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Ecological and Incubation Properties of Laying Hens' Eggs when Using Antioxidant Supplement in the Ration.

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ABSTRACT

The inclusion of complex antioxidant biological supplement in the ration of laying hens increases detoxification activity of the liver, optimizes the biochemical composition of eggs, heightens minerals and vitamins deposition in them, contributes to the decrease of xenobiotics that demonstrates their ecological safety and improves incubation properties.

Keywords: heavy metals, vitamins, antioxidant biological supplements, impregnation, hatchability.

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INTRODUCTION

Alongside with the development of advanced technological methods of eggs incubation, a problem of finding ways to increase their hatchability is rather actual, as it is a rather important factor of reproduction and growth of industrial livestock. The incubation properties of eggs depend on the environment, influencing the level of the genetic potential of laying hens, their feeding coming first among the conditions. Biological usefulness of incubation eggs is related to the ability of the laying hen organism to digest normally and to pass on a number of nutrients essential for the embryonic development from the forage on different levels of the incubation process. Meanwhile the shortage of beta-carotene, vitamins E, C and selenium (because of their instability) as important elements of the organism antioxidant status optimization and its disease resistance is followed by the worsening of incubation eggs properties and the appearance of physiologically immature remedial young birds [3,4,5, 6,8, 9, 10].

Taking into consideration the relevance and the timeliness of the problem the scientists of the Ulyanovsk State Agricultural Academy named after P.A. Stolypin carried out the research on the use of antioxidant mineral-vitamin supplement in the forage of laying hens. The ascertainment of the supplement influence on the level of heavy metals content in the liver, the protein and the yolk of eggs and their biochemical composition, fertilization of eggs and their hatchability was also the point of the investigation.

MATERIALS AND TECHNIQUES

The scientific experiment was carried out at the LLC "Simbirskaya poultry farm" of Ulyanovsk region. Three groups of commercial herd cross "Rodonit 2" laying hens took part in the experiment, 364 hens in each group: I group – the test one, II and III – experimental groups. The feeding of the studied poultry was done in accordance with the "Feeding poultry recommendations" (VNITIP, 2004). At the same time different in composition antioxidant supplement was added by the technique of step mixing to one ton of the compound feed: in the group II it was 1 litre of vitamin and selenium containing "Kartsesel" and in the group III – 240 grams of liposomal form of the substance "Lipovitam Beta".

The vitamin-mineral supplement "Kartsesel" contains 0,18% of beta carotene, 0,5% of vitamin E (alpha-tocopherol acetate), 0,5% of vitamin C (ascorbyl palmitate) and 0,225% of selenium (diatsetofenonil selenid) in the unrefined oil. In 1 gramm of "Lipovitam Beta" there are 0,0294 gr of natural beta carotene, 0,1471 gr of vitamin C, 0,0294 of vitamin E, 0,059 gr of phospholipids, 0,0002 of butylhydroxyanisole, and sorbitol as a filler. While dissolving in the digestive tract the components of "Lipovitam Beta" are enclosed into a microcapsule (liposome), ensuring their high bioavailability (more than 90%, and 10-30% in traditional substances), and acting as a storage, from which the biological substances are released gradually, in necessary dosage and during the required time interval [1, 2]. Operating principle of the supplements is based on the mobilization and intensification of the internal resources of the organism, liver and kidneys protection, normalization of the metabolism, prevention of the free radicals development processes and their pathological influence on the reproduction organs and eggs quality.

In the course of the research, the keeping conditions of the laying hens of the compared groups were equal and the zoohygienic microclimate conditions were optimal.

Physiological experiments were carried out in the accredited "Testing laboratory of the biological objects quality, feeding of livestock and poultry" of the Ulyanovsk State Agricultural Academy.

To study the detoxification activity of the liver of laying hens their test killing of four hens from each group was held in the period of laying peak. The nitrite and nitrate content was defined by the ionometer EB-74, the content of heavy and toxic metals (S, Zn, Mn, Fe, Co, Cu, Cd, Pb, Ag), as well as the safety of egg were determined by the presence of Cd, Pb, Hg by the atomic absorption spectrometry method with the electrothermal atomization of chemical elements at the "Quant-Z-ETA" appliance. This method was also used to define the lead and cadmium content in the laying hens dung. The yield of hatching eggs (%) was defined by the ratio of suitable for incubation eggs amount to the general amount of the examined eggs. The hatching properties of the eggs (fertilization, hatchability, breeding of the young, incubation waste) were determined by incubating eggs from each group at 26, 44 and 59 week age of the laying hens. The fertilization of the eggs was expressed by the percentage of their fertilization from the amount put for the incubation. The hatchability of

the eggs was denoted by the percentage of the raised healthy young poultry from the amount of the fertilized eggs. The breeding of the young poultry was determined by the percentage of the raised young poultry from the amount of the eggs put for the incubation. The results of the research were processed by the methods of mathematical statistics [6].

RESULTS OF THE RESEARCH

All substances that get into the organism of the laying hen with the feed, are fissioned and absorbed in the blood and then brought to the internal organs by veins, vessels and capillaries. In its turn the liver performs the function of the barrier between the systems of blood circulation and digestion, decreasing and eliminating negative effects from allergens and toxins or removing them from the organism entirely.

It was established, that feeding laying hens with the compound feed, enriched with the antioxidant vitamin-mineral supplement contributed to the detoxification activity of the liver (decreases the accumulation of xenobiotics). It is proved by the content decrease of nitrates in the liver by 1, 59 - 1, 42 times, and nitrites by 1, 42 - 1, 18 times ($P < 0,05 - 0,01$) with the complete absence of lead, cadmium, mercury (table 1). Alongside with it the level of the removal of lead from the organism with the dung increased sufficiently by 1, 61 – 1, 48 ($P < 0,01$) and of cadmium by 1, 27-1, 26 ($P < 0,001$) times more than in the test group.

Table 1: The content of xenobiotics in the liver and dung of the laying hens, mg/kg

Index	Group		
	I	II	III
Xenobiotics in the liver			
Nitrites	34,500±3,096	21,750±1,750 ⁺	24,250±1,652 ⁺
Nitrates	0,225±0,010	0,158±0,013 [*]	0,190±0,006 ⁺
Lead	0,033±0,004	not detected	not detected
Cadmium	0,012±0,001	not detected	not detected
Mercury	0,00108±0,00009	vestige	not detected
Xenobiotics in the dung			
Lead	0,2058±0,0188	0,3304±0,0119 [*]	0,3056±0,0236 [*]
Cadmium	0,0508±0,0012	0,0644±0,020 ^{**}	0,0640±0,0033

+ $P < 0,05$; * $P < 0,01$; ** $P < 0,001$

Table 2: Heavy metals in the protein and in the yolk of the eggs, mg/kg

Metal	The age of laying hens and the group					
	26 weeks			44 weeks		
	I	II	III	I	II-O	III – O
In the protein						
Pb	0,0893±0,0002	0,0239±0,0001 [*]	0,0241±0,0003 [*]	0,1102±0,0002	0,0248±0,0004 [*]	0,0259±0,0001 [*]
Cd	0,0239±0,0001	0,0130±0,0003 [*]	0,0127±0,0003 [*]	0,0208±0,0001	0,0121±0,0003 [*]	0,0117±0,0004 [*]
Hg	0,0008±0,0001	not detected	not detected	0,0006±0,0001	not detected	not detected
In the yolk						
Pb	0,0995±0,0002	0,0255±0,0005 [*]	0,0267±0,0001 [*]	0,1118±0,0001	0,0269±0,0003 [*]	0,0273±0,0003 [*]
Cd	0,0253±0,0003	not detected	0,0125±0,0005 [*]	0,0217±0,0001	not detected	not detected
Hg	not detected	not detected	not detected	not detected	not detected	not detected

* $P < 0,001$

Biological transformation of toxic substances in the livers of laying hens of experimental groups, active metabolic processes in their organisms, stimulated by the influence of the added into the compound feed supplements, permitted to decrease the content of heavy metals in the eggs and improve their ecological safety. Thus, the content of lead and cadmium in the egg protein decreased in the age of 26 weeks in group II by 3, 74 and 1, 84 times respectively, and in the age of 44 weeks it decreased by 4, 44 and 1,72 times. In group

III the decrease was by 3, 71 and 1, 88 times ($P < 0,001$) in the age of 26 weeks and by 4, 25 and 1,78 times ($P < 0,001$) in the age of 44 weeks with complete absence of mercury (table 2). In the yolk of the eggs the content of lead in the group with “Kartsesel” is by 3, 90 and 4, 16 times smaller and no cadmium is detected. In the group with “Lipovitam Beta” the content of lead was decreased by 3, 73 - 4, 1 times. The content of cadmium in the yolk of the eggs in the age of 26 weeks was by 2, 02 times smaller than in the test group. In the age of 44 weeks it was not detected at all, though in the yolk of the eggs in the test group there was the presence of cadmium within 0, 0217 - 0, 0253 mg/kg.

A full-fledged incubatory egg must include all the substances necessary for the development of an embryo. Along with it each of the constituent parts performs a definite function in the period of incubation. The protein has the sufficient amount of water for the developing embryo and also the necessary amino acids and a germicidal substance – lysozyme, that kills the germs or hinders their development. In its turn the yolk is an ovum in itself with necessary nutrients – proteins, lipids, carbohydrates, macro- and microelements, vitamins that feeds the blastoderm the embryo develops from [7]. The influence of the balanced in nutritional and biologically active substances hen ration on the chemical composition of the eggs, synthesis of its constituents is a fully proved fact.

It was established (table 3) that in the eggs of 26 week age hens in the group with “Kartsesel” the content of dry matter is increased by 0, 170% in the protein part and by 0,223% in the yolk ($P < 0,001$). In the eggs of 44 week age hens it is increased by 0,307 and 0,387% on account of greater accumulation in the dry matter of protein ($p < 0,05-0,01$), fat ($P < 0,05-0,01$), carbohydrates ($P, 0,05-0,001$). The laying hens of the experimental group III, that consumed the vitamin complex of the liposomal form “Lipovitam Beta” in the compound feed surpassed the test hens in the age of 26 weeks in the content of dry matter in the eggs by 0,172% in the protein part and by 0,231% ($P < 0,001$) in the yolk. In the age of 44 weeks the figures were the following: by 0,311% in the protein part and by 0,415% ($P < 0,001$) in the yolk.

Table 3: The chemical composition of the laying hens’ eggs

Index	The group in the laying period					
	I	II	III	I	II	III
The content in the protein part, %						
Dry matter	12,018±0,013	12,188±0,019 ⁺	12,190±0,018 ⁺	11,669±0,023	11,976±0,380 ⁺	11,984±0,026 ⁺
Protein	10,688±0,023	10,800±0,028 ^{**}	10,761±0,015 ^{**}	10,454±0,048	10,643±0,045 ^{**}	10,611±0,020 ^{**}
Fat	0,022±0,001	0,026±0,001 ^{**}	0,028±0,001 ^{***}	0,027±0,001	0,028±0,001	0,029±0,001 ^{**}
Carbohydrates	0,782±0,015	0,833±0,017 ^{**}	0,871±0,017 ^{***}	0,683±0,035	0,776±0,017 ^{**}	0,819±0,036 ^{**}
Ash	0,526±0,017	0,529±0,032	0,530±0,030	0,505±0,013	0,529±0,015	0,521±0,016
The content in the yolk, %						
Dry matter	50,794±0,016	51,017±0,028 ⁺	51,025±0,043 ⁺	50,723±0,025	51,110±0,051 ⁺	51,138±0,049 ⁺
Protein	16,477±0,026	16,572±0,022 ^{**}	16,587±0,018 ^{***}	16,640±0,041	16,812±0,035 ^{**}	16,829±0,040 ^{***}
Fat	32,171±0,031	32,281±0,028 ^{**}	32,259±0,033 ⁺	31,828±0,035	32,015±0,048 ^{**}	32,003±0,055 ^{**}
Carbohydrates	1,062±0,001	1,080±0,002 ⁺	1,088±0,002 ⁺	1,108±0,014	1,146±0,013	1,147±0,015 [*]
Ash	1,084±0,033	1,084±0,046	1,091±0,044	1,147±0,039	1,137±0,041	1,159±0,035

** $P < 0,05$; *** $P < 0,01$; + $P < 0,001$

The biggest difference with the test group was marked in the content of the yolk of the group II of laying hens: P by 3,82%; Na by 4,08; Co by 20; Mn – 6,06; Cu – 3,01; Mo – 22,22%, vitamins A, B₂ and carotenoids by 1,00 and 8,13 and 9,88% ($P < 0,01-0,001$). In the eggs of the group III of laying hens Ca by 4,03%; P by 5,15; Mg by 26,67; Mn by 12,12; Mo by 22,22, the content of vitamins A, B₂ and carotenoids exceeds ($P < 0,01-0,001$) the test indicators by 1,67; 12,01 and 7,70% (table 4).

Table 4: The mineral vitamin composition of the laying hens' yolk, in 100 g

Index	Group		
	I	II	III
Macroelements, mg			
Ca	124±2,801	127±1,265	129±1,713
P	524±5,800	544±5,765*	551±6,860**
Na	49±0,423	51±0,526**	50±0,333*
K	125±0,371	128±0,559***	128±0,359***
Mg	15±0,841	20±0,929***	19±1,286*
S	158±0,476	160±0,573**	161±0,449***
Microelements, mkg			
Fe	5719±54,801	5793±46,369	5815±52,033
Co	20±0,966	24±0,605**	26±0,817**
Mn	33±0,428	35±0,651**	37±0,458***
Cu	133±3,038	137±1,521	138±1,740
Mo	9±0,396	11±0,233***	11±0,327**
Zn	3075±11,791	3115±2,722**	3126±4,716***
Vitamins			
Carotenoids, mkg/g	19,488±0,213	21,413±0,566**	20,988±0,309**
Vitamin A, mg	1,196±0,002	1,208±0,002**	1,216±0,001***
Vitamin B ₂ , mg	0,283±0,010	0,306±0,003*	0,317±0,004**

*P< 0,05; **P< 0,01; ***P< 0,001

The results of the incubation show that the fertilization of the laying hens eggs in the group with “Kartsesel” reached 91,40 %, and with “Lipovitam Beta” – 92,74%, that is by 3,50 and 4,84% more than in the eggs of the test laying hens due to the influence of antioxidant supplements. The supplements also improved ecological safety, biochemical consistency of laying hens’ eggs, bioavailability and deposition of carotenoids, vitamin A and B group, macro and microelements in them. Embryonic mortality in the eggs of the hens, consuming the compound feed with the supplements was smaller (4, 57-2, 69%) than in the eggs of the test hens (5, 38%). Due to this the biggest egg hatching was marked in the experimental group hens – 88, 53 and 91, 30% and 86, 54% in the test group. The least level of embryonic mortality in the eggs of the hens that consumed vitamin-mineral supplements in the compound feed contributed to the increase of such an indicator as hatchability of healthy young poultry by 4, 83 and 8, 6% in comparison with the test group (76, 08%).

CONCLUSIONS

The enrichment of the compound feed for the laying hens by the complex antioxidant supplement “Kartsesel” and “Lipovitam Beta” allows to improve detoxification activity of the liver and to reduce the content of such xenobiotics as nitrites, nitrates in it. The accumulation of residual quantity of lead, cadmium and mercury, present in the ration, can be prevented completely, because of their increased excretion from the body with the dung – lead by 1,61 and 1,48 (P<0,01) and cadmium by 1,276 and 1,26 times in comparison with the laying hens of the test group. As a result, the ecological safety of eggs is also improved.

In the protein part of the eggs in the 26 week age of the laying hens the content of lead, cadmium is decreased by 3,74-3,71 and 1,84- 1,88 times (P<0,001) and in the 44 week age by 4,44 – 4,25 and 1,72-1,78 times respectively (P<0,001), with complete absence of mercury. In the yolk of the experimental group laying hens eggs the content of lead became by 3,90-3,73 and 4,17-4,10 times less and no cadmium was detected, whereas in the yolk of test group laying hens eggs the content of cadmium was within 0,0217-0,0253 mg/kg.

The biochemical composition of eggs is improved due to the increased concentration of the dry matter (P<0,001) in their protein part, as well as in the yolk, the content of carotenoids (by 9,88-7,70 %), vitamin A (by 1,00-1,67%), vitamin B₂ (by 8,13-12,01%). The mineral composition of eggs is also significantly improved, that elevates their incubation properties. As a result, the fertilization of the experimental groups eggs is by 3,50 and 4,84 bigger, and hatchability of healthy young poultry is by 4,83 and 8,6% bigger in comparison with the test group.

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