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Blood Parameters of Rabbits Given Different Amounts of Iodine Citrate

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Abstract. The need for iodine in rabbit diets has not been fully elucidated, although some commercial diets use it in varying amounts without scientific justification. The main goal of the experiment was to establish the effect of applied quantities of an organic iodine compound produced by nanotechnology – iodine citrate – on blood parameters of rabbits after weaning from 40 to 96 days of age. Experimental studies were conducted in the conditions of the vivarium of the scientific institution – Institute of Animal Biology of the National Academy of Sciences of Lviv on 30 rabbits of the Termonska breed. The control and experimental groups had the same number of 6 animals, of which 3 were males and 3 were females. Young rabbits of the control group were kept on standard granulated compound feed and water without restriction. In contrast to the control, the animals of I, II, III, and IV experimental groups additionally received a solution of iodine citrate in the amount of 2.5; 3.75; 5.0 and 7.5 μg/l of water, respectively. Blood parameters were determined on the 40th day of life (preparatory period) and on the 18th, 43rd and 56th days of iodine citrate supplementation. Studies have established a higher number of red blood cells and haemoglobin concentration in the blood of rabbits of Group II ($P \leq 0.05$) on the 43rd and 56th days; Group III ($P \leq 0.05$) and Group IV ($P \leq 0.05$-0.01) on the 18th, 43rd, and 56th days of the study. The haematocrit value of the blood of rabbits of Group II was respectively higher by 16.6% on the 56th day; Group III – by 17.1%; 20.0%, and 22.8%, and in Group IV – by 26.4%; 29.4%, and 23.5% on the 18th, 43rd, and 56th days of the study. The albumin content in the blood of rabbits of Group I was higher by 4.1% on the 43rd day; Group II – by 6.8%; 8.0%; 9.5%; Group III – by 6.1%; 4.6%; 9.5%; Group IV – by 4.5%; 2.7%; 7.3% on the 18th, 43^{rd,} and 56th days of the study, respectively. The content of total calcium in the blood of rabbits of Group II exceeded the control by 22.5% on day 43, the level of inorganic phosphorus in the blood of rabbits of Groups II, III, and IV was respectively higher by 5.8%, 5.0%, and 4.1% on the 56th day of the study compared to the control

Keywords: nanocompound, metabolism, erythrocytes, calcium, phosphorus

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INTRODUCTION

The use of nanoparticle compounds in industrial intensive animal husbandry has attracted great research interest due to their unique properties in the body. The special sizes of nanoparticles from 1 to 100 Nm change their characteristics of the effect in the compound, which is manifested by activating properties on the course of biochemical reactions of the body (Khan *et al.,* 2019). The main function of iodine in the mammalian body is the metabolism of thyroid biologically active substances, which regulate energy metabolism. The synthesis of thyroid hormones requires a constant supply of the trace element iodine from the feed of the diet, which is provided from the soil. Therefore, for the full functioning of the mammalian body, it is necessary to constantly provide it with iodine (Babic Leko *et al.,* 2019). Separate studies established a substantial effect of organic iodine compounds on the body's metabolism. Thus, the drinking of various amounts of citrate I, Se, and S solution to broiler chickens produced by nanotechnology was described by changes in the haematological, biochemical, and productive parameters of their body. Chickens of Group II received the lowest dose of I, Se, S at the rate of 5 μg I/l, 1.25 μg Se/l, 7.5 μg S/l of liquid, in experimental poultry their number increased by 2 (III), 4 (IV), 6 (V), and 8 (VI) times compared to Group II. On the 35th day of the experiment, an increase in the content of cholesterol, triacylglycerols and albumin in the blood of Groups II, III, and VI of chickens was found, and a decrease in creatinine – in Groups III and VI. Compared to Groups I, II, III, under these conditions, the content of urea, Ca, P, cholesterol, and albumin in the blood of chickens of Groups IV, V, and VI significantly increased only in Group IV on the 48th day. The results obtained indicate a different effect of nano-supplementation depending on the amount used (Fedoruk *et al.,* 2021). A study was conducted to investigate the properties of iodine-containing nanoparticles that can absorb X-rays and determine the boundaries of the tumour in a fluorescent way. Radiation therapy of the brains of mice with orthotopic human gliomas and triple-negative human breast cancer showed considerable prolongation of their lives when iodine-containing nanoparticles were included (Hainfeld *et al.,* 2022). Studies established the importance of iodine for the animal body, its involvement in the synthesis of thyroid hormones, and the causes of iodine-deficient diseases. The antioxidant, antimicrobial, and antitumour effects of iodine were proved (Tronko & Kravchenko, 2021). The use of copper iodide nanoparticles in the diet of male rats increased thyroid hormones compared to a control group that did not receive these supplements (Ulwali *et al.,* 2019). Upon examining pregnant women in the endemic zone, thyroid dysfunction was noted, of which 62.4% were found to be deficient in iodine in the body at the end of pregnancy. In 37.6% of pregnant women, the concentration of iodine excretion in the urine exceeded 100 μg/l, which may lead to the idea of optimal iodine intake into the body, but insufficient for physiological processes in pregnant women (Kravchenko & Medvedev, 2018). The world is systematically improving programmes for correcting mineral nutrition, namely the added use of various sources of iodine in the human diet (Delshad *et al.*, 2018). Studies were conducted to determine the content of thyroid hormones in the body of rabbits. There was a positive and statistically significant correlation between serum and urine triiodothyronine (r=0.76) and a high positive correlation between serum and faecal triiodothyronine concentrations (r=0.62). It was found that the correlation of concentrations of other thyroid hormones between serum, urine, and faeces was insignificant. The physiological functioning of thyroid hormones is essential for rabbit metabolism, energy homeostasis, and reproduction (Chmurska-Gasowska *et al.,* 2021). The study of the effect of antioxidants and sources of organic iodine, *Laminaria digitate* – Group II and *Cystoseira barbata* – Group III, on blood parameters of California rabbits was marked by a significant increase in the level of thyroxine, total protein, and albumin in the experimental groups. In the meat of rabbits of the Group II, a significant excess of iodine content was found by 81.0 μg, and in animals of the Group III – by 234.1%. Animals of the experimental groups were characterised by higher productivity on day 90 of the study (Zuboshenko *et al.,* 2020). Added drinking of iodine in the form of the "*Jodis Concentrate*" preparation in the diet of repair female rabbits increased the development of follicles in the ovaries and contributed to more intensive protein expression in rabbit oocytes, which positively affected the reproductive function of female rabbits (Abadjieva *et al.,* 2018).

Drinking different amounts of mineral nanoparticles in the composition I, Se, S affected the dose-dependent effect on the body of rabbits after weaning. A large amount of the compound used was marked by higher indicators of haematopoiesis, protein levels, amino transferase activity, and activation of resistance of the rabbit body up to 110 days of age (Boiko *et al.,* 2021). It is necessary to note the activating effect of drinking nanocompounds of trace elements Silicon and Zinc on the body of rabbits after weaning, which was marked by higher blood parameters, within physiological values and productivity at the end of the experiment (Lesyk *et al.,* 2020; Boiko *et al.,* 2020).

In the diets of rabbits, iodine standards for different age groups were not established. However, iodine deficiency in the diet of fattening rabbits adversely affected their health, productivity, and the preservation of livestock. Commercial diets use iodine supplements in the form of sea salt or potassium iodide or iodate, which range from 0.2 to 2 mg/kg (De Blas & Wiseman, 2020).

Since there are several questions regarding the need and dosage of iodine in the diet of rabbits, including its organic compounds, it is necessary to conduct additional research.

The purpose of the experiment was to investigate the effect of different amounts of iodine citrate on changes in haematological and biochemical parameters of rabbit blood after weaning in the period from 40 to 96 days of life.

MATERIALS AND METHODS

The experimental part of this study was carried out based on the equipped vivarium of the Institute of Animal Biology of the National Academy of Sciences, Lviv. 30 rabbits-analogues of the Termon breed were selected for the study. Animals after weaning (40 days of life) were divided into five groups, with the control group consuming balanced pelleted feed and water without restriction. Rabbits of experimental Groups I, II, III, and IV, apart from balanced granulated compound feed, additionally received iodine citrate with water at a dose of 2.5, 3.75, 5.0 and 7.5 μg I/l of water, respectively. The used additive was obtained from Nanomaterials and Nanotechnologies LLC, Kyiv (Ukrainian patent for utility model No. 38391. IPC, 2006). The experimental period continued for 66 days, of which 10 days were the equalisation period and 56 days were the period for determining the main planned parameters of the blood of rabbits, the material for research was selected on the 58th, 83rd, and 96th days of life (18th, 43rd, and 56th day of drinking supplements) in 6 animals (3 males and 3 females) from the group. The total number of red blood cells, white blood cells, haemoglobin concentration and haematocrit value were determined in the blood using a Mythic-18 haematological analyser. Blood samples for haematological studies were collected in special test tubes with pre-introduced anticoagulant dicalcium salt of ethylenediamine — tetra acetic acid (EDTA – K2+), after which no later than four hours determination was made using the device and the indicators under study were obtained. Determination of the content of albumin, creatinine, urea, Ca, and P in plasma was performed on a biochemical analyser "Humalazer-2000" (Germany) using reagents of the company "LACHEMA" (Czech Republic) (Vislo, 2012). All manipulations with animals were performed per bioethical standards that meet the requirements of the European Convention for the protection of vertebrates used for experimental and scientific purposes (1986) and the resolution of the First National Congress on Bioethics (2001). Statistical processing of the obtained digital material was calculated using the Student's t-test. The average digital data was considered statistically significant when the differences in indicators between the control and research groups were less than $P<0.05$.

RESULTS AND DISCUSSION

In the conditions of industrial intensive rabbit breeding, each part of the diet is essential. Providing the body of rabbits with nutrients during the physiological stress of weaning rabbits is a critical period that affects the productivity of animals during rearing. It is also important to provide the body with minerals, namely iodine compounds. However, there is not much literature data to justify its quantities, while in commercial diets for rabbits it is used in different amounts. Conducted research on the use of organic iodine in compounds with other elements resulted in positive changes in their body (Boiko *et al.,* 2021; Fedoruk *et al.,* 2021). Literature data indicate the need for periodic studies of the blood of rabbits with industrial maintenance, as an effective and rapid marker of providing their body with nutrients from the diet (Chmurska-Gąsowska *et al.,* 2021). Drinking different amounts of iodine citrate in the diet of rabbits from the 40th day of life was marked by changes in the ratio of shaped blood elements. Thus, in the blood of rabbits of the second experimental group, the number of red blood cells was higher by 26.5% and 28.5%, respectively, on the 43rd and 56th days of the study compared to the control (Table 1).

***Table 1**. Absolute content of red blood cells, white blood cells, concentration of haemoglobin and haematocrit in the blood of rabbits after drinking various amounts of iodine citrate (M±m, n=6)*

Indicator	Animal group	Study periods			
		Preparatory	Research (day of life/day of study)		
		40th day	58/18	83/43	96/56
Red blood cells, 10^{12}/l	C	4.8±0.11	4.9±0.12	5.5±0.20	5.4±0.27
	E-I	4.6±0.22	5.11±0.19	5.8±0.18	5.4±0.25
	E-II	4.9±0.20	5.0±0.23	**6.2±0.11***	**6.3±0.18***
	E-III	4.7±0.21	**5.5±0.17***	**6.3±0.10****	**6.4±0.20***
	E-IV	4.8±0.23	**5.7±0.25***	**6.1±0.12***	**6.3±0.12***

Table 1, Continued

Indicator	Animal group	Study periods			
		Preparatory 40th day	Research (day of life/day of study)		
			58/18	83/43	96/56
Haemoglobin, h/l	C	111.9±0.79	122.2±4.08	126.8±4.12	130.2±3.58
	E-I	113.0±0.96	124.0±5.05	132.3±4.75	141.3±3.56
	E-II	110.3±2.81	129.8±4.92	**144.6±4.49***	**144.1±3.08***
	E-III	110.7±1.93	**140.0±4.02***	**148.5±5.12***	**147.3±5.55***
	E-IV	109.2±3.49	**142.3±4.93***	**152.5±5.11****	**148.8±4.41****
White blood cells, 10^9/l	C	6.4±0.24	6.0±0.28	7.0±0.35	7.2±0.43
	E-I	5.9±0.20	6.3±0.27	7.6±0.26	7.8±0.41
	E-II	6.0±0.20	6.6±0.34	6.8±0.36	7.6±0.45
	E-III	5.9±0.26	6.4±0.32	7.3±0.26	7.9±0.11
	E-IV	5.7±0.30	6.9±0.33	6.8±0.47	7.7±0.35
Haematocrit, l/l	C	0.33±0.011	0.35±0.013	0,37±0.015	0.37±0.017
	E-I	0.35±0.012	0.38±0.021	0.38±0.020	0.40±0.015
	E-II	0.36±0.014	0.37±0.022	0.40±0.014	**0.42±0.010***
	E-III	0.35±0.015	**0.41±0.015***	**0.42±0.014***	**0.43±0.019***
	E-IV	0.34±0.010	**0.43±0.016****	**0.44±0.008***	**0.42±0.013***

***Note**: in this and the following tables, statistically likely differences were taken into account in comparison with the control group: * – P≤0.05; ** – P≤0.01; *** – P≤0.001, where K is the control group, D – i; D-II; D-III; and D-IV-a solution of iodine citrate was drunk at the rate of 2.5; 3.75; 5.0 and 7.5 micrograms and/L of water, respectively*

Larger applied quantities of the trace element in the diet were characterised by a pronounced effect in the blood of animals of Group III with an increase in the number of erythrocytes by 17.0%; 34.0% and 36.6% and Group IV – by 18.7%, 27.0% and 31.2% on the 18th, 43rd, and 56th days of the study, respectively, compared to the control group of animals. The results of the red blood cell count correlated with the concentration of haemoglobin in the blood of rabbits. The dependence of these blood parameters in rabbits was also noted by other researchers (Sukar et al., 2020). In this study, such relationships were noted depending on the amount of supplement used. The level of haemoglobin in the blood of rabbits of Group II exceeded the control level by 31.0% and 30.6% on the 43rd and 56th days of the experiment, respectively. The level of this indicator in the blood of rabbits of Group III was higher by 26.4%, 34.1% and 33.0%, and Group IV – by 30.3%, 39.6% and 36.2% on the 18th, 43rd, and 56th days of the experiment, respectively, compared to the control. Notably, the smallest amount of iodine citrate applied (2.5 μg I/l of water) to animals and the experimental group did not affect the statistically significant changes in the indicator of red blood cells and haemoglobin, but only a tendency to their highest level.

Leukocytes are blood cells that perform a protective function, their number in the body of rabbits is within wide physiological parameters. Therefore, monitoring their level is important for assessing the state of immunobiological function of the rabbit body. Drinking iodine citrate in various amounts did not affect the significant changes in the number of white blood cells, which were within physiological values and indicated a stable physiological state of the body and the absence of a negative effect of the applied additive of nanotechnological origin.

The value of the haematocrit in the blood indicates the ratio of its liquid part and the number of shaped elements. In general, this indicator of changes in the number of blood cells corresponded to relative fluctuations in the body's liquid transport system, which is characterised by a higher functional ability depending on the trace element used. Thus, the haematocrit value of the blood of rabbits of Group II was higher by 16.6% in the final stage of the study. While in the blood of rabbits of Group III, its value was higher compared to the control by 17.1%, 20.0% and 22.8%, respectively, and in Group IV by 26.4%, 29.4% and 23.5% on the 58th, 83rd and 96th days of animal life. The obtained results of the study of the functional number of shaped elements and their ratio to the liquid part of the blood of rabbits may indicate an intensive metabolism in the body with different amounts of organic iodine in the diet, which activates the biosynthesis of thyroid hormones and triggers a cascade of biochemical reactions, which positively affected the metabolism and haematopoiesis in the body.

Added drinking of iodine citrate in the diet of rabbits was affected by a number of changes in the albumin content, which depended on the amount and duration of use of the supplement (Table 2).

***Table 2**. Some biochemical parameters of rabbit blood for drinking different amounts of iodine citrate (M±m, n=6)*

Indicator	Group	Research periods			
		preparatory, 40th day of life	experimental (age/day of drinking supplements)		
			58/18	83/43	96/56
Albumins, g/l	C	41.07±0.45	41.96±0.53	41.08±0.33	42.30±1.01
	E-I	41.61±0.61	41.88±0.39	**43.35±0.46****	44.22±0.88
	E-II	41.39±0.59	**44.22±0.43****	**44.72±1.03****	**45.35±0.47***
	E-III	41.40±0.68	**43.96±0.30****	**43.33±0.74***	**45.37±0.75***
	E-IV	42.39±0.64	**44.30±0.59****	**43.54±0.63****	**45.50±0.65***
Creatinine, μmol/l	C	91.3±3.98	119.6±12.08	128.0±6.50	120.0±5.94
	E-I	90.3±2.08	113.4±5.02	114.8±1.66	117.4±3.40
	E-II	96.8±3.15	119.4±10.53	122.3±8.18	121.8±5.15
	E-III	91.7±2.46	113.8±6.38	115.3±12.24	126.2±3.97
	E-IV	93.6±2.39	110.2±6.90	113.5±9.27	118.9±9.37
Urea, mmol/l	C	4.90±0.51	5.03±1.01	6.90±1.53	7.75±0.64
	E-I	5.20±0.77	4.28±0.86	5.98±1.19	7.43±0.66
	E-II	5.10±0.66	6.13±1.48	6.95±0.66	7.58±0.54
	E-III	4.40±0.62	4.48±0.89	6.10±0.98	6.63±0.33
	E-IV	4.30±0.64	4.35±0.61	6.95±0.37	6.80±0.58

In particular, the level of albumin in the blood of rabbits and the experimental group was 4.1% higher on the 43rd day of the study relative to the control. Considerably more significant differences were noted for the use of larger amounts of iodine citrate. Thus, the albumin content in the blood of rabbits of the II experimental group was respectively higher by 6.8%, 8.0%; 9.5%; Group III by 6.1%; 4.6%; 9.5%; Group IV – by 4.5%, 2.7%; 7.3% on the 18th, 43rd and 56th days of the study compared to the control group. Statistically significant differences between the experimental and control groups of animals constitute a positive factor in the activation of metabolic processes and non-specific protection of the body under the influence of iodine citrate in a larger amount used. It is known from the literature that albumin is synthesized in the liver, in hepatocytes, by the activity of the preproalbumin gene (Wouw & Joles, 2022). In rabbits, the liver is the main organ of metabolic processes. Perhaps the combination of the activating effect of organic iodine on thyroid hormones stimulated energy metabolism through a series of biochemical reactions in the body of rabbits. In addition, it is known that plasma proteins are involved in the protective processes of Innate and adaptive immune mechanisms, through the complement system using the CR1 receptor and due to their phagocytic properties (erythrophagocytosis), red blood cells can eliminate pathogens. In addition, they are likely involved in the immune response as antigen-presenting cells via Class II major histocompatibility complex antigens (Anderson *et al.,* 2018). Provide non-specific resistance activity of humoral and cellular type organisms (Yassin *et al.,* 2021). It is necessary to note the correlation between the level of albumin and the number of erythrocytes, which have the properties of protecting the body. Their higher levels in animals that have been given large amounts of iodine citrate for a long time may indicate a stimulating effect of the supplement on the immunobiological reactivity of the rabbit body.

The use of iodine citrate did not affect the significant changes in creatinine content in the blood of rabbits. Its levels were within physiological parameters, and the fluctuations were lower or higher relative to the control. Such changes indicate the physiological course of metabolic processes in the body of rabbits and the absence of negative effects from the applied amounts of the supplement.

The concentration of urea in the blood of rabbits of the experimental groups did not significantly change compared to the control, the differences were noted at the trend level. This may indicate that the compound used does not significantly affect the course of the body's metabolic processes involved in changes in the urea content.

Calcium metabolism in the body of rabbits has physiological features. First, it is a necessary macronutrient in the diet of rabbits for the course of physiological functions (structural, enzyme, signal). Second, excess calcium in the body is easily eliminated from the blood through the urinary excretion system (Vidal *et al.,* 2020). Drinking different amounts of iodine citrate to rabbits after weaning resulted in an insignificant increase in the level of total calcium in the blood during the study (Table 3).

***Table 3**. Total calcium and inorganic phosphorus content by drinking different amounts of iodine citrate (M±m, n=6)*

Indicator	Group	Research periods			
		preparatory, 40th day of life	experimental (age/day of drinking supplements)		
			58/18	83/43	96/56
Total calcium, mmol/l	C	3.3±0.17	3.0±0.34	3.1±0.22	3.3±0.27
	E-I	3.0±0.36	3.5±0.28	3.0±0.51	3.6±0.10
	E-II	3.1±0.08	3.7±0.63	3.8±0.09*	3.4±0.16
	E-III	3.5±0.18	3.8±0.64	3.5±0.20	3.5±0.12
	E-IV	3.2±0.51	3.9±0.37	3.4±0.56	3.4±0.22
Inorganic phosphorus, mmol/l	C	1.3±0.25	1.2±0.31	1.3±0.18	1.2±0.12
	E-I	1.2±0.24	1.3±0.33	1.5±0.51	1.4±0.29
	E-II	1.5±0.12	1.4±0.42	1.4±0.62	1.9±0.23*
	E-III	1.4±0.58	1.5±0.41	1.8±0.62	1.8±0.10**
	E-IV	1.5±0.17	1.8±0.32	1.7±0.57	1.7±0.17*
Calcium: Phosphorus	C	2.53:1	2.50:1	2.38:1	2.75:1
	E-I	2.50:1	2.69:1	2.01:1	2.57:1
	E-II	2.06:1	2.64:1	2.71:1	1.78:1
	E-III	2.50:1	2.53:1	1.94:1	1.94:1
	E-IV	2.13:1	2.16:1	2.00:1	2.02:1

It should be noted that the total calcium content in the blood of rabbits of the second experimental group exceeded the control by 22.5% only on the 43rd day of the study. The obtained results of the probable content and tendency to increase the level of total calcium in the blood of rabbits may be the reason for the use of iodine citrate; however, the length of time and different amounts of iodine citrate affected the assimilation of calcium from the forage of the diet. The results support literature sources that provide examples of elevated blood calcium levels due to the use of organic iodine in the rabbit diet (Reda *et al.*, 2020).

The involvement of P in the metabolism of rabbits has been understudied. Inorganic phosphorus is important in cell metabolism, but its involvement in the processes of bone calcification along with calcium is crucial. These two elements interact in transformation of the rabbit's cartilage skeleton into bone tissue after birth (Agedeson *et al.,* 2021). Feeding the iodine citrate compound to rabbits increased the absorption of phosphorus from the diet feed on the 18th and 43rd days of the study, although the results were at the level of the trend relative to the control. However, long-term drinking of the supplement resulted in other changes. Thus, the content of inorganic phosphorus in the blood of rabbits of the II, III and IV experimental groups was respectively higher by 5.8%, 5.0% and 4.1% on the 56th day of the study compared to the control group of animals. The obtained changes in the level of phosphorus in the blood of rabbits can indicate the influence of both the amount of the applied organic iodine compound and the duration of its consumption in the diet. Longer use of the supplement, for 56 days, to a greater extent ensured the supply of iodine to the body and contributed to its accumulation. Minor changes on the verge of a higher trend can be explained by the active metabolism in the body of fast-growing young animals and the rapid use of this element for metabolism.

An important indicator in providing the body with calcium and phosphorus is their ratio. Drinking iodine citrate from 40 to 58 days of life to rabbits affected changes in the blood of experimental animals in relation to the control with the ratio of calcium to phosphorus in the range of 2.16-2.69:1, on the 43rd day — 1.94-2.71:1, on the 56th day of the study 1.78-2.75:1. The obtained results of the study indicate an active absorption of calcium in the body at the first and second stages of the study and a high level of phosphorus at the final period of the experiment, which prevailed in animals of the experimental groups II-IV, which used large amounts of iodine citrate.

Therefore, added drinking of iodine citrate in a larger number of rabbits of experimental groups II–IV after weaning was affected by positive probable changes in metabolic processes, namely haematopoiesis, resistance, and assimilation of Calcium and Phosphorus compared to the control.

CONCLUSIONS

1. Added drinking of iodine citrate to rabbits after weaning at the rate of 2.5 μg I/l of water (Group I) was marked by the smallest changes in their blood, with the sole increase in albumin levels by 5.5% on the 43rd day of the study compared to the control.

2. Drinking iodine citrate to rabbits from the 40th day of life in the amount of 3.75 μg I/l of water (Group II) resulted in a significant increase in the number of erythrocytes and the level of haemoglobin in their blood, relative to the control, by 26.5% and 28.5%, and 31.0% and 30.6%, on the 43rd and 56th days, respectively; haematocrit – by 16.6% on the 56th day; total calcium – by 22.5% on the 43rd day; inorganic phosphorus – by 5.8% on the 56th day of the study; albumin – by 6.8%, 8.0%, 9.5% during the study.

3.The use of iodine citrate at the rate of 5.0 μg I/l of water (III experimental group) was characterised by a higher level of erythrocytes by 17.0%, 34.0%, and 36.6%; haemoglobin – by 26.4%, 34.1%, and 33.0%; haematocrit – by 17.1%, 20.0%, and 22.8%; albumin – by 6.1%, 4.6%, and 9.5%; and inorganic phosphorus – by 5.0% on the 56th day of the study compared to the control.

4.The use of the largest amount of 7.5 μg I/l of iodine citrate water (Group IV) was noted in the blood of rabbits, compared to the control, with higher indicators: erythrocytes – by 18.7%, 27.0%, and 31.2%; haemoglobin – by 30.3%, 39.6%, and 36.2%; haematocrit by 26.4%, 29.4%, and 23.5%, albumin – by 4.5%, 2.7%, 7.3% on the 18th, 43rd, and 56th days of the experiment and inorganic phosphorus by 4.1% on the 56th day of the study.

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Параметри крові кролів за випоювання різних кількостей йоду цитрату

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Анотація. У раціоні кролів повністю не з'ясована потреба у Йоді, хоча деякі комерційні раціони застосовують його у різних кількостях, не маючи наукового обґрунтування. Основною ціллю експерименту було встановити дію застосованих кількостей органічної сполуки йоду, виготовленої методом нанотехнології – йоду цитрату на параметри крові кролів після відлучення з 40 до 96 доби життя. Експериментальні дослідження були проведенні в умовах віварію наукової установи – Інститут біології тварин НААН м. Львів на 30 кролях породи Термонська. У контрольній та дослідних групах була однакова кількість, по 6 тварин, з яких 3 самці і 3 самиці. Молодняк кролів контрольної групи утримувався на стандартному гранульованому комбікормі й воді без обмеження. На відміну від контролю тварини I, II, III і IV експериментальних тварин додатково отримували, стосовно розчин йоду цитрату у кількості 2,5; 3,75; 5,0 і 7,5 мкг/л води. Визначення показників крові проводили на 40 добу життя (підготовчий період) та на 18-ту, 43-тю і 56-ту доби застосування добавки йоду цитрату. Дослідженнями встановлено вищу кількість еритроцитів та концентрацію гемоглобіну у крові кролів II групи ($P \leq 0,05$) на 43-тю і 56-ту добу; III групи ($P \leq 0,05$) та IV групи ($P \leq 0,05$-$0,01$) на 18-ту, 43-тю і 56-ту добу дослідження. Величина гематокриту крові кролів II групи була відповідно вищою на 16,6 % на 56-ту добу; III групи на 17,1 %; 20,0 % і 22,8 %, а у IV групі на 26,4; 29,4 і 23,5 % на 18-ту, 43-тю і 56-ту добу дослідження. Вміст альбуміну в крові кролів I групи був вищим відповідно на 4,1 % на 43-тю добу; II групи на 6,8 %; 8,0 %; 9,5 %; III групи на 6,1 %; 4,6 %; 9,5 %; IV групи на 4,5 %; 2,7 %; 7,3 % на 18-ту, 43-тю і 56-ту добу дослідження. Вміст загального кальцію у крові кролів II групи перевищував контрольну на 22,5 % на 43 добу, рівень неорганічного фосфору у крові кролів II, III і IV груп був відповідно вищим на 5,8 %, 5,0 % і 4,1 % на 56 добу дослідження порівняно з контролем

Ключові слова: наносполука, метаболізм, еритроцити, кальцій, фосфор