

## Conference Paper

# Improving the Ecological Status of Laying Hens By Increasing Iodine Nutrition

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## Abstract

One of the main problems of poultry farms located in the industrially polluted area is environmentally friendly products production. Iodine supplements in the rations of laying hens have a positive effect on mineral metabolism and the elimination of heavy metals from their bodies. To conduct the research according to the group-analog method, 4 groups of laying hens of the UK-Kuban UK cross were formed -- 123, at the age of 29 weeks, 40 animals each. One group served as a control and was treated with a general ration, and the other three groups were experimental and, in addition to the diet, received respectively 1.0, 1.5, 2.0, mg of iodine (as potassium iodide) per 1 kg of feed. Conducted scientific and management experiment and data analysis show that the content of heavy metals in the studied muscles is reduced due to an increase in iodine nutrition. In particular, the zinc content in the chest muscles decreased by 12.3 mg/kg or 35 %, and in the leg muscles by 12.4 mg/kg or 30.7 %. At the same time, an increase in iodine nutrition contributes to a decrease in the concentration of heavy metals in the internal organs, which undoubtedly improves the ecological status of laying hens and the products obtained from them.

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## 1. Introduction

The agricultural bird, due to a number of biological features, is highly productive, so feed mixtures that are well balanced in all nutrients are necessary to maintain this [4, 5].

Despite the wide fluctuations in the content of mineral elements in feed, their level in the organs and tissues of animals and birds remains fairly constant due to the body's ability to maintain homeostasis of mineral substances. But these regulatory mechanisms are not infinite and with intensive use of animals, mineral metabolism disorders can lead to disruption of organs' and body systems' functional activity, deterioration of feed nutrient and increase in feed costs for production, disruption of reproductive capabilities [7].

Insufficient amount of macro-and microelements in the animal's body can occur not only because of their low content in the feed, but also with an excess of the disturbing

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ratio between the elements: calcium and phosphorus; calcium and copper; copper and zinc; iodine and iron, etc. [2].

The ecological status of animals and birds is determined primarily by the content in their body of heavy metal salts, since this determines the safety and quality of produced livestock products [3, 11].

This is especially relevant in the conditions of the RNO-Alania, due to the recent high concentration of industrial enterprises in Vladikavkaz, including the plant "Electro-zinc". The pollution with heavy metals of soil, water, and air in Vladikavkaz and surrounding areas exceeds background values several times. This mainly concerns zinc, copper, cadmium [1, 12].

In most cases, heavy metals are cations, easily accumulate in the soil and, enter through food chains first into farm animals and birds bodies, and then with livestock products into the human body [6].

According to a number of authors [8--10], the content of heavy metals salts in drinking water of republican livestock and poultry farms exceeds the maximum permissible standards for zinc in 3 to 6 times, copper -- 5 times, lead -- 3 to 5 times. According to their apt expression, animals and birds in the republic consume "metallic" water with all the consequences.

Because of the above and apparent iodine deficiency in the RSO-Alania biosphere, we studied the possibility of improving mineral metabolism and reducing the concentration of heavy metals in the tissues and organs of laying hens due to the increased iodine nutrition by the inclusion of different doses of potassium iodide in their diet.

## 2. Methods of the Research

To carry out scientific and management experiment at the Vladikavkaz poultry farm in RNO-Alania, 4 groups of laying hens of the UK-Kuban cross were formed by the analog group method -- 123, at the age of 29 weeks, 40 heads each. The first group served as a control and were treated with a general ration, and 2, 3, 4 groups were experimental and, in addition to the diet, received respectively 1.0, 1.5, 2.0, mg of iodine (as potassium iodide) per 1 kg of feed.

All experimental animals were kept in the same zoo veterinary conditions -- the difference was only in the amount of potassium iodide added to the ration of poultry from the experimental groups.

In the course of scientific and management experiment, in addition to the main productive indicators, the effect of iodine feeding on mineral metabolism and in particular the content of heavy metals in various tissues and internal organs of laying hens, according to generally accepted techniques in zoo-technics, was studied.

At the same time, the calculation of the iodine content in the compound feed prepared from local feeds and balanced for the main nutrients showed that the level of iodine availability in the laying hens from the control group was only 69.5 %, and the need to introduce additional iodine supplements was obvious.

As a result of the introduction of potassium iodide into the diet, laying hens of the 1st experimental group were provided with iodine by 129.5 %, 2 experimental -- by 159.5 % and 3 experimental -- 189.5 %.

### 3. Results and Discussion

The obtained results indicate a positive effect of increasing the iodine nutrition level on the main productive indicators of laying hens, in particular egg production, egg production intensity, and egg mass yield and others. Conducting physiological research on the balance of substances as part of scientific and management experiment has shown optimization of the basic macronutrients exchange. In particular, the content of calcium, phosphorus and magnesium in the chest and leg muscles and some internal organs of the experimental bird were studied.

Obtained data analysis suggests that the content of the studied trace elements in the muscle tissue and individual internal organs: heart, liver and spleen was within the normal range, however, the indicators of the experimental groups were slightly better than the control. In particular, a more significant effect of iodine nutrition was on the content of phosphorus and calcium, and less on the concentration of magnesium. The most significant difference ( $P < 0.05$ ) was found between the control and 2 experimental group, where laying hens received an additional 1.5 mg of iodine per 1 kg of feed.

The results allow concluding that the positive effects of additional iodine doses on the accumulation of macronutrients in the muscles and main internal organs are positive, which increases the mineral status of laying hens' organism.

However, based on the objectives of the study, more importance was attached to the study of the laying hens' environmental performance, namely, to clarify the iodine feeding adsorption effects level on heavy metals. The ecological status of poultry is determined primarily by the amount of the most dangerous heavy metals and the possibility of limiting their release into animal products.

Based on the experiments' location and the danger of accumulation in the experimental bird body of heavy metals, we examined the content of zinc, copper and lead in the muscle tissue of laying hens (Table 1).

It should be noted that for all the studied elements in all experimental groups there are no indicators exceeding the maximum permissible values. This is due to the fact that the components of the feed for poultry, in particular grain, were from the republican ecologically unpolluted area and their content of heavy metals was within the MPC.

However, according to data presented in the table, the content of heavy metals in the chest and leg muscles of laying hens from the control group differ significantly from the population of the experimental groups. For example, the zinc content in the chest muscles of chickens in the control group was 35.1 mg/kg, while in the experimental groups this figure dropped to 22.8 mg/kg, i.e. by 12.3 mg/kg or 35 %. The decrease in the zinc content in the leg muscles was from 40.4 to 28.0 mg/kg, i.e. 12.4 mg/kg or 30.7 %.

TABLE 1: The content of some heavy metals in laying hens muscles, mg/kg.

Muscles	Group	Heavy metals		
		Zinc	Copper	Lead
Chest	Control	35,1±3,5	4,3±0,10	1,50±0,10
	1-experimental	27,6±6,4	4,0±0,11	1,47±0,09
	2-experimental	22,8±6,3	3,7±0,12	1,16±0,12
	3-experimental	25,4±4,4	3,9±0,18	1,32±0,18
Leg	Control	40,4±2,9	5,3±0,18	1,89±0,14
	1-experimental	32,8±5,6	5,0±0,21	1,78±0,12
	2-experimental	28,0±7,1	4,7±0,14	1,38±0,11
	3-experimental	30,6±4,8	4,9±0,13	1,64±0,13

Other elements' concentration had also decreased, but to a lesser extent. Thus, the lead content decreased from 1.50 to 1.16 mg/kg or by 22.6 and from 1.89 to 1.38 mg/kg or by 27 %, respectively, in the chest and leg muscles. The copper content in the chest muscles decreased by 14.0 %, and in the leg muscles a little more -- by 16.7 %. In all cases, the largest decrease in the concentration of heavy metals was observed in the experimental group 2, where laying hens in addition to the diet were fed 1.5 mg of iodine per 1 kg of feed.

Thus, we can claim that increasing the level of iodine nutrition to 159.5 % of the feeding rate has the most positive effect on reducing the concentration of heavy metals in the muscle tissue of laying hens.

The next stage of the research was to determine the content of some heavy metals in the main internal organs of laying hens (table 2).

TABLE 2: The content of some heavy metals in the laying hens' main internal organs, mg/kg.

Organs	Group	Heavy metals		
		Zinc	Copper	Lead
Heart	Control	31,4±1,2	5,3±0,80	0,23±0,02
	1-experimental	30,0±1,2	4,8±0,70	0,19±0,01
	2-experimental	26,2±1,3	4,1±0,60	0,14±0,02
	3-experimental	27,8±1,4	4,4±0,50	0,16±0,02
Liver	Control	32,2±0,7	4,4±0,40	0,25±0,01
	1-experimental	28,1±1,2	3,9±0,30	0,22±0,01
	2-experimental	22,4±2,2	3,2±0,20	0,18±0,02
	3-experimental	23,7±2,4	3,4±0,30	0,20±0,01
Lungs	Control	25,7±1,1	3,2±0,12	0,30±0,04
	1-experimental	22,3±1,3	3,0±0,12	0,27±0,03
	2-experimental	19,4±3,2	2,6±0,14	0,20±0,02
	3-experimental	21,5±2,1	2,8±0,11	0,22±0,01
Kidney	Control	28,4±1,4	3,2±0,40	2,10±0,07
	1-experimental	23,2±1,5	3,0±0,30	1,80±0,06
	2-experimental	21,0±1,2	2,6±0,20	1,40±0,05
	3-experimental	22,4±1,0	2,9±0,14	1,70±0,04
Spleen	Control	32,4±1,2	4,8±0,70	2,20±0,06
	1-experimental	29,2±1,3	4,0±0,32	1,90±0,05
	2-experimental	24,2±1,4	3,7±0,22	1,40±0,04
	3-experimental	25,4±1,7	3,9±0,21	1,60±0,03

Describing the results of studying the laying hens' internal organs in the control group on zinc, we can say that the greatest amount of it was found in the spleen (32.4 mg/kg), liver (32.2 mg/kg), heart (31.4 mg/kg). According to the content of copper, the organs are arranged in a somewhat different order than in zinc, namely: cardiac muscle (5.3 mg/kg), spleen (4.8), liver (4.4).

Regarding heavy metals, in the body of laying hens of the control group, lead content was in the least amount, with a different distribution in individual organs. So, it was mainly found in the spleen (2.2 mg/kg), and less in the heart muscle (0.23 mg/kg). Absolute indicators of the heavy metals content, of course, are important for determining the

ecological status of poultry, but we were interested in studying the relative indicators showing the difference between the groups in percentages.

In the heart muscle in laying hens of the experimental groups, a decrease in the zinc, copper and lead content occurs, respectively, in the range of 4.46--16.56 %; 9.43--22.64 % and 17.39--30.43 %; in the liver -- 12.73--30.43 %; 11.36--28.73 % and 12.0--28.0 %; in the lungs -- 13.23--24.51 %; 6.25--18.75 % and 6.0--33.33 %; in the kidneys -- 8.31 --26.06 %; 6.25--18.75 % and 14.29--33.33 %; in the spleen -- 9.88--25.31 %; 16.67--22.92 % and 13.64--36.36 %.

In the muscle tissue and internal organs of laying hens of the experimental groups, there were found less heavy metals, compared with their counterparts from the control group, which speaks in favor of the adsorption properties of iodine supplements, which contribute to their removal from the body. Moreover, it should be noted that the greatest positive effect was recorded at the rate of inclusion of potassium iodide, containing 1.5 mg of iodine in the composition, which is about one and a half times more than the standard indicators.

## 4. Conclusion

Based on the above, we can conclude that potassium iodide, as a source of iodine, has a positive effect on mineral metabolism and contributes to the enrichment of laying hens with calcium, phosphorus and magnesium. At the same time, increasing the iodine nutrition level contributes to the removal of heavy metals (zinc, copper and lead) from the laying hens body, which improves the ecological status of the bird itself and the products obtained from it.

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