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EXCHANGE OF PROTEINS AND NUCLEIC ACIDS IN THE TISSUES OF CHICKENS IN CONNECTION WITH AGE AND PHYSIOLOGICAL STATE OF THE BODY

ОБМІН БІЛКІВ ТА НУКЛЕЇНОВИХ КИСЛОТ В ТКАНИНАХ КУРЕЙ У ЗВЯЗКУ З ВІКОМ ТА ФІЗІОЛОГІЧНИМ СТАНОМ ОРГАНІЗМУ

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Abstract. *The results of the study of the exchange of proteins and nucleic acids in the tissues of chickens in connection with the age and physiological state of the body are given. It was established that the live weight of experimental chickens met their standards, which are accepted for the corresponding age periods. The fastest growth and development was observed in the first three months of life, then body weight increased more slowly, and at the age of 6.5-12 months it was maximum - 2000-2200 g for Leghorn chickens, 2200-2400 g - for New Hampshire chickens. The absolute weight of the liver of Leghorn chickens gradually increased until almost 12 months of age (spring egg-laying), and during molting and sexual rest (18 months) it significantly decreased (by 24%) and corresponded to the weight of the organ during puberty (4.5 months). With the beginning of a new egg-laying cycle (20 months), the weight of the liver increased again, but did not reach the level of spring egg-laying (12 months). The relative weight of the liver gradually decreases with age, except for the weight during winter egg laying (6.5 months) and during spring egg laying (12 months). During these periods, the relative weight of the liver does not change. The absolute mass of both sections of the oviduct increases many times before the beginning of egg laying and reaches its maximum values during spring egg laying, exceeding by 4-8 times their mass during puberty (4.5 months), and with the cessation of egg laying it sharply decreases and reaches the level during puberty. With the beginning of a new egg-laying cycle, both sections of the oviduct increase again by 2-4 times, but do not reach their mass at the age of 12 months. In the liver, the content of non-protein nitrogen also actively increases with age, and its maximum values are noted at 6.5 and 12 months, that is, at the beginning and during the most intensive spring egg-laying, and during the period of sexual rest, its amount decreases by 20-25%; with the beginning of the second ovulation cycle, a new rise is noted, but to a lesser extent than in previous periods of sexual activity.*

Key words: *liver, chickens, egg laying, breed, protein, nitrogen, metabolism*

In order to build a full-fledged theory of the ontogenesis of agricultural animals and poultry, it is necessary to have a broad foundation of facts on the chemistry of protoplasm and changes in its individual components during embryogenesis and in the postnatal period of life up to aging and lethality, which is of great general biological and practical importance in animal husbandry. In particular, the study of metabolism in tissues is important for the correct organization of feeding and maintenance of animals in order to increase their productivity.

Nucleic acids take part in the synthesis of specific proteins, in the growth and reproduction of cells, in the transmission of hereditary properties [5, 6]. Changes in

the number of nucleic acids in tissues can serve as indicators of the intensity of protein synthesis in them, depending on the age and functional state of the body.

It is known that with age, the synthesis and rate of self-renewal of proteins gradually decrease and at the same time the concentration of nucleic acids decreases, which is equally characteristic of animals, microorganisms and plants, that is, a phenomenon characteristic of all living nature [1].

With age, not only the amount of ribonucleic acids (RNA) and deoxyribonucleic acids (DNA) in the protoplasm decreases, but also the ratio between nucleic acids, proteins and lipids changes [7], reflecting the level of synthetic processes in the cell.

Given that the body of chickens synthesizes a large amount of protein, we studied the peculiarities of their metabolism in different periods of their growth and development at different physiological states of the body.

Research was conducted on egg-laying Leghorn chickens and New Hampshire egg-meat breed in the following age periods: 2-3 days after hatching; 1, 2, 3 months – growth and development; 4.5 months – puberty; 6.5 months - the beginning of egg laying; 12 months - spring egg-laying; 18 months – sexual calmness, molting; 20 months - the beginning of a new egg-laying cycle. Feeding and maintenance of chickens were complete, in accordance with age, season of the year and productivity.

Research objects: the liver is a heterogeneous organ that performs numerous synthetic functions in the body; pectoral muscles – organs with pronounced mechanical and energetic functions, which represent the most valuable part of the carcass; oviduct, the function of which is extremely complex. In the oviduct, all substances necessary for the completion of egg formation are added to the yolk. Protein and non-protein nitrogen, collagen, nucleic acids and phosphoproteins were determined in the tissues. In each series of experiments, there were 6-8 chickens, which were slaughtered after a 12-hour diet. The removed tissues were immediately placed on ice and examined. Average data were obtained based on the results of 6-8 studies and statistically processed.

The live weight of experimental chickens met their standards, which are accepted for the corresponding age periods. The fastest growth and development was observed in the first three months of life, then body weight increased more slowly, and at the age of 6.5-12 months it was maximum - 2000-2200 g for Leghorn chickens, 2200-2400 g - for New Hampshire chickens.

We will present the data obtained on the Leghorn breed. The absolute weight of the liver gradually increased until almost 12 months of age (spring egg-laying), and during molting and sexual rest (18 months) it significantly decreased (by 24%) and corresponded to the weight of the organ during puberty (4.5 months). With the beginning of a new egg-laying cycle (20 months), the weight of the liver increased again, but did not reach the level of spring egg-laying (12 months).

The relative weight of the liver gradually decreases with age, except for the weight during winter egg laying (6.5 months) and during spring egg laying (12 months). During these periods, the relative weight of the liver does not change. The high weight of the liver at 6.5, 12 and 20 months can be explained by its increased functional activity in connection with egg laying. Obviously, during the egg-laying period, various egg precursors are synthesized in the liver.

The absolute mass of both sections of the oviduct increases many times before the beginning of egg laying and reaches its maximum values during spring egg laying, exceeding by 4-8 times their mass during puberty (4.5 months), and with the cessation of egg laying it sharply decreases and reaches the level during puberty. With the beginning of a new egg-laying cycle, both sections of the oviduct increase again by 2-4 times, but do not reach their mass at the age of 12 months.

The growth and development of the fallopian tubes are caused by hypertrophy and hyperplasia of all layers of the organ, especially the tubular and unicellular glands of the secretory layer. Different rates of growth and development of chickens in different periods of post-embryonic life and dynamism of physiological states of the body are related to the intensity and peculiarities of metabolism in different age periods of life. we studied these features using the example of changes in the nitrogenous and phosphorous compounds of the liver, pectoral muscles, the protein part of the fallopian tube, and the uterus.

During the growth and development of the body, protein nitrogen accumulates in the liver and muscles, and its maximum content is noted for the liver at the age of 6.5-12 months, for the muscles at the age of 12 months. At the age of 18 months (sexual quiescence), the amount of protein decreases (more in the liver and less in the muscles). With the beginning of a new egg-laying cycle, the level of protein nitrogen rises slightly, but not higher than during the spring egg-laying period (12 months). In the first days after birth, the liver contains 25-30% more protein than in the muscle, in the following periods its amount in both organs is approximately the same, with the exception of the age of 12, 18 and 20 months, when the protein in the muscles is somewhat more.

Works [3, 6] show that in the post-embryonic period of life, the protein content in tissues first increases, and then, after reaching a certain level, remains unchanged or gradually decreases. Our data correspond to the general biological orientation with the establishment of specific features for the liver and muscles of chickens. The picture of protein nitrogen changes in the oviduct of chickens looks different. In the process of growth and the onset of a new physiological state of the organism, the content of protein nitrogen in the tissues of the oviduct changes dramatically, especially in the protein part, where its amount increases by 50-70% compared to the period of puberty, and during sexual rest it decreases by almost the same amount . With the beginning of a new cycle of egg-laying (20 months), a new increase in the protein content is noted, but it does not reach the indicators at 12 months of age.

Similar changes with age and a change in the physiological state are observed in the uterus, but the total amount of protein is 24-45% less than in the protein department, which is due to their different function in egg formation.

Obviously, the reactions of protein deamination and hydrolysis take place more actively in the muscles than in the liver and oviduct. They contain more free nitrogen compounds, such as nucleotides, creatine and creatine phosphoric acid, creatinine, free amino acids, etc. In the pectoral muscles, non-protein nitrogen actively increases in the first month of life, more slowly in the next three months and maximally in 6.5 months, that is, in the period when growth and development are mostly finished and egg laying begins. In the following periods, the content of non-protein nitrogen in the

muscles gradually decreases or almost does not change due to the change in the physiological state of the body. Taking into account the intensive growth of protein and non-protein nitrogen until now, we can say that during the period of growth and development, protein synthesis prevails over other transformations, and in the future, a dynamic equilibrium is established in the reactions of synthesis and decay of nitrogenous substances.

In the liver, the content of non-protein nitrogen also actively increases with age, and its maximum values are noted at 6.5 and 12 months, that is, at the beginning and during the most intensive spring egg-laying, and during the period of sexual rest, its amount decreases by 20-25%; with the beginning of the second ovulation cycle, a new rise is noted, but to a lesser extent than in previous periods of sexual activity. This directionality of changes in non-protein nitrogen is also observed in both sections of the oviduct, in which it actively increases with the egg-laying period. At this time, non-protein nitrogen in the protein part of the oviduct is 20-25% more than during puberty.

Thus, the level of non-protein nitrogen in the liver and fallopian tube changes not only with age, but also depending on the functional activity of the organ, which changes depending on the physiological state of the body. This indicates that the most active transformation of proteins in the liver and fallopian tube occurs during egg laying, when the protein in the body is intensively synthesized, which is necessary for the formation of egg mass and other needs of the body. Precursors of egg proteins are obviously synthesized in the liver.

The high content of non-protein nitrogen in the tissues of the oviduct during egg-laying is apparently due not only to the products of protein metabolism of tissues, but also to low- and high-molecular nitrogen compounds brought by the blood, the amount of which increases during egg-laying by 50-100% [4].

The data on protein and non-protein nitrogen allow us to conclude that each type of tissue has its own characteristics of protein metabolism, which change differently due to age and the physiological state of the body. Collagen swells well with an excess of water and gives it away with increased removal of liquid from the body.

It was established that with age, the amount of collagen in the pectoral muscles decreases, and the most sharply in the first two months of life - by 25-30% compared to its content in day-old chickens, and by 18 months of age - by 50%. The amount of water changes in approximately the same way. Similar changes in collagen with age are noted [2] in the muscles of humans, pigs, and rats. Based on our data and those of other researchers, it can be assumed that as the animal body ages, the content of collagen in the tissues does not increase, but its physical and chemical structure changes, in particular, it becomes stronger against tearing, the time of fiber contraction increases, and its elasticity decreases. All these changes can be considered as a result of the increase in the strength of the bonds between all the components of the collagen complex, and not as a result of the accumulation of this protein.

In the uterus, the amount of collagen is 20% greater than in the protein department. This is consistent with the dynamics of water in them, the amount of which is greater in the uterus than in the protein part of the fallopian tube. In both

sections of the fallopian tube, the collagen content decreases with age, despite the change in its functional activity.

При утворенні шкаралупи в матці колаген складав 2,95%, а при формуванні білку в білковому відділі кількість колагену в матці була майже в два рази більше – 4,34%. Вміст колагену зростає і в білкоому відділі на 14,5%, коли яйце переходить у матку.

In all periods of research, the muscles contained 4-6 times less RNA phosphorus than in the liver and fallopian tube. In the liver and muscles, RNA phosphorus actively increases until one month of age, that is, during the period of the most active growth and development, when relatively large amounts of protein are needed as a plastic material for developing organs and tissues, as well as for resistance. In subsequent periods, the concentration of RNA in muscles steadily decreases with age and almost does not change due to different physiological states of the body.

In the liver, a decrease in the content of RNA is noted only before puberty and at 6.5 and 12 months, with the beginning and active spring egg-laying, there is a sharp rise in the content of RNA in the cytoplasm of the liver - by 25-30% more than at the age of 4.5 months. Then, with the completion of egg-laying, the amount of RNA decreases again, and with the beginning of a new cycle of egg-laying, its synthesis increases again.В м’язах вміст фосфору ДНК з віком поступово зменшується, крім тимчасової стабілізації в 4,5-6,5 і 12 місяців, тобто вміст ДНК в м’язах змінюється приблизно так само, як і РНК.

The ratio of RNA phosphorus / DNA phosphorus remains constant until 12 months of age, and then increases slightly as a result of a relative decrease in nuclear volume. In the liver, DNA phosphorus increases until the age of three months. At this time, obviously, cells divide most actively, which is determined by the level of DNA in them. During this period, the fastest increase in the absolute mass of the liver was noted. At 4.5 months, the amount of DNA decreases by 10-12% compared to its content at three months of age. With the beginning of egg-laying (6.5 months), the greatest increase in DNA phosphorus is noted, in 12 and 20 months its level does not actually change, and at 18 months, when egg-laying stops, the amount of DNA increases by 24% compared to the period of spring egg-laying (12 months) and a new egg-laying cycle (20 months). This should be explained by a decrease in the synthetic activity of liver cells and a relative increase in the volume of cell nuclei, which is confirmed by a decrease in the nuclear-cytoplasmic ratio of RNA phosphorus / DNA phosphorus, the amount of RNA phosphorus and the absolute weight of the liver.

Attention is drawn to the higher phosphorus saturation of RNA cytoplasmic formations of the protein department, in which it is 35-50% more than in the uterus, which is due to the different level of protein synthesis in their glandular cells. In the protein part of the oviduct, the entire mass of egg white proteins is secreted, and in the uterus, a little collagen is produced to form the framework of the shell and the epishell. The synthesis of ONK in the oviduct is more intense at 12 and 20 months, that is, during the period of spring egg-laying and its new cycle, and at 18 months (during sexual rest) the amount of RNA decreases, as it did before 6.5 months of age. If we take into account that before the beginning of egg-laying (6.5 months) and

especially before the period of spring egg-laying, both sections of the oviduct increase by 4-8 times, and the phosphorus content of RNA increases in 12 and 20 months per unit mass of tissue, then when calculating for the whole organ, a colossal synthesis of RNA is observed (Fig. 7), which undoubtedly takes part in the synthesis of egg proteins at the expense of amino acids brought by blood, and possibly also in the transformation of other blood proteins into egg protein.

With the cessation of egg laying, the RNA content in both departments decreases to the level at 4.5 months of age, and with the beginning of a new cycle of egg laying, the amount of RNA increases again, but does not reach the indicators of 12 months of age. Phosphorus in DNA practically changes little until spring egg-laying and during its repeated cycle, and increases by 43% during the period of sexual rest. This can also be explained by the relative increase in the volume of the nuclei of the glandular apparatus of the oviduct sections, which is indirectly confirmed by the decrease in the mass of both sections of the oviduct (involution) and a sharp decrease in the content of RNA up to this time, which saturates mainly the cytoplasm.

The stability of the DNA phosphorus content per unit mass of tissue during the egg-laying period is relative, since a large increase in DNA phosphorus is observed when calculating the entire organ. This indicates its active synthesis before the egg-laying period, as well as RNA. In our opinion, there is nothing unusual in this, since RNA and DNA are genetically related, DNA determines the synthesis of RNA.

In the liver, the content of phosphoproteins gradually decreases with age and, in fact, almost does not depend on the physiological state of the body. Another picture of the dynamics of phosphoproteins in the oviduct. During puberty, there is very little phosphorus in the tissues of the oviduct, and with the beginning of egg-laying (6.5 months) and especially during spring egg-laying (12 months), the number of phosphoproteins increases sharply; during sexual rest (18 months) in the uterus, they disappear completely, traces are found in the protein part. With the beginning of a new cycle of sexual activity (20 months), the amount of phosphorus in phosphoproteins increases again, but much less than during spring egg-laying (by 40-35%).

Conclusions.

The exchange of total proteins, collagen and nucleic acids has specific features for each type of tissue and depends on the age, physiological state of the body and breed of bird.

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Анотація. *Наведені результати дослідження обміну білків та нуклеїнових кислот в тканинах курей у звязку з віком та фізіологічним станом організму. Встановлено, що жива маса дослідних курей відповідала їх стандартам, які прийняті для відповідних вікових періодів. Найбільш швидкий ріст і розвиток відмічались у перші три місяці життя, потім вага тіла збільшувалась повільніше, і у віці 6,5-12 місяців вона була максимальною – 2000-2200 г для курей леггорн 2200-2400 г – для курей породи нью-гемпшир. Абсолютна маса печінки курей породи леггорн поступово зростала майже до 12-місячного віку (весняна яйцекладка), а під час линяння і статевого спокою (18 місяців) значно зменшувалась (на 24%) і відповідала масі органу в період статевого дозрівання (4,5 місяці). З початком нового циклу яйцекладки (20 місяців) маса печінки знову зростала, але не досягала рівня при весняній яйцекладці (12 місяців). Відносна маса печінки з віком поступово зменшується, за винятком маси при зимовій яйцекладці (6,5 місяців) і при весняній (12 місяців). В ці періоди відносна маса печінки не змінюється. Абсолютна маса обох відділів яйцепроводу збільшується в багато разів до початку яйцекладки і максимальних показників досягає під час весняної яйцекладки, перевищуючи в 4-8 разів їх масу в період статевого дозрівання (4,5 місяці), а з припиненням кладки яєць різко зменшується і досягає рівня в період статевого дозрівання. З початком нового циклу яйцекладки обидва відділи яйцепроводу знову збільшуються в 2-4 рази, але не досягають маси їх в 12-місячному віці. В печінці вміст небілкового азоту з віком також активно наростає, і максимальні показники його відмічені в 6,5 і 12 місяців, тобто на початку і під час найбільш інтенсивної весняної яйцекладки, а в період статевого спокою кількість його зменшується на 20-25%; з початком повторного циклу яйцекладки відмічається новий підйом, але в меншій мірі, ніж в попередні періоди статевої активності.*

Ключові слова: *печінка, кури, яйцекладка, порода, білок, азот,обмін речовин*