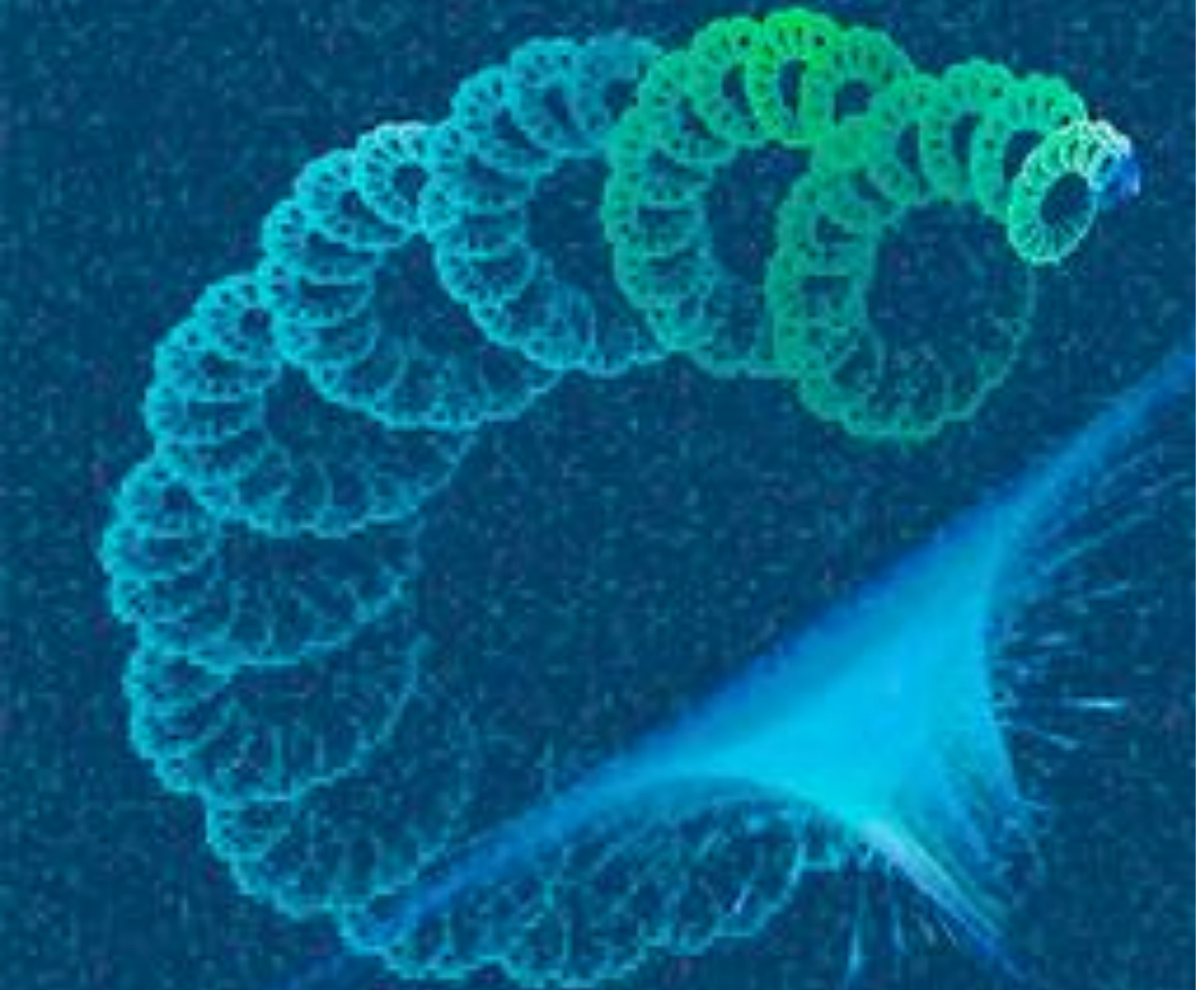

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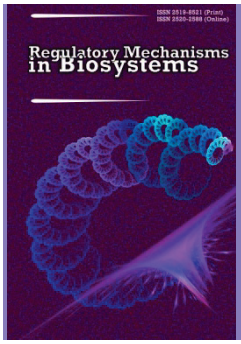

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Effect of dry extract from *Saccharomyces cerevisiae* culture with selenium-containing amino acids on the productivity and chemical composition of meat of broiler chickens

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Introduction of biologically active supplements to the diet of poultry results in maximal use of nutrients and positively influences the live weight and slaughter parameters. This promotes rational and economical use of fodders and boosts the poultry productivity. We studied a mineral feed supplement – an organic selenium compound, which has a much greater bioavailability than inorganic sources of selenium. Selenomethionine is easily digested in the organism and effectively used for synthesis of proteins. Broiler chickens of the experimental group that had been consuming the selenoamino-acid feed additive had greater live weight at the age of 14–42 days, compared with the control. Intake of the mineral supplement by the broiler chickens in the experimental group increased their mean daily increment by 8.5% and the absolute increment by 8.6%, compared with the control peers. In the experimental group of broilers, the mineral supplement increased the pre-slaughter live weight by 8.4%, weight of intact carcass by 10.1%. Also, the weight of the semi-processed carcasses (i.e. those with removed intestines and cloaca, filled crop, oviduct and ovary (in female specimens) increased by 4.3%, and the weight of the processed carcasses (the internal organs and abdominal-cavity fat and esophagus of which were removed, without head, legs and wing metacarpals) increased by 8.0%, compared with the control group of broilers. In the experimental group, the feed supplement gave 13.7% rise in the weight of the breast muscles and 14.5% increase in the weight of the thigh muscles, compared with the control group. Intake of this supplement in the experimental group promoted 7.5% increase in the weight of the gizzard by and 9.2% increase in the weight of the duodenum, as compared with the control. Usage of the selenoamino-acid feed supplement increased the protein concentration in the breast muscles of the broiler chickens by 1.9%, compared with the control. Intake of the mineral supplement increased the amounts of dry matter and fat in the thigh muscles of the experimental group, compared with the control group. Therefore, adding dry yeast extract to diet of broilers together with selenium-containing amino acids is a promising method of increasing the effectiveness of poultry farming.

Keywords: increments; live weights; nutrition; fodder expenditures; slaughter weight; internal organs; meat quality; blood.

Introduction

In many countries of the world, production of competitive and ecologically sage and profitable products is currently a growing problem. In European countries, use of antibiotics such as growth stimulators in animal farming is prohibited. Therefore, compounds that are dangerous for the human health became replaced by biologically active supplements that do not accumulate in products of animal farming (Podolian, 2017; Shevchenko et al., 2017). The effectiveness of increasing the productivity of poultry depends on how the production technologies allow the birds to realise their genetic potential. The main factor of realization of poultry genetic potential is feeding with complete mixed feeds and protein-vitamin supplements (Podolian, 2016; Razanova, 2018).

Scientific studies have substantiated the efficacy of various feed supplements: microelements, vitamins, amino acids, phytobiotics, probiotics, enzymes, which do not accumulate in the products of animal farming (Chudak et al., 2020; Lieshchova & Brygadyrenko, 2023). Among the biologically active compounds, those preferred are compounds of natural origin, including mineral. Analysis of the literature indicates that animal nutrition uses a large amount of mineral feed supplements (Surai, 2002; Razanova, 2022; Farionik et al., 2023). Mineral components of the diet play an important role in the metabolic processes of the cells, regulate homeostasis, acid-base homeostasis, and osmotic pressure. Deficiency of mineral elements leads to impairments in metabolism of compounds, decrease in productivity, and increase in morbidity of poultry (Downs, 2000; Dankevych, 2020).

The objective of this study was to identify the influence of the mineral supplement containing organic forms of selenium and dry yeast extract on live weight, fodder expenditures, slaughter and hematological parameters of the broiler chickens.

Materials and methods

The protocol and procedures in this study were in accordance with the Directive 2010/63/EU of the European Parliament and the Council on Protection of Animals, and also the Law of Ukraine On the Protection of Animals from Abuse, Decree of the Cabinet of Ministers of Ukraine as of July, 28 2010 No. 1585 On Adoption of the List of Normative-Legal Acts on Issues of Protection of Animals from Abuse. The program of the studies was approved by the Ethics Committee of the Department of Technologies of Production and Processing of Products of Animal Farming and Veterinary Medicine of the Vinnytsia National Agrarian University.

Research on the influence of mineral supplement Alkosel R397 on the productivity and hematological parameters of the broiler chickens was

performed in the conditions of the vivarium of the Vinnytsia National Agrarian University. The experiment was carried out according to the methods of Ibatullin et al. (2017). The experiment lasted for 42 days. For the experiment, we selected two groups of broiler chickens of the Ross-308 cross, 20 individuals in each. The first group was the control, the animals of which consumed the main diet – complete mixed feed manufactured by the Multigain trademark. The second group was the experimental, the birds of which received the Alkosel R397 feed supplement with the mixed feed, in calculation of 100 g per 1 T of mixed feed. Alkosel R397 is a feed supplement for enrichment and balancing of diets with selenium. It contains selenoamino acids and proteins of dried enzymatic extract of *Saccharomyces cerevisiae* NCYC R397, which contain selenium, and also a filler.

During the experiments, we studied survival of the population, dynamics of live weight with the accuracy up to 1 g; the expenditures of fodder per 1 kg of live-weight increment – assessed according to Ibatullin et al. (2017). For an in-depth examination, we analyzed 5 broiler chickens from each group, having average live-weight parameters (Ibatullin et al., 2017). By performing the chemical analysis of the longissimus, we studied the contents of dry matter, protein, fat, ash. The content of protein, total fat and ash in the muscles were studied according to the methods recommended by the International Organization for Standardization. Biochemical composition of flesh of the muscles was identified using the following methods: dry matter – using the method of drying the samples until the constant mass at the temperature of 100–105 ºC; the fat content – by extracting the dry weighed amount using ether; ash content – by burning weighed amount in a muffle furnace at the temperature of 400–450 ºC; protein content – by identifying the total nitrogen. The hematological parameters were studied in the veterinary clinic of the city of Vinnytsia, according to the methods of Vlizlo et al. (2012).

The results were analyzed using the ANOVA software, taking into account the Bonferroni's correction. The differences between the groups were considered statistically significant at $P < 0.05$. We calculated the mean value and its standard deviation ($x \pm SD$).

Results

Broiler chickens of the experimental group, which were fed the Alkosel R397 mineral feed supplement, had 4.3% ($P < 0.05$) increase in the live weight at the age of 14 days, 6.4% ($P < 0.01$) at the age of 21 days, 4.5% ($P < 0.01$) at the age of 28 days, and 11.4% ($P < 0.001$) at the age of 35 days, compared with the control peers (Table 1). At the end of the experiment, usage of selenoamino-acid feed supplement in the nutrition of broiler chickens increased their live weight by 8.4% ($P < 0.001$) at the age of 42 days, compared with the control.

Table 1
Influence of selenoamino-acid feed supplement
on live weight (g) of the broiler chickens ($x \pm SD$, $n = 20$)

Age, days	Control group	Experimental group
1	47.8 ± 1.0	47.6 ± 1.1
7	125.0 ± 2.3	130.6 ± 2.3
14	388.5 ± 4.7	405.5 ± 5.8*
21	772.8 ± 11.2	822.5 ± 10.8**
28	1,334.6 ± 13.5	1,395.8 ± 14.1**
35	1,832.7 ± 15.9	2,042.6 ± 16.5***
42	2,428.0 ± 16.6	2,633.0 ± 17.3***

Note: * – $P < 0.05$, ** – $P < 0.01$, *** – $P < 0.001$ differences between the control and experimental groups during each study periods.

Broiler chickens of the experimental group had 8.5% ($P < 0.05$) higher mean daily increment and 8.6% ($P < 0.001$) higher absolute increment, compared with the control group (Table 2).

Feeding with the mineral supplement decreased the expenditures of fodder per 1 kg of increment of the broiler chickens (Table 3). In the experimental-group poultry, the mineral supplement decreased the expenditures of fodder per 1 kg by 5.5%, compared with the control.

At the end of the experiment, we performed the control slaughter and determined the slaughter qualities of the broiler chickens fed with the mineral supplement (Table 4). Broiler chickens that had been consuming the Alkosel R397 mineral supplement were heavier by the pre-slaughter live weight by 8.4% ($P < 0.001$), by the weight of non-processed carcass by 10.1% ($P < 0.001$), semi-processed carcass (with removed intestines and cloaca, filled crop, oviduct and ovary (in female specimens) by 4.3% ($P < 0.05$) and processed carcasses (the internal organs and abdominal-cavity fat and esophagus of which were removed, without head, legs and wing metacarpals) by 8.0% ($P < 0.01$), compared with the control. Furthermore, weight of the breast muscles of birds of the experimental group had increased by 13.7% ($P < 0.01$) and such of the thigh muscles by 14.5% ($P < 0.01$), compared with the control.

Table 2
Increment in broilers
consuming selenoamino-acid feed supplement ($x \pm SD$, $n = 20$)

Increment	Control group	Experimental group
Mean daily, g	56.7 ± 1.6	61.5 ± 1.5*
Absolute, g	2,380.2 ± 12.8	2,585.4 ± 14.4***

Note: see Table 1.

Table 3
Fodder expenditures for the broiler chickens
consuming the selenoamino-acid supplement (kg)

Fodder expenditures	Control group	Experimental group
Over the study period	89	91
Per individual	4.3	4.4
Per 1 kg of increment	1.80	1.70

Table 4
Slaughter parameters (g) of the broiler chickens
fed with the selenoamino-acid feed supplement ($x \pm SD$, $n = 5$)

Parameter	Control group	Experimental group
Pre-slaughter live weight	2,420.0 ± 17.5	2,625.0 ± 18.4***
Weight of non-processed carcass	2,262.8 ± 18.6	2,492.0 ± 19.8***
Weight of semi-processed carcass	2,114.5 ± 21.5	2,205.6 ± 22.6*
Weight of processed carcass	1,685.0 ± 20.4	1,820.0 ± 19.8**
Weight of the breast muscles	492.5 ± 10.4	560.2 ± 10.8**
Weight of the thigh muscles	405.6 ± 9.2	464.6 ± 8.5**

Note: see Table 1.

Intake of the Alkosel R397 feed supplement by broilers of the experimental group caused 7.5% ($P < 0.05$) increase in the weight of the gizzard and 9.2% ($P < 0.05$) increase in the weight of the duodenum, compared with the control (Table 5).

Table 5
Influence of the selenoamino-acid feed supplement
on the weight (g) of the digestive organs of the broilers ($x \pm SD$, $n = 5$)

Digestive organ		Group	
		Control group	Experimental group
Esophagus		8.3 ± 0.7	8.6 ± 1.0
Glandular stomach		7.8 ± 0.6	8.0 ± 0.4
Gizzard		29.2 ± 0.7	31.4 ± 0.5*
Small intestine	duodenum	13.1 ± 0.3	14.3 ± 0.4*
	jejunum	29.8 ± 0.7	32.2 ± 0.8
	ileum	30.2 ± 1.3	31.3 ± 1.1
Large intestine	right cecum	8.6 ± 0.7	9.2 ± 0.9
	left cecum	8.0 ± 0.4	8.1 ± 0.5
	rectum	2.0 ± 0.6	2.1 ± 0.7

Note: see Table 1.

Against the control, intake of the mineral supplement by broiler chickens of the experimental group increased the content of dry matter in the breast muscles by 0.2% ($P < 0.05$) and protein by 1.9% ($P < 0.05$, Table 6). Intake of the mineral supplement increased the concentration of dry matter in the thigh muscles of experimental-group poultry by 0.4% ($P < 0.05$) and fat by 0.9% ($P < 0.05$), compared with the control.

Use of the mineral supplement in the diet of broiler chickens of the experimental group promoted the tendency towards increase in the total protein in blood by 3.7% and blood erythrocytes by 10.3%, compared with the control, though no significant difference was determined (Table 7). The blood parameters were within the physiological norms.

Table 6
Chemical composition (%) of the meat of the poultry consuming the selenoamino-acid feed supplement (x ± SD, n = 5)

Muscles	Parameter	Control group	Experimental group
Breast muscles	dry matter	92.31 ± 0.05	92.54 ± 0.06*
	protein	72.42 ± 0.34	73.81 ± 0.32*
	fat	6.19 ± 0.09	6.32 ± 0.12
	ash	3.82 ± 0.05	3.93 ± 0.06
Thigh muscles	dry matter	90.84 ± 0.10	91.22 ± 0.08*
	protein	61.31 ± 0.32	62.24 ± 0.29
	fat	20.80 ± 0.05	21.01 ± 0.04*
	ash	4.01 ± 0.04	4.11 ± 0.06

Note: see Table 1.

Table 7
Hematological parameters of the broiler chickens consuming the selenoamino-acid feed supplement (x ± SD, n = 5)

Parameter	Control group	Experimental group
Total protein, g/L	37.2 ± 0.3	38.6 ± 0.5
Albumin, %	44.2 ± 0.6	45.4 ± 0.5
Globulin, %	56.5 ± 0.7	57.2 ± 0.9
Calcium, mmol/L	3.81 ± 0.06	4.02 ± 0.11
Phosphorus, mmol/L	2.02 ± 0.09	2.23 ± 0.19
Erythrocytes, 10^{12}/L	2.83 ± 0.22	3.24 ± 0.18
Hemoglobin, g/L	94.2 ± 1.1	95.4 ± 0.9
Leukocytes, 10^{9}/L	24.5 ± 0.3	25.1 ± 0.4

Note: see Table 1.

Discussion

Improvement of the consumption and increase in the efficiency of using the feeds, obtaining maximal production of poultry farming are ensured by high level of balanced nutrition using various natural feed supplements. Currently, many scientists and practitioners are concentrating their efforts on using supplements that do not accumulate in the tissues and products of animal farming and are safe for humans. In the studies of efficiency of various feed supplements in poultry farming, scientists pay special attention to productivity, slaughter and hematological parameters (Surai & Kochish, 2019; Poberezhets, 2021). Growth of animals depends not only on genetic features but is determined by the level and type of nutrition. By using feed supplements, mixed feeds and diets can be balanced, and therefore the productivity of animals improved (Chudak et al., 2019). Selenium is an important component of many selenoproteins, most of which are involved in the antioxidant system of cell. It is also necessary for support of the optimal health and quality of meat (Medvid et al., 2017; Lei et al., 2022).

Our studies revealed that intake of the selenoamino-acid feed supplement positively influenced the growth and increments of the poultry. Relative to the control, use of the Alkosel R397 feed supplement by the broiler chickens of the experimental group caused 8.4% ($P < 0.001$) increase in the live weight, 8.5% ($P < 0.05$) increase in the mean daily increment, and 8.6% ($P < 0.001$) increase in the absolute increment. Results suggesting a significant increase in the productivity of agricultural animals under the influence of mineral supplements are coherent with studies of other authors. Polishchuk & Bulavkina (2010) reported that organic selenium supplements of new generation increased live weight of poultry, intensity of egg-laying, and improved meat quality. Bakhshalinejad et al. (2011) studied influence of various selenium sources and levels of Se-containing dietary supplements on the productivity, antioxidant status and immune parameters of the Ross 308 broiler chickens. They determined that addition of organic Se sources to the diet substantially improved the mean daily increment, compared with the poultry that had been consuming diets with inorganic sources of this chemical element (Bakhshalinejad et al., 2011).

Our studies of productivity of broiler chickens found influence of the Alkosel R397 selenium-containing feed supplement on the slaughter parameters of poultry. Slaughter parameters of animals are more indicative of meat qualities than live weight and increments. Compared with the control, intake of the selenoamino-acid feed supplement by the experimental group of broiler chickens produced 8.4% ($P < 0.001$) increase in the pre-slaughter weight, 10.1% ($P < 0.001$) in the weight of intact carcass, 4.3% ($P < 0.05$) in the weight of semi-processed carcass and 8.0% ($P < 0.01$) increase in the weight of processed carcass. Moreover, broilers of the experimental group had weight increases, measuring 13.7% ($P < 0.01$) in the breast muscles, 14.5% ($P < 0.01$) in the thigh muscles, against the control. Choct et al. (2004) studied influence of selenium concentration on the productivity of broilers and meat quality. They found that high content of selenium in the diet notably decreased the coefficient of fodder conversion, while increasing increments and productivity of the poultry. The birds that had consumed organic selenium in their diet had greater weight of eviscerated carcasses and the breast muscles. Also, Wang et al. (2011) found a positive effect of selenium-containing feed supplements on productivity of growth, slaughter parameters, meat quality, deposition of Se, and antioxidant properties in broilers. Therefore, food supplements L-Se-Met and D-Se-Met can improve antioxidant ability and Se deposition in blood serum and the tissues and reduce the loss of thoracic-muscle weight in broilers.

The studies of influence of the selenoamino-acid feed supplement on qualitative parameters of meat of the broiler chickens found its positive effect on chemical composition of the muscles. Energy value of meat can be evaluated by the content of dry matter in meat, as well as fat content. Intake of the mineral feed supplement by broiler chickens of the experimental group promoted increases in dry matter and protein in the breast muscles and dry matter and fat in the thigh muscles. Downs et al. (2000) observed that organic selenium in the feeding of broilers positively influenced the yield of eviscerated carcass and the breast muscles, and even reduced the moisture content in the meat. Results of our studies are consistent with the studies by Perić et al. (2009): in our opinion, broilers that had consumed selenium had greater productivity, and their thoracic muscles contained less moisture, indicating juiciness of meat.

Blood is the first to react to various physiological processes occurring in a bird's body. Hematological parameters are a decisive link/crucial for in evaluating the physiological condition of poultry, metabolic processes, and the level of resistance in its organism. During our studies, the experimental group of broiler chickens was observed to have a tendency towards increase in total protein in the blood and number of erythrocytes, though no significant difference was determined. This may be a sign of intensification of metabolic process in poultry. Chudak et al. (2021) determined that intake of a mineral supplement increased the level of hemoglobin and erythrocytes. Similar experiments were performed by Mahmoud & Edens (2003). They found that poultry that consumed organic selenium had higher activity and improved parameters of antioxidant system in blood and the liver. Dalia et al. (2017) determined that organic Se positively influenced the serum activity of ALT, AST and level of creatinine in serum of broilers. Al-Waeli et al. (2013) studied the influence of selenium-containing feed supplement on the hematological parameters of poultry, which fluctuated within the physiological values, revealing no negative effects on the health.

Therefore, intake of mineral feed supplements by broiler chickens increase their productivity, improve slaughter parameters, chemical composition of meat and intensify metabolic process in the body.

Conclusions

Intake of the Alkosel R397 feed supplement by broiler chickens of the experimental group increased the live weight by 8.4% ($P < 0.001$), mean daily increment by 8.5% ($P < 0.05$), and the absolute increment by 8.6% ($P < 0.001$), compared with the control. In the experimental group of broiler chickens, the studied mineral supplement caused increases in the pre-slaughter weight by 8.4% ($P < 0.001$), the weight of intact carcass by 10.1% ($P < 0.001$), semi-processed carcass by 4.3% ($P < 0.05$) and processed carcass by 8.0% ($P < 0.01$), compared with the control. In poultry of the experimental group, the weight of the breast muscles was higher by 13.7% ($P < 0.01$), the thigh muscles by 14.5% ($P < 0.01$), the gizzard by 7.5% ($P < 0.05$), and the duodenum by 9.2% ($P < 0.05$) than the control. Having consumed the Alkosel R397 feed supplement, broiler chickens of the experimental group had 0.2% ($P < 0.05$) higher content of dry matter, 1.9% ($P < 0.05$) more protein in the breast muscles, 0.4% ($P < 0.05$) increase in the dry matter, and 0.9% ($P < 0.05$) in fat in the thigh muscles, as

compared with the control. This confirms the necessity of using selenoamino acids for increasing profits from poultry farming.

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The authors declare no conflicts of interests.

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