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ORIGINAL ARTICLE

Some Desacarisation-associated Sanogenetic Mechanisms in Chickens after Dermanyssosis

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The paper presents some natural supramolecular sanogenetic mechanisms that occur in the body of chickens after dermanyssosis with the participation of stress-associated hormones, cortisol and triiodothyronine, during desacarisation. This study contains a description of physiological and biochemical bases of recovery of the body after an extreme environmental factor (haematophagous ectoparasite *Dermanyssus gallinae*). Particular scientific interest is in studying changes in the dynamics of morphophysiological and biophysiochemical blood parameters in birds with eliminated stress factor of extreme strength, an aggressive haematophagous ectoparasite, and a concurrent desacarisation of the poultry building with a synthetic pyrethroid-based drug. At the same time, partially normalized key parameters of endocrine and metabolic homeostasis was detected in the birds after dermanyssosis, which occurred due to activated natural sanogenetic mechanisms, and compensatory and adaptive reactions. Significant changes were detected in the hormonal state in the chickens from the experimental group that resulted in the decreased cortisol-producing function of the adrenal glands and the increased thyroid gland functional activity. The latter is, in our opinion, the most important sanogenetic mechanism that ensures maintenance of the antioxidant status, which is especially necessary when the body recovers after an extreme environmental factor. Along with this, a natural recovery of the RBC elements as well as immunity was observed. At the same time, decreased intensity of lipid peroxidation processes in the experimental chickens predetermines maintaining the integrity of these cells.

Key words: dermanyssosis, desacarisation, sanogenesis, sanogenetic mechanisms, stress factor

Earlier, our studies described in detail a negative impact of the stress factor of extreme strength, *Dermanyssus gallinae* on laying hens (Indyuhova *et al.*, 2022b). At the same time, it was noted that they develop oxidative stress and multidimensional, profound disorders of metabolic processes (intensified gluconeogenesis, predominating anaerobic glycolysis and, as a result, acidosis), severe anemia syndrome, hypoxic conditions, etc.

Sanogenetic mechanisms are of great importance in homeostasis restoration in presence of pathologies of various origins (Kryzhanovsky, 2011; Fudin *et al.*, 2015). They are represented by various sanogenetic processes that provide correction of changes under various stress factors and restoration of functions in the animal body. The most important component of sanogenesis is compensation. It should be noted that hens with dermanyssosis, namely, long-term parasitism of *D. gallinae* on laying hens, showed a tendency to inactivation of many compensatory reactions in their body (Maximov *et al.*, 2021).

Kryzhanovsky (2011) notes in his study that recovery processes after pathologies of various origins in complex highly organized living systems occur at all levels to a certain extent starting from the molecular one, and all of them are interconnected and interdependent. That is why it is of particular scientific interest to study changes in the dynamics of morphophysiological and biophysiochemical blood parameters in birds when a stress factor of extreme strength, an aggressive haematophagous ectoparasite, is eliminated after desacarisation of the poultry building with a synthetic pyrethroid-based drug.

In this regard, the research purpose is to describe some desacarisation-associated sanogenetic mechanisms in the body of laying hens after dermanyssosis.

MATERIALS AND METHODS

The study object was Hy-Line laying hens at the age of eight months. The birds were kept in the industrial sector (Nizhny Novgorod Region). The poultry farm was contaminated by dermanyssosis. An extreme mite contamination was detected in the poultry building where the experimental birds were kept (Indyuhova *et al.*, 2021). The control group was healthy laying hens. The feeding and keeping conditions of the experimental and control birds were identical and met zootechnical requirements.

Desacarisation measures were taken using 5% D-cyphenothrin emulsion according to the Instructions for Use (Indyuhova *et al.*, 2021).

Blood samples were taken from the axillary vein of 10 chickens from each group before treatment, then twice with a 10-day interval after such measures. Morphophysiological and biophysiochemical blood parameters of the chickens were determined using methods described in the publication by I.P. Kondrakhin (2004).

Digital material was statistically processed using the parametric Student's method.

RESULTS AND DISCUSSION

A living organism has all physiological and biochemical processes controlled by a genetic program which is aimed at harmonizing the functional state of the organism (Fudin *et al.*, 2015).

In the presented study, the research object is laying hens at the age of eight months. At this age, signs of age-related involution are observed in the birds' thymus that affects all parts of the immune system, as well as the body as a whole (Seleznev and Ovsishcher, 2007). In addition, many researchers note in their studies the following critical periods of growth and development in laying hens: day 10, 30, 45, 60, 90, 120, 180 and 360 (Bigun, 2017). At the same time, a significant change in the physiological status is observed in the birds that is accompanied by destabilized metabolic processes, restructured functional activity of some organs and tissues and, as a result, increased hypersensitivity of the birds to effects of stress factors, etc. Along with this, it can be assumed that haematophagous parasites, especially during the critical periods in chickens, contribute to the development of a pronounced destabilization of biophysiochemical processes in their body, which obviously complicates parasitic diseases. Therefore, all this requires a more detailed

understanding of the sanogenetic mechanisms associated with desacarisation after dermanyssosis. This study is a continuation of a publication series on description of biophysiochemical mechanisms in the chickens recovering after ectoparasitosis (Indyuhova *et al.*, 2021, Indyuhova *et al.*, 2022c).

The biophysiochemical recovery mechanisms of the animal organism are initiated when a stress factor is weakened or eliminated. Thus, after dermanyssosis, significant changes were observed in the RBC system of the chickens that performs the most important functions. Among them is a full supply of all organs and tissues with oxygen, acid-base balance maintenance, etc. Thyroid hormones play a special role in stimulating erythropoiesis. They control the synthesis of a mitosis-stimulating factor, and a differentiation hormone erythropoietin, which stimulates the synthesis of erythrocytes in the red bone marrow, particularly, the growth of erythroid precursors (Blindar and Zubrikhina, 2007). After desacarisation, improved endocrine function of the thyroid gland was found in the experimental chickens on day 10 and 20. Thus, a concentration of the key thyroid hormone, free triiodothyronine, was 9.80±0.45 pmol/L in the blood at 10 days versus 7.65±0.49 in the control; $P<0.05$, and 10.79±0.58 pmol/L at 20 days versus 8.98±0.66 pmol/L in the control. It was noted in a study by Liu *et al.* (2017) that 28-week-old Hy-Line laying hens had a concentration of free triiodothyronine during the use of a feed additive of 9.89±0.75 pmol/L versus 4.39±0.89 pmol/L in the control. The authors associated these changes in triiodothyronine with improved performance in the poultry. These values were within the physiological range. It is mentioned in the literature that normalized thyroid gland activity is observed in a living organism in the post-stress period (Trilis and Davydov, 2006). In our studies, all this may partly cause a positive increase in erythrocytes in the experimental chickens from 2.08±0.08 to 2.52±0.04 $\times 10^{12}$/L and hemoglobin concentration from 108.3±5,94 to 127.8±2.09 g/L. It was noted earlier in our study that decreased intensity of the hematopoietic function was detected in the chickens with prolonged parasitism of *D. gallinae*, which was obviously associated with its compensation mechanisms transited to the exhaustion phase (Maximov *et al.*, 2021). Thus, initiated secondary sanogenetic mechanisms allow activation of the key biophysiochemical processes including active synthesis of iodine-containing thyroid hormones, etc., to normalize the above-described morphophysiological blood parameters. At the same time, the number of erythrocytes in the experimental chickens was within the lower physiological range at 20 days after desacarisation. The described fact predetermines a favorable prognosis for normalization of this blood parameter.

At the same time, signs of stimulated hematopoiesis in the experimental chickens can also be observed by normalized number of leukocytes and increased percentage of monocytes within the physiological range, which is a reflection of the sanogenetic mechanism implementation, particularly, the initiation of recovery processes in the body (Lugovskaya, 2011). Thus, the described changes in the immune system elements may also be partly associated with physiologically optimal concentrations of iodine-containing hormones in the blood. The latter have a modulating effect on immune system cells, and participate in the maturation of immune-competent cells (Indyuhova *et al.*, 2021).

Along with the above, free radical processes are activated in the laying hens under an extreme stress factor leading to excessive intensification of lipid peroxidation (Indyuhova *et al.*, 2022b). Following the desacarisation at 20 days, the antioxidant activity of blood serum did not change in the experimental laying hens (46.7±1.52% versus 56.70±1.40% in the control; $P<0.01$). The stated above was due to the depletion of antioxidant systems in the birds after the parasitic disease. At the same time, a gradual decrease was detected in some lipid peroxidation products to control values during the entire study period (20 days) that may be due to implemented antioxidant capabilities of iodothyronines in the experimental birds. Thyroid hormones are known to have antioxidant activity, which is due to the presence of phenolic groups. Thus in the literature, a decrease was mentioned in the functional activity of the thyroid gland during a stress reaction (Yasenyavskaya and Ryabykina, 2009). Thus, this

activated sanogenetic link allows minimizing consequences of oxidative stress, in particular, cell integrity disruption, enzyme inactivation, modification and destruction of proteins, nucleic acids, lipids, etc. The stated is, in our opinion, the most important sanogenetic mechanism.

An important place in the individual development of the organism belongs to hormonal regulation. The endocrine glands produce a wide range of hormones that regulate biophysiochemical processes that ensure adaptability of the body to extreme environmental stressors. The main group of hormones responsible for these processes are glucocorticoids (corticosterone, cortisol). They interact with intracellular receptors of a large number of target organs, activate gluconeogenic enzymes, stimulate protein degradation in muscles, and conversion of glucogenic and gluco-ketogenic amino acids and glycerol into glucose. In the *D. gallinae* parasitism, significantly high cortisol concentrations were observed in the blood in the experimental chickens (Indyuhova *et al.*, 2022b). This also remained after the desacarisation, but tended to decrease. This indicates that the body needs additional energy sources during the recovery period, obviously due to intensified catabolism processes (Indyuhova *et al.*, 2021). The stated above is the basis for efficient energy supply of cells and tissues that actively use glucose as the main substrate for oxidation. However, a steady, prolonged and excessive increase in glucose in the blood leads to the excess expenditure and acidosis, and at the same time, to a systemic metabolic disorder.

It is known that the intensity of metabolic processes depends on hormonal regulation of cells and tissues. It is also important to consider sanogenetic mechanisms through the prism of metabolic changes that reflect the implementation of adaptation and compensation processes. Under the action of an extreme stress factor on the chickens, one can note optimized carbohydrate metabolism due to intensified gluconeogenesis (Indyuhova *et al.*, 2022b) along with a pronounced decrease in total protein and triglycerides. Thus, an increase in blood glucose concentration by 10.3% ($P<0.01$) was observed in the birds with dermanyssosis versus the control. At 20 days after the desacarisation, the experimental chickens showed a 4.0% increase tendency in glucose levels versus the healthy birds. All values of this parameter were within the physiological range. The latter may be due to intensified gluconeogenesis in the experimental chickens in relation to the control. But with a downward trend. This glucose level was obviously due to the initiation of the chickens' recovery mechanisms, in particular, the improved adaptive capabilities of their body. Further, the experimental birds showed an increase in creatinine concentration by 1.3 ($P<0.001$) and creatine phosphokinase activity by 10.2% ($P<0.05$) at 20 days after the desacarisation versus the control. This evidences the development of dystrophic processes in the muscle tissue of the laying hens. It can be assumed that intensified gluconeogenesis in the birds after the treatment is associated with the initiation of terminal sanogenetic mechanisms, causing the depletion of the body's reserve. This may be one of the reasons for incomplete restoration of homeostasis parameters in the experimental chickens.

The experimental birds found depletion of protein and lipid metabolism components during the entire research period (20 days). These metabolic shifts were obviously due to a significant reduction in the body's reserve.

Following the desacarisation, we can observe a tendency to a decrease in the proportion of anaerobic glycolysis in the birds, which was due to decreased lactate dehydrogenase activity as compared to the initial values. The stated is possibly due to the restoration of oxygen supply to cells and tissues by optimized RBC parameters. A significant increase in lactate dehydrogenase activity by 1.4 ($P<0.001$) was earlier observed in the chickens with dermanyssosis versus the control (Indyuhova *et al.*, 2022b). The stated indicated an increased proportion of glycolysis, lactate accumulation and, at the same time, uncompensated acidosis development in the tissues and blood. Therefore, there is an obvious tendency to restore the acid-base balance in the chickens following the desacarisation. It can be assumed that this contributes to the activation of various sanogenetic mechanisms for reducing an alteration degree of membranes and cell

enzymes. Obviously, the stated is also associated with calorigenic effect of thyroid hormones that increase oxygen absorption by tissues. The latter affects the decreased activity of the above intracellular enzymes responsible for lactic acid oxidized to pyruvate. All this indicates a trend towards optimized energy homeostasis in the chickens from the experimental group.

The detected adaptive sanogenetic mechanisms that adapt the chickens to normal functioning after exposure to an extreme stimulus of the haematophagous *D. gallinae*, particularly, a change in the most significant hormones at this age (Osorio *et al.*, 2011), indicate the initiated complex of biophysiochemical recovery mechanisms of their body and a tendency to optimize the homeostasis. However, a search for effective means to activate sanogenetic mechanisms is a topical area (Kryzhanovsky, 2011; Indyuhova *et al.*, 2022a).

CONCLUSION

The presented study considered some natural sanogenetic mechanisms identified in the laying hens after dermanyssosis with participation of key stress-associated hormones, cortisol and triiodothyronine, following the desacarisation. At the same time, the role of hormonal regulation, particularly, thyroid hormone, was observed in the normalized function of the blood system that maintains certain blood components (number of erythrocytes and leukocytes, hemoglobin concentrations), and in reduced intensity of lipid peroxidation processes in the birds after the desacarisation. Metabolism changes with a tendency to progressive depletion of energy substrates of lipid and protein nature were recorded in the chickens, being possibly associated with long-term high cortisol concentrations in the blood.

CONFLICTS OF INTEREST

The author declare that they have no potential conflicts of interest.

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