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DYNAMICS OF HAEMATOLOGICAL AND FUNCTIONAL PARAMETERS OF PEKIN DUCK BLOOD DURING ADMINISTRATION OF ORGANIC SELENIUM PREPARATION

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SUMMARY

Age-related dynamics of hematological and functional parameters of Pekin duck blood during administration of organic selenium preparation DAFS-25k (at a 1.3 mg/kg dose) was presented. In order to study morphological parameters from the age of one day old to 120 days old blood was collected from axillary vein of birds prior to feeding each 15 days in the morning. To assess hematological parameters RBC and WBC count was performed, hemoglobin contents and hematocrit value were determined and color index of blood was calculated. The experiment demonstrated gradual increase in these parameters in the experimental and control groups. Birds from the experimental group demonstrated higher parameters than those of the control group. It was determined that hemoglobin contents was 9.86% higher in the experimental group in comparison with the control group due to selenium administration. The blood color index in this group was also higher ($p \leq 0.05$). Biochemical blood analysis included the following parameters: total protein, albumin, uric acid, glucose, calcium, phosphorus, ALT and AST transaminase. The test results showed that during all age periods total protein and albumin contents in ducks of the experimental group exceeded those of the control group. The selenium-containing preparation had a positive influence on the carbohydrate metabolism ensuring high level of metabolic processes in birds, contributed to optimal calcium to phosphorus ratio which positively influenced mineral metabolism and development of the locomotor system. Obtained AST and ALT values in both groups are not beyond reference values which indirectly confirms absence of toxic effect on ducks' organism if selenium is administered at the specified doses. It was determined that DAFS-25k has not affected hematological and functional parameters of Pekin duck blood and it contributed to mineral metabolism correction, reduction of stress factor effect within critical periods of development and improvement of the excretory system function.

Key words: Pekin duck, organic selenium preparation, hematology test, biochemical blood analysis.

INTRODUCTION

Russian poultry industry makes a weighty contribution to the food security, as it is a key producer of high quality animal proteins, whose proportion in daily ration of the Russian citizens amounts to 40% due to egg and poultry meat consumption [4, 12]. Within the structure of the poultry industry the production of meat ducklings ranks next to the broiler chicken production.

Meat ducklings are characterized with high growth rate: during the first 7-8 weeks of life their body weight increases 50-60-fold and reaches 3 kg and even more by the moment of slaughter. Herewith the feed conversion is 3.2-3.4 kg for each 1 kg of weight gain. Among the meat-type duck breeds the Pekin ducks are the most wide spread as their high index of meat production allows for their industrial breeding [11].

Use of selective and genetic material stocks is impossible without high level of veterinary service and up-to-date feeding technologies, which include consumption of different additives in order to prevent metabolic disorders and to improve feed bioconversion. One of such additives is an organic selenium preparation DAFS-25k that is involved in the process of cellular respiration and oxidative phosphorylation. The preparation reduces the rate of catalysis of individual enzyme systems, demonstrates anti-toxic properties, prevents overoxidation of fatty acids and accumulation of toxic elements in the body and aids to the increase of glutathione peroxidase activity thus regulating metabolism [6]. There are published reports on the use of selenium in animal and poultry rations [5, 8]. However, reports of its effect on metabolism in birds are fragmentary and there are no such reports on Pekin ducks.

Therefore, the goal of the work included determination of the effect of the organic selenium preparation DAFS-25k on morphological and biochemical blood parameters of Pekin ducks.

Table 1
Age-dependent changes of blood morphology in Pekin ducks in the control and experimental group
n = 5

Age, days	Hematocrit, %		RBC, $\times 10^{12}$/l		Hemoglobin, g/l		Color index		WBC, $\times 10^{9}$/l	
	control	experiment	control	experiment	control	experiment	control	experiment	control	experiment
1	39.88±0.22		3.51±0.11		110.14±1.61		1.53±0.06		12.84±0.12	
15	41.50±0.27	41.62±0.23	3.62 ±0.15	3.68 ±0.08	115.63 ±2.32	117.30 ±2.16	0.95 ±0.07	0.95 ±0.05	13.62 ±0.17	13.32 ±0.81
30	41.00±0.27	41.30±0.13	3.68 ±0.12	3.74 ±0.05	115.18 ±3.46	119.86 ±2.37	0.95 ±0.08	0.96 ±0.03	14.08 ±0.11	14.12 ±0.21
45	41.36 ±0.16	42.64 ±0.13	3.70 ±0.11	3.85 ±0.06	116.01 ±2.34	121.04 ±2.18	0.94 ±0.04	0.94 ±0.03	13.89 ±0.14	14.04 ±0.16
60	41.84 ±0.17	43.18 ±0.15	3.62 ±0.08	3.71 ±0.07	116.21 ±2.16	123.48 ±3.14	0.98 ±0.06	0.99 ±0.05	12.84 ±0.45	13.67 ±0.32
75	42.44 ±0.18	42.86 ±0.11	3.81 ±0.06	3.82 ±0.06	116.74 ±2.26	126.38 ±2.16*	0.92 ±0.02	0.99 ±0.02*	12.99 ±0.10	13.09 ±0.18
90	42.68 ±0.18	43.01 ±0.18	3.84 ±0.06	3.88 ±0.07	116.62 ±1.16	127.20 ±3.37*	0.92 ±0.01	0.98 ±0.01*	12.64 ±0.15	13.39 ±0.22
105	42.94 ±0.19	43.79 ±0.10	3.79 ±0.08	3.82 ±0.06	116.14 ±2.18	127.85 ±1.13*	0.93 ±0.01	1.00 ±0.01*	12.74 ±0.11	12.84 ±0.18
120	42.74 ±0.17	43.81 ±0.13	3.85 ±0.09	3.95 ±0.09	117.21 ±1.22	127.98 ±2.18*	0.93 ±0.01	1.00 ±0.02*	12.65 ±0.10	12.93 ±0.16

* $p \leq 0.05$ as compared to the control.

MATERIALS AND METHODS

Test object. Day-old Pekin ducklings were used in the experiment. The birds hatched in Romashino KFH (Moscow Oblast) that is free from infectious and invasive diseases. The ducklings were raised in Anisimov backyard (Vladimir Oblast). The keeping and feeding conditions were compliant with the standards and requirements specified in Methodical Instructions for Process Design of Poultry Farms RD-APK 1.10.05.04-13. Selenium content in the combined feed was tested using atomic absorption spectrometer MGA 915-MD in the Kostroma Oblast veterinary laboratory.

Experimental and control groups (40 birds in each) were formed for the experiment. Before the experiment five day-old ducklings were euthanized for determination of their blood profile. The control birds were given basic ration conventionally used on for the farm. Selenium containing preparation DAFS-25k was daily added to the ration of the experimental ducklings at a dose of 1.3 mg/ kg of feed. In order to study morphofunctional parameters, each 15 days the blood was collected from axillary vein of birds in the morning before feeding. The experiment lasted for 120 days.

RBC and WBC were counted according to Fomina K.S and Shmelkova V.I. in Goryaev camera; hemoglobin was determined using Sahli's method and HCT was determined using hematocrit centrifuge CM-70. Color index (CI) was calculated according to the formula

Blood biochemistry test included determination of a number of parameters: total protein, albumin, uric acid, glucose, calcium, phosphorous, Alanine transaminase (ALT) and Aspartate transaminase (AST). The tests were performed using semi-automated open-type biochemistry analyzer Biochem BA with Olvex manufactured reagents.

Table 2
Changes of proteins, uric acid and glucose in blood sera of Pekin ducks in control and experimental groups
n = 5

Age, days	Total protein, g/l		Albumen, g/l		Uric acid, μM/l		Glucose, mM/l	
	control	experimental	control	experimental	control	experimental	control	experimental
1	37.18±0.32		18.52±0.21		486.22±24.03		5.32±0.11	
15	39.62 ±0.34	40.12 ±0.41	20.42 ±0.17	21.96 ±0.20	392.15 ±18.06	382.42 ±14.06	8.32 ±0.11	8.64 ±0.12
30	37.96 ±0.33	43.60 ±0.12*	20.41 ±0.19	23.65 ±0.18*	380.34 ±14.15	370.36 ±11.15	9.28 ±0.12	9.80 ±0.22
45	39.85 ±0.38	44.68 ±0.34*	23.37 ±0.28	25.81 ±0.23*	372.31 ±12.11	365.28 ±10.05	9.36 ±0.11	10.91 ±0.11*
60	41.65 ±0.28	45.28 ±0.28*	23.19 ±0.19	25.90 ±0.25*	391.44 ±15.04	358.36 ±12.14	9.28 ±0.14	10.81 ±0.16*
75	38.18 ±0.34	44.02 ±0.18*	21.36 ±0.35	24.42 ±0.18*	378.44 ±10.27	342.41 ±10.26	9.26 ±0.12	10.79 ±0.18*
90	40.51 ±0.24	45.15 ±0.37*	21.82 ±0.19	23.71 ±0.33*	362.54 ±16.06	340.49 ±12.08	9.32 ±0.17	10.89 ±0.17*
105	41.89 ±0.31	44.08 ±0.39*	23.14 ±0.31	25.18 ±0.29*	350.56 ±14.05	333.19 ±12.26	9.69 ±0.18	10.90 ±0.16*
120	41.10 ±0.25	45.67 ±0.30*	23.42 ±0.26	25.10 ±0.27	354.51 ±10.11	338.57 ±10.04	9.82 ±0.14	10.93 ±0.13*

*$p \leq 0.05$ as compared to the control.

Table 3
Changes in calcium and phosphorus levels in blood sera of Pekin ducks in control and experimental groups
n = 5

Age, days	Calcium, mM/l		Phosphorus, mM/l		Calcium to phosphorus ratio, %	
	control	experimental	control	experimental	control	experimental
1	2.87±0.07		1.39±0.07		2.06±0.07	
15	3.08±0.09	3.16±0.10	1.45±0.08	1.49±0.08	2.12±0.11	2.12±0.09
30	3.19±0.09	3.42±0.10*	1.49±0.07	1.58±0.09	2.13±0.11	2.15±0.08
45	3.18±0.07	3.45±0.07*	1.49±0.06	1.61±0.08*	2.14±0.07	2.14±0.11
60	3.20±0.10	3.45±0.08*	1.49±0.04	1.57±0.09*	2.15±0.07	2.20±0.07
75	3.22±0.08	3.72±0.09*	1.51±0.05	1.67±0.09*	2.13±0.12	2.22±0.09
90	3.75±0.09	4.22±0.10*	1.75±0.11	1.93±0.12*	2.14±0.11	2.18±0.10
105	3.45±0.09	3.88±0.09*	1.60±0.09	1.80±0.08*	2.16±0.13	2.15±0.11
120	3.30±0.08	3.73±0.09*	1.51±0.07	1.70±0.08*	2.18±0.14	2.20±0.09

*$p \leq 0.05$ as compared to the control.

The obtained figures were processed using variation statistics method and Microsoft Excel software.

RESULTS AND DISCUSSION

Hematological tests of Pekin ducks' blood demonstrated that at the age of one day old the amount of RBC was (3.51 ± 0.11)×10^{12}/l, hemoglobin – (110.14 ± 1.61) g/l, WBC – (12.84 ± 0.12)×10^{9}/l, that is consistent with the reference ranges typical for this bird species (Table 1) [2]. Smooth increase of the parameters was demonstrated in both groups before the age of 60 days old, however, in the experimental group all parameters were reported to be higher as compared to the control group. RBC level reduction at the age of 60 days old in both groups was due to the critical stage of development involving entering into mold. The experimental birds demonstrated less expressed reduction that could be related to the beneficial effect of selenium on the hematopoiesis. At the age of 75-120 days old statistically significant 9.86%-increase of hemoglobin was reported in the experimental group as compared to the control group. Hence, the color index was also higher in the birds in this group ($p \leq 0.05$). Within the whole experiment (120 days) both in the control and experimental groups the RBC level nonlinearly increased from 3.51 × 10^{12}/l to 3.85 and 3.95×10^{12}/l, i.e. from 9.11 to 11.56%.

Organic selenium preparation DAFS-25k did not make any negative effect on the immunobiological status as WBC level in experimental ducklings remained within the range of 12.84–14.12×10^{9}/l and had no statistically significant difference with the control group. Data on hematologic profile dynamics following the ration correction with selenium were consistent with other published reports [9–11].

Results of biochemical blood assay demonstrated that at all ages the total protein and albumin were higher in ducklings in the experimental group as compared to the control group, with the difference being statistically significant starting from the age of 30 days old ($p \leq 0.05$) and amounting to 9.81-11.40%. It is worth mentioning that at the age of 30 and 75 days old the rate of protein synthesis decreased in the both groups due to critical stages in the ducklings' development involving substitution of natal dawn with juvenile plumage and peak of juvenile moult. During these periods, the decrease of protein synthesis was more expressed in the control group. Organic selenium preparation aided to the correction of the protein synthesis function of the cells in experimental ducklings. Similar data were reported by other researchers [7, 8, 13].

DAFS-25к also demonstrated positive effect on the carbohydrate metabolism. In experimental duckling the blood glucose was higher during all tested age periods. However, the difference became statistically significant only starting from the age of 30 days old and amounted to 11.3% ($p \leq 0.05$, Table 2) by day 120. This is associated with more intense metabolism in this group.

Uric acid is a poorly soluble compound, which is synthesized in the liver and extracted by the kidneys as a basic product of metabolic breakdown of protein-associated nucleic acids. The experimental group demonstrated stable dynamics in the uric acid decrease in blood sera that was indicative of high functional activity of urinary system and was consistent with the published data [1, 3].

Analysis of calcium and phosphorus changes definitely demonstrated their higher levels in blood sera of Pekin ducks in the experimental group, which were not below the reference ranges (Table 3). DAFS-25k contributed to the optimization of calcium to phosphorus ratio hence making beneficial effect on mineral metabolism and formation of muscular and skeletal systems.

Aspartate transaminase (AST) and alanine aminotransferase (ALT) enzymes catalyze major processes involving protein metabolism; they are involved in the amino acid transamination and their synthesis. The experimental 45-day-old ducklings demonstrated higher ALT activity. Analysis of AST dynamics was indicative of the tendency of this index increase in the experimental group (Table 4). In both groups, the AST and ALT levels did not go beyond the reference ranges that implied absence of toxic effect of selenium on the ducklings if applied in recommended dosage.

Table 4
Changes of enzymatic activity of aminotransferase in blood sera of Pekin ducks in control and experimental groups
n = 5

Age, days	ALT, Units/l		AST, Units/l	
	control	experimental	control	experimental
1	20.40±0.23		77.97±0.48	
15	16.74±0.16	17.11±0.20	63.12±0.38	64.21±0.28
30	18.21±0.18	19.34±0.18	66.80±0.32	68.51±0.36
45	19.18±0.14	20.11±0.12*	67.14±0.43	69.30±0.38
60	23.67±0.28	26.08±0.18*	63.45±0.52	64.48±0.44
75	23.45±0.16	26.54±0.16*	67.11±0.48	67.21±0.42
90	23.48±0.33	28.14±0.34*	68.40±0.31	69.12±0.38
105	24.68±0.22	28.62±0.18*	70.45±0.23	72.06±0.58
120	24.88±0.28	29.14±0.18*	70.78±0.60	72.12±0.42

*$p \leq 0.05$ as compared to the control.

CONCLUSION

The studies demonstrated that in response to organic selenium preparation DAFS-25k the hemoglobin level in the blood of experimental ducklings was 9.86% higher as compared to the control birds thus facilitating more intense oxygen transportation to the tissues and activation of reduction-oxidation reactions. DAFS-25k made beneficial effect on the protein exchange; herewith, the total protein was 9.81% higher and albumin was 11.40% higher in the blood sera of experimental ducklings as compared to the controls, which was indicative of the activation of the protein synthesis function. Glucose level in blood of experimental ducklings was 11.3% higher than the similar index of the control birds, and this facilitates higher energy support of metabolism. If administered in the recommended dosage, the feed additive aids to the mineral exchange alignment and stimulates excretory system activity as evidenced by the lower level of uric acid in the blood of experimental ducks, and the results of the analysis of AST and ALT changes support the absence of toxic effect resulting from its use.

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