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EFFECTS OF SORBENT FEED ADDITIVES ON THE DEVELOPMENT OF INTERNAL ORGANS AND BLOOD PARAMETERS OF BROILER CHICKENS

E.V. Shatskikh [1*], D.M. Galiev [1], I.V. Rogozinnikova [1], A.N. Masliuk [1]

[1] *Department of Zoological Engineering, Ural State Agrarian University, Ekaterinburg, RUSSIA.*

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ABSTRACT

We studied the effects of Carbitox and BSH-VIT sorbent feed additives on the productivity of 1280 broiler chickens, the development of their internal organs, and some blood parameters. Based on the results of experiment #A on adding Carbitox feed additive to the diet of broiler chickens, the absolute gains in all experimental groups were greater than parameters in control animals both in male and female chickens. According to the results of experiment #B on adding BSH-VIT to the diet, in all experimental groups, there was a higher live weight gain in comparison with the control one. There was a tendency to a decrease in the weight of the liver and gizzard stomach in broilers that received BSH-VIT. When using the studied feed additives, analyzed blood parameters of birds were within the physiological norm what indicates the absence of negative effects of tested additives on birds. Administration schemes with a gradual decrease of additives by the end of the growing period showed results similar to those obtained with the equal administration of tested agents. On this basis, we can recommend using these preparations in feeding chickens according to the schemes of experimental groups to reduce the total number of intestinal sorbents used in prophylactic doses.

Disciplinary: Biotechnology, Bioengineering, Zoological Engineering; Agricultural Science, Biology, Veterinary Medicine.

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1 INTRODUCTION

Diet for meat poultry is made taking into account its needs in different periods of ontogenesis; for a short period of growing broiler chickens, their diet changes 3-4 times. At the same time, in the start period of growing, chickens require high quality of feed and, in particular, of feed protein; in the final period, their feed contains more energy. As a rule, the dose of sorbent preparations is specified for the entire growing period, however, these feed additives can be used in different doses depending on the

*Corresponding author (E.V. Shatskikh). Email: evshackih@yandex.ru

technological period. It should be taken into account that intestinal sorbents are not digested in animals and, consequently, do not have any nutritional value. The proportion of adsorbents in feed composition in comparison with other feed additives is relatively high what is typical, in particular, for mineral sorbents. Therefore, one of the negative effects of adding intestinal sorbents to a diet is decreased total nutritional value of a unit of feed.

Intestinal sorbents are used in poultry farming both to control various toxins contained in feed and for the prevention of mycotoxicoses in birds and stimulation of their productivity. The positive effect of these drugs on meat productivity of broiler chickens and their blood parameters was proven (Ovchinnikov et al., 2015; Izmaylovich, 2016a; Al-Araji et al., 2016), and also on the development of internal organs (Kiseleva et al., 2019; Lakkawar et al., 2017).

The goal of this research was to assess the effect of Carbitox and BSH-Vit sorbent feed additives on the productive parameters of broiler chickens, as well as on the development of their internal organs and several blood parameters.

Carbitox complex feed additive includes mineral sorbents: zeolite, bentonite, silicon oxide, opal; organic phytosorbent; probiotic component immobilized on phytosorbent: 3 strains of *Bacillus subtillis*, 1 strain of *Bacillus licheniformis*, lactic acid bacteria complex. The productive effect of this feed additive on animals was demonstrated in many studies (Kononenko et al., 2016; Izmaylovich, 2016b; 2016c).

BSH-VIT is a mineral feed additive based on neutralized white mud and enriched with 0.2% iodine. This preparation contains up to 80% of sodalite-like sodium aluminosilicates (cancrenite, nosean-cancrenite) which provides molecular sieve separation and adsorption of heavy metal ions and mycotoxins. Aluminosilicates make cavities that determine their adsorption properties. Svalukhina (1994), Svalukhina and Buraev (1995), Kotomtsev and Buraev (2010), Usevich et al. (2018), did the study of the effectiveness of this feed additive in animal feeding.

2 EXPERIMENTAL STUDIES

Experimental studies were carried out in the work conditions of OAO Sredneuralskaya Poultry Factory, on Ross 308 broilers. Two research and economic experiments were carried out. The formation of groups for the experiments and scientific basis of this study was performed under the methods recommended by the Federal Scientific Center “All-Russian Scientific Research and Technology Institute for Poultry Industry” of RAS (2013).

The scheme of experiment #A on adding a Carbitox feed additive to the diet of broiler chickens is shown in Table 1. The Control group received a basic diet. Experimental groups, in addition to the basic diet, received Carbitox feed additive in different doses depending on the growing period.

For each of the experiments #A and #B, 640 broiler chickens with an average live weight of 43 grams were selected and divided equally into 4 groups, i.e., one control and three experimental. Each group included 160 birds, 80 males, and 80 females. Experiments continued throughout the entire growing period.

Feeding was carried out using diets adopted at the farm for the experiments. It was phase feeding divided into four periods: start (1-10 days), growing 1 (11-20 days), growing 2 (21-30 days), end (from 31 days to the end of growing).

Table 1: Scheme of the experiment #A on adding Carbitox feed additive to the diet of broilers

Group	Birds	Start 1-10 days	Growing 1 11-20 days	Growing 2 21-30 days	End 31-38 days
Control	80 ♂ 80♀	Basic diet (BD)			
#1A	80♂ 80♀	BD	BD + Carbitox 1 kg/t of feed		
#2A	80♂ 80♀	BD	BD + Carbitox 1 kg/t of feed	BD + Carbitox 0.75 kg/t of feed	BD + Carbitox 0.5 kg/t of feed
#3A	80♂ 80♀	BD	BD + Carbitox 1.5 kg/t of feed	BD + Carbitox 1 kg/t of feed	BD + Carbitox 0.5 kg/t of feed

Table 2 shows the scheme of experiment #B on adding BSH-VIT feed additive to the diet of broiler chickens. The Control group received a basic diet. Experimental groups, in addition to the basic diet, received BSH-VIT feed additive in different doses depending on the growing period.

Table 2: Scheme of the experiment #B on adding BSH-VIT feed additive to the diet of broilers

Group	birds	Start 1-10 days	Growing 1 11-20 days	Growing 2 21-30 days	Growing 31-38 days
Control	80 ♂ 80♀	Basic diet (BD)			
#1B	80♂ 80♀	BD+ BSH-VIT 2 kg/t of feed			
#2B	80♂ 80♀	BD + BSH-VIT 2.5 kg/t of feed	BD + BSH-VIT 2 kg/t of feed	BD + BSH-VIT 1 kg/t of feed	BD + BSH-VIT 0.5 kg/t of feed
#3B	80♂ 80♀	BD	BD + BSH-VIT 2.5 kg/t of feed	BD + BSH-VIT 1.5 kg/t of feed	BD + BSH-VIT 0.5 kg/t of feed

Anatomical dressing of poultry was carried out according to the technique of the Federal Scientific Center "All-Russian Scientific Research and Technology Institute for Poultry Industry" of RAS (2013). For this, 3 broiler males with average live weight were taken from each group at the end of the growing period.

At 38 days of age, the blood of three average male broilers from each group was taken by decapitation to determine its morphological and biochemical parameters. A blood test was performed at Municipal Autonomous Institution "Clinical and Diagnostic Center". The morphological study of blood was carried out in a hemostatic laboratory, with the help of an ADVIA 120 automatic analyzer manufactured by BAYER, as well as by manual counting of shaped elements in the Goryaev chamber. Blood biochemistry was performed in a clinical diagnostic laboratory on a Vitros 350 analyzer (Ortho-Clinical Diagnostic, USA).

The main experimental data were processed using the variation statistics method and PC Microsoft Excel. The difference was considered to be significant at $P \leq 0.05$; $P \leq 0.01$; $P \leq 0.001$.

3 STUDY DETAILS

3.1 RESULTS OF THE EXPERIMENT ON ADDING CARBITOX FEED ADDITIVE TO THE DIET OF BROILER CHICKENS

Zootechnical productivity parameters obtained as a result of the experiment on adding Carbitox

*Corresponding author (E.V. Shatskikh). Email: evshackih@yandex.ru

feed additive to the diet of broiler chickens are shown in Table 3.

Table 3: Broiler chicken productivity at different ages for experiment #A (n = 80)

Group		10 days, g	20 days, g	30 days, g	38 days, g	Survival rate, %
Males	Control	268.3±3.35	769.8±6.7	1,457.1±13.3	2,123.5±14.2	96.3
	#1A	267.7±3.74	777.0±7.5	1,487.2±15.6	2,160.7±12.8*	93.8
	#2A	266.9±3.41	763.1±6.7	1,467.2±11.1	2,127.6±17.9	98.8
	#3A	267.4±3.25	778.6±5.6	1,494±10.6*	2,163.9±12.1*	96.3
Females	Control	288.3±3.97	710.0±7.5	1,303.7±12.5	1,886.9±17.4	100
	#1A	288.2±3.84	729.5±7.8	1,377.5±14.9**	1,994.6±24.9**	92.5
	#2A	288.9±3.44	719.3±8.3	1,336.5±14.6	1,930.5±20.2	100
	#3A	288.6±3.85	720.6±7.2	1,351.2±12.7**	1,923.5±17.9	100

The trend of the superiority of experimental birds in live weight was already observed at 20 days of age, but differences were more significant at the age of 30 days: for example, males of groups #1A, #2A, and #3A exceeded the control animal of the same age in live weight by 2.1; 0.7 and 2.5% ($P \leq 0.05$), respectively, and females by 5.7% ($P \leq 0.01$), 2.5 and 3.6% ($P \leq 0.01$).

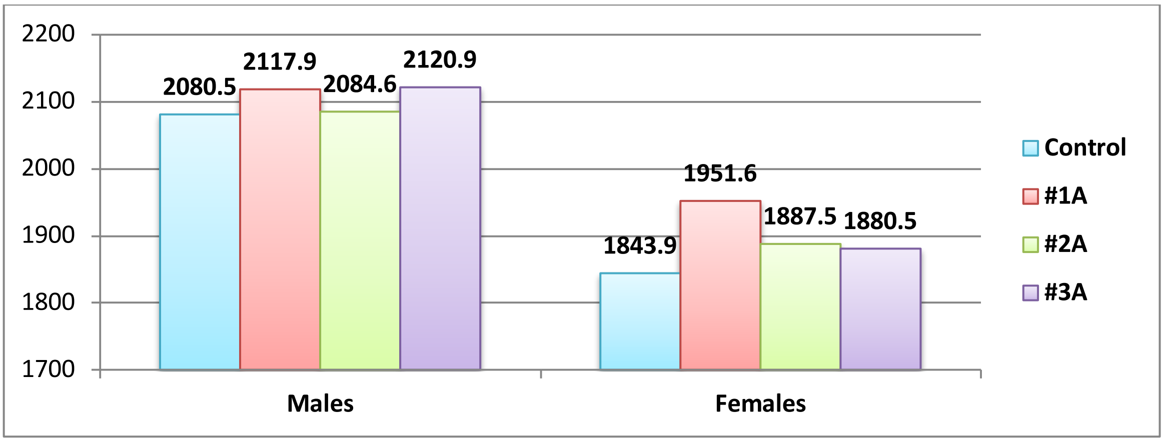

Figure 1: Absolute gain at 38 days (g), for #A.

At the end of feeding (38 days), the live weights of males of experimental groups 1A, #2A, and #3A were higher than this of control ones by 1.8% ($P \leq 0.05$); 0.2 and 1.9% ($P \leq 0.05$), respectively. Females of experimental groups #1A, #2A, and #3A that received Carbitox were 5.8 ($P \leq 0.01$), 2.3, and 2.0 % ahead of control females of the same age, respectively.

The absolute gain rate was obtained by the difference between the initial and final live weight of broiler chickens. In males of the control group, this value amounted to 2,080.46 g, while in experimental groups #1A, #2A, and #3A, it was by 1.8, 0.2, and 1.9% higher compared to the control, respectively. In the control group of females, the absolute gain was at the level of 1,843.87 g; in experimental groups #1A, #2A, and #3A, it was by 5.8, 2.3, and 2.0% higher than in the control one, respectively (Figure 1).

Evaluation of survival rates showed that in experimental groups #2A and #3A that received tested drugs according to the scheme with dose reducing by the end of feeding it was higher, or on a par with the control level. Adding drug in the dose of 1 kg/t of feed from the 11^{th} to the 38^{th} days of growing demonstrated decreased safety by 2.5% and 3.75% compared with the control group.

Adding more test drug to the diet of broilers was accompanied by a reduction in feed costs per 1 kg of live weight gain in comparison with the control group: in experimental males by 2.3-3.4%, in females by 1.8-2.4% what is associated with more intense bird growth.

Additional feeding factors led also to the changes in the weight of the internal organs of chickens, both in absolute values and with regard to the live weight of broiler chickens (Table 4).

Table 4: Weight of the internal organs of broiler chickens, for #A (g).

Organ	Group			
	Control	#1A	#2A	#3A
Liver	54.83±2.66	46.63±3.21	46.43±2.93*	46.37±2.48*
Relative weight, %	2.59	2.14	2.16	2.13
Heart	13.87±1.07	10.80±0.62*	11.13±0.59*	11.63±0.12*
Relative weight, %	0.65	0.54	0.52	0.49
Gizzard stomach	32.00±3.27	30.07±2.42	32.10±3.49	30.53±1.44
Relative weight, %	1.51	1.41	1.49	1.38
Kidneys	15.97±4.91	11.83±1.82	13.30±1.98	13.10±1.13
Relative weight, %	0.75	0.61	0.62	0.54
Lungs	15.00±1.96	13.40±1.02	11.27±1.03	14.03±0.87
Relative weight, %	0.71	0.65	0.52	0.61
Spleen	3.30±0.49	3.17±0.33	3.03±0.93	2.07±0.45
Relative weight, %	0.16	0.10	0.14	0.14

In experimental groups #1A, #2A and #3A, a significant decrease in liver weight was registered compared with the control group: by 14.9; 15.3 ($P \leq 0.05$) and 15.4 ($P \leq 0.05$) %, respectively. The relative weight of this organ was also lower in the experimental groups of chickens on average by 0.45% compared with the control group.

Heart weight in experimental groups #1A, #2A, and #3A showed a significant ($P \leq 0.05$) decrease in both relative (on average by 0.13%) and absolute values (on average by 19.3%) compared with the control group. Herewith, minimum heart weight was registered in experimental group 1.

Gizzard's stomach weight in experimental birds was lower in its relative value by 0.02-0.13% than in the control group but there was no significant difference between the groups. A similar pattern can be observed for all organs tested during this experiment.

The blood test revealed (Table 5) that hemoglobin and red blood cells in the blood of chickens were within the physiological norm. There were no statistically significant differences in these parameters during biometric data processing. There was a slight increase in white blood cells in the experimental groups of broiler chickens; this effect may be associated with a probiotic component in feed additive, similar results were mentioned in Ushakova et al. (2012), Ovchinnikov et al. (2019). In addition to probiotic, the Carbitox feed additive contains phytosorbent that may also have an immune stimulating effect (Loretts et al., 2018).

Table 5: Blood parameters of broiler chickens (n=3)

Blood parameters	Group			
	Control	#1A	#2A	Experimental 3
RBC, 10^{12}/L	2.58±0.08	2.56±0.05	2.65±0.1	2.44±0.18
Hemoglobin, g/L	93.33±4.18	93.00±3.05	98.67±2.03	94.67±4.1
Mean cell hemoglobin, pg	42.87±1.75	43.73±0.64	44.87±0.9	45.73±0.73
WBC, 10^{9}/L	30.47±1.25	31.50±0.76	32.53±1.01	31.83±1.24
Total protein, g/L	38.67±0.87	39.73±2.19	41.60±2.55	39.13±1.69

There was no significant difference in total protein level in the blood of experimental chickens while total protein concentration in serum of broiler chickens of experimental groups #1A, #2A, and #3A was higher in comparison with the control group by 1.2, 7.6, and 2.7%, respectively.

3.2 RESULTS OF THE EXPERIMENT ON ADDING BSH-VIT FEED ADDITIVE TO THE DIET OF BROILER CHICKENS

Zootechnical parameters of productivity in broiler chickens are shown in Table 6.

At 10 days, chickens of experimental groups #1B and #2B that received BSH-VIT feed additive during this period exceeded the control group in live weight: males by 2.6-3.5%, females by 1.7-1.9%. At 20 days, males of experimental groups #1B, #2B, and #3B significantly exceeded control ones by 6.9 (P≤0.001); 6.3 (P≤0.01), and 3.9% (P≤0.05), respectively. Live weight in females of experimental groups was also higher than that of control ones; in this regard, a significant difference with the control group was registered in the experimental group 3-4.2% higher (P≤0.05). At 30 days, broiler males of experimental groups #1B, #2B, and #3B significantly exceeded the control group by 4.1 (P≤0.05); 4.4 (P≤0.05), and 3.9 (P≤0.05), respectively. Live weight in experimental females was also higher than in control ones; a significant difference was obtained for experimental group 3, i.e. higher by 4.4% (P≤0.05). At the end of the growing period (38 days), a significant difference in live weight with the control group was observed in females of experimental groups 1 (by 2.8%) and 3 (by 4.8%) (P≤0.05).

Table 6: Broiler chicken productivity, experiment #B (n=80)

Group		10 days, g	20 days, g	30 days, g	38 days, g	Livability, %
Males	Control	220.8±2.8	666.2±9.5	1,320.7±17.6	2,066.9±26.9	93.8
	#1B	226.6±3.0	712.5±9.9***	1,374.3±19.9*	2,088.1±26.4	100.0
	#2B	228.5±2.7*	708.0±8.8**	1,379.5±16.4*	2,094.1±22.3	95.0
	#3B	217.8±3.2	692.2±9.0*	1,372.8±16.1*	2,085.7±23.6	98.8
Females	Control	211.2±2.7	616.6±9.7	1,216.0±16.5	1,843.5±17.9	98.8
	#1B	215.2±2.7	633.0±7.7	1,250.5±14.0	1,894.4±16.6*	98.8
	#2B	214.8±2.9	631.4±10.5	1,245.9±23.8	1,891.5±25.6	98.8
	#3B	210.8±2.7	642.7±8.9*	1,269.0±21.4*	1,931.2±23.8**	97.5

In broiler males that received sorbent additive, this parameter tended to increase and was at the level of 0.9-1.3%.

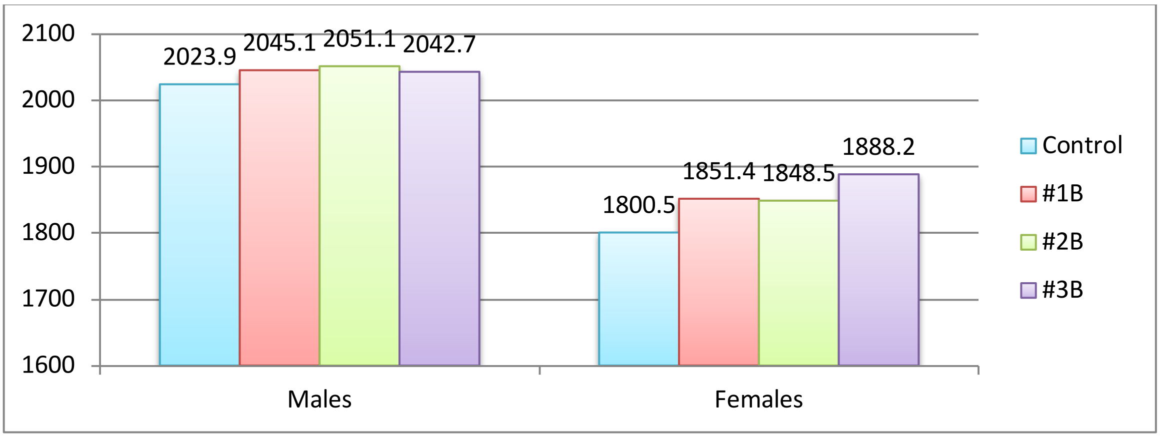

Figure 2: Absolute weight gain at 38 days old for #B (g).

Absolute live weight gain in chickens of the control group for the entire growing period was 2,023.9 g in males and 1,800.5 in females. All experimental groups showed a higher live weight gain compared to the control group, by an average of 1.1% in males and 3.4% in females (Figure 2).

Survival rate analysis showed an increase in experimental groups #1B, #2B, #3B, in males by 6.25, 1.28, and 5.0% in comparison with control birds. In broiler females, this parameter was the same in experimental groups #1B, #2B, and in the control group, it amounted to 98.75%. The survival rate in experimental group #3B was lower than in the control group by 1.25%.

Table 7 shows the absolute and relative weight of some internal organs of 38-day old broiler males.

The liver is an organ that acts as a filter and neutralizes toxins that come to the body with food. In experimental groups #1B, #2B, and #3B, liver weight was lower compared with the control group by 17.4 ($P \le 0.05$), 7.2, and 13.8%, respectively. The relative weight of the liver was the smallest in experimental group 1 (2.13%); it is 0.48% less than the corresponding value in the control group. Smaller liver weight in experimental chickens may indicate that the additive performs its main function, i.e. reduces the negative effect of exo- and endotoxins on the body and specifically on broiler liver lowering detoxification load on this organ.

No significant differences in the weight of kidneys, lungs, and heart between the control and experimental groups of broiler chickens were found. There were no significant differences in the absolute weight of intestine between the control and experimental groups, however, there is a tendency to its increase in experimental groups by an average of 7%.

Table 7: Weight of the internal organs of #B broiler chickens, g

Organ	Group			
	Control	#1B	#2B	#3B
Liver, g	57.70±2.66	47.63±0.84*	53.57±2.50	49.73±1.07
Relative weight, %	2.61	2.13	2.47	2.22
Heart, g	9.13±0.84	10.33±1.36	9.27±0.48	9.17±0.22
Relative weight, %	0.41	0.46	0.43	0.41
Gizzard stomach, g	32.77±0.94	29.50±1.28*	31.90±2.20	29.53±1.10*
Relative weight, %	1.50	1.33	1.47	1.31
Kidneys, g	13.33±0.67	14.00±1.15	14.00±0.58	13.33±0.67
Relative weight, %	0.60	0.63	0.64	0.59
Lungs, g	14.67±2.91	12.67±0.67	13.33±2.40	16.00±2.31
Relative weight, %	0.66	0.57	0.61	0.71
Intestine, g	86.57± 5.11	91.47±5.55	96.13±5.38	90.57±5.02
Relative weight, %	3.91	4.09	4.43	4.02

The average absolute weight of gizzard stomachs of the males of experimental groups #1B, #2B, and #3B was lower than that of the control group by 10.0; 2.7, and 9.9%, respectively; moreover, in experimental groups #1B and #3B, the difference was significant ($P \le 0.05$). Changes in the relative weight of this organ are of the same pattern, namely, decreased weight in experimental groups compared with the control group.

Studied blood parameters of broilers that received BSH-VIT feed additive were within the physiological norm (Table 8); no significant differences were found between experimental groups

#1B, #2B, and #3B and the control group; however, there were some variations.

Table 8: Blood parameters of broiler chickens for #B.

Parameter	Group			
	Control	#1B	#2B	#3B
RBC, 10^{12}/L	2.20±0.20	2.57±0.04	2.54±0.05	2.61±0.03
Hemoglobin, g/L	82.33±7.36	85.50±0.87	83.00±0.29	89.00±1.15
Hematocrit, %	24.40±4.19	30.50±0.29	31.00±1.45	32.35±0.20
Mean cell hemoglobin, pg	34.17±2.04	31.80±0.81	31.50±0.32	32.80±0.06
WBC, 10^{9}/L	21.23±2.78	16.88±0.51	17.60±1.73	26.95±0.78
Total protein, g/L	38.03±3.81	37.47±3.08	40.63±2.72	36.57±0.55

The main function of red blood cells is the transfer of oxygen and carbon dioxide what happens due to the hemoglobin they contain. Hemoglobin amount in red blood cells was 4-8% less in the blood of chickens of experimental groups #1B, #2B, and #3B in comparison with the control group. But at the same time, the number of red blood cells in experimental groups was 13-16% higher than in the control group. As a result, the average amount of hemoglobin in blood was greater in experimental groups #1B, #2B, and #3B by 1-8% compared with the control group. In studies on broiler chickens (Drozd, 2019) and cattle (Usevich et al., 2018) that received BSH-HIT deed additive with their diet, increased amount of hemoglobin in the blood of animals was also observed, by 29% and 16.7%, respectively, compared with the control groups that consumed feed without this feed additive. Iron oxide is present in BSH-VIT feed additive (Buraev et al., 2015) what can additionally enrich the diet of birds with this microelement required for hemoglobin synthesis of the animal body.

Hematocrit is the volume percentage of formed elements in total blood volume. A large part of all blood formed elements is represented by red blood cells. In all experimental groups, this parameter was higher by an average of 20-25% than in the control group.

White blood cells perform protective functions. In experimental groups #1B, and #2B, their number was lower than in the control by 17-20%, and in experimental group #3B, it was 27% higher.

Total protein in the blood of control chickens amounted to 38.03 g/L. In experimental groups #1B and #3B, the value of this parameter was 1.5-3.8% less than in the control one, and in experimental group 2-6.8% more than the control level.

4 CONCLUSION

Studied Carbitox and BSH-VIT feed additives being used according to the proposed schemes had a positive effect on poultry productivity; moreover, there was no negative effect on the health of chickens that was confirmed by the blood test. There was an obvious effect of these drugs on the development of the internal organs of birds: decreased weight of liver and heart in groups that received Carbitox feed additive and decreased weight of liver and gizzard stomach in groups received BSH-HIT feed additive in comparison with the corresponding values in control groups. Schemes for administering drugs with gradually decreasing doses of studied drugs by the end of the growing period (experimental groups #2B and #3B) showed good results similar to those obtained in experimental groups 1 where additives were used throughout the growing cycle in one dose. On this basis, it is possible to recommend using these drugs when growing broiler chickens according to schemes of experimental groups #2B and #3B to reduce the total amount of intestinal sorbents used in prophylactic doses.

5 AVAILABILITY OF DATA AND MATERIAL

Information can be made available by contacting the corresponding author.

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Dr.Shatskikh Elena Viktorovna holds a Doctor of Biological Sciences. Her research interests include Development and Scientific and Practical Justification of Rational Approaches to Feeding, Adaptation, Increase the Resistance of Poultry Crosses to Modern Technologies.

Galiev Danis Minnjanovich is interested in the Feeding of Farm Animals and Birds.

Rogozinnikova Irina Viktorovna is a Candidate of Biological Sciences. Research interests: Feeding Farm Animals and Birds.

Maslyuk Anna Nikolaevna is a Candidate of Biological Sciences. Scientific interests: issues of the use of Biologically Active Additives and Feed Technologies aimed at Improving the Productive and Economic indicators of Animals and Poultry.

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