Low-intensity laser radiation effect on protein metabolism in young sheep

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Abstract. The demand for sheep products these days becomes higher, as evidenced by the tendency to increase small ruminants in the world and Russia. It leads to manufacturers' desire to get products as quickly as possible, without worrying about their quality. Various medications are used, which later, when eating animal meat, can have a detrimental effect on the human body. These studies aimed to study the effect of low-intensity laser radiation on the sheep's organism and obtain ecologically clean and high-quality mutton. For this, during the experiments, the blood of animals was studied. An essential role of protein metabolism in the animal body is blood serum proteins, qualitative and quantitative characteristics. They are the primary plastic material of tissues and organs and carry out regulatory, catalytic, and immunobiological functions. The growth rate is closely related to protein deposition. Individual development is determined by the constant exchange of substances and energy between the body and the external environment. However, each animal species has its metabolic traits, and, in particular, it concerns the transformation of proteins. Age-related biochemistry of protein metabolism has significant material in disclosing the fundamental biochemical constants of metabolism in animals' bodies. Simultaneously, the study of the peculiarities of protein metabolism is one of the main links in the knowledge of the biochemical essence of each period of sheep's life.

1. Introduction
The hematopoietic system is susceptible to laser radiation [1, 2].

The most accessible research system, reflecting the entire complex of physiological, biochemical processes in the body of sheep, is blood. The importance of blood testing dictated, first of all, by its large and irreplaceable role as an intermediary between the external environment and body cells [3].

The productivity of animals is associated with metabolic processes in their bodies. The magnitude and rate of metabolic processes can be indirectly determined by the change in blood metabolites' concentration. As the internal environment of the body, blood has a constant composition. Besides, it is one of the systems that reflects all the changes occurring in the animal body. Its quantitative and qualitative composition largely determines the intensity of metabolism and associated processes of growth, development, and productivity [4].

In the presence of various reception mechanisms and transformation of the energy of laser radiation of low intensity by living systems under conditions of optimal modes and dose of exposure, positive
changes in metabolic processes are observed. Decreases in hypoxia in tissues increase their regenerative potential and ultimately increases the viability of the organism. Its resistance to unfavorable environmental factors expands the limits of its adaptive capabilities [5].

Analyzing the change in enzymes’ activity provides valuable information about the primary biochemical mechanisms of the stimulating effect of laser radiation on the cell's functional activity. Enzymes functioning at the junction of protein and carbohydrate metabolism, and enzymes of the tricarboxylic acid cycle increase their activity when exposed to stimulating doses of low-energy laser radiation, which gives an impetus to redox processes [6, 7].

It is noted that when a living organism is exposed to laser light beams, an increase in the biosynthesis of nucleic acids occurs and an increase in mitochondria and ribosomes, which indicates the activation of the nuclear apparatus of the cell [8].

The study of morphological and biochemical parameters of blood, to a certain extent, explains the variability of productivity indicators.

Further consideration of this issue, in our opinion, will help to identify the features of the metabolism of young sheep under biophysical factors of influence [9].

2. Materials and methods
The experiment was at the All-Russian Scientific Research Institute of Sheep and Goat Breeding - a branch of the Federal State Budgetary Scientific Institution "North Caucasian Federal Scientific Agrarian Center" (poll Dorset x North Caucasian meat and wool). Ewes in the second half of pregnancy were divided into two groups: control (n = 67) without low-intensity laser radiation and experimental (n = 40) with low-intensity laser radiation. In the experimental group's ewes, exposure to low-intensity laser radiation was in the second half of the contraction in the area between the last lumbar vertebra and the sacrum.

The offspring obtained from ewes were divided into three groups of lambs (rams), which were the object of the study: from ewes in the control group - two groups of lambs I - control (without the use of laser radiation), II experimental with the use of low-intensity laser radiation, from experienced ewes - one group (III), with the use of low-intensity laser radiation. In lambs, laser radiation was applied to the nerve center, responsible for the thymus' innervation, located in the region of the first thoracic vertebra.

The scheme for using low-intensity laser radiation on lambs is in table 1.

| Group                          | Treatment area | Treatment organ | Treatment time, min | Treatment multiplicity | Animals age |
|-------------------------------|----------------|-----------------|---------------------|------------------------|-------------|
| I (control), lambs obtained from ewes of the control group (without treatment) (n=20) | Without low-intensity laser radiation treatment | | | | |
| II (experimental), lambs obtained from ewes of the control group (without treatment) (n=21) | first thoracic vertebra | Thymus | 1.5 | twice | 15 and 20 days |
| III (experimental), lambs obtained from ewes of the experimental group (with a single treatment) (n=24) | first thoracic vertebra | Thymus | 1.5 | twice | 15 and 20 days |

3. Results and discussion
The concentration of whey protein, albumin, globulins, urea, and creatinine in different groups of animals' peripheral blood was considered to determine the intensity of protein metabolism in young sheep. The results of the data obtained indicate peculiarities of protein metabolism indicators at different
development stages and differences in the concentration of these most important metabolites of protein metabolism, depending on the factors affecting their body (Table 2). The lowest whey protein level was during the neonatal period (group I - 60.06 g/l; II - 60.46 g/l; III - 60.86 g/l). In subsequent age periods, the total protein concentration in the blood of lambs of group I increased, reaching its maximum value by the age of 2 months: Group I - 65.84 g/l; II - 74.60 g/l; III - 76.20 g/l. However, the whey protein level in all age periods in the blood of experimental animals of groups II and III was significantly higher than in the first control. So, the superiority of lambs of groups II and III over animals of group I was 5.0 and 7.8% at the age of 1 month, 13.3 and 15.7% at two months, 5.9 and 9.0% at four months (P <0.001).

The ontogenetic characteristics of qualitative protein composition and its fractions in the studied young sheeps the lowest concentration of albumin and globulins were at the first stages of postnatal ontogenesis. Thus, in newborn lambs of all studied groups, the level of albumin and globulins ranged from 28.95-29.89 g/l, 30.35-31.91 g/l. From the age of one month, the level of protein metabolites increased in the studied young animals of all groups, reaching a maximum of 2 months, ranging from 31.38-35.73 g/l, 34.46-40.47 g/l. At the same time, a clear advantage in the content of both albumin and globulins was in the animals of the II and III experimental groups: at one month of age, the difference in the studied parameters was 3.1-3.8%; 6.7-11.5%, in the two months - 11.3-13.8%; 15.3-17.4%, 4-month 5.1-8.3%; 6.7-10.0%, respectively, to the peers of the 1st control group (P <0.01; P <0.001).

Table 2. Protein metabolism of the studied young sheep.

| Indicators       | Experimental group |
|------------------|--------------------|
|                  | I                  | II                  | III                 |
| **Total protein, g/l** | **newborns**       |                     |                     |
| Albumin, g/l     | 29.71±0.51         | 29.89±0.34          | 28.95±0.68          |
| Globulins, g/l   | 30.35±0.34         | 30.57±0.23          | 31.91±0.59          |
| Globulin fractions, g/l | α <8.61±0.17     | 8.74±0.12           | 7.83±0.14           |
|                  | β 7.55±0.2         | 7.11±0.14           | 7.59±0.18           |
|                  | γ 14.38±0.24       | 14.72±0.19          | 16.49±0.17          |
| Urea, mmol/l     | 5.38±0.16          | 5.37±0.11           | 5.19±0.11           |
| Creatinine, μmol/L | 131.6±2.2        | 128.2±2.1           | 121.0±2.6           |
| **Total protein, g/l** | **One month old**  |                     |                     |
| Albumin, g/l     | 30.83±0.71         | 31.77±0.5           | 32.0±0.28           |
| Globulins, g/l   | 33.69±0.7          | 35.95±0.75          | 37.56±1.1           |
| Globulin fractions, g/l | α 10.01±0.15    | 10.07±0.13          | 10.12±0.25          |
|                  | β 9.02±0.16        | 9.03±0.15           | 9.05±0.13           |
|                  | γ 14.66±0.19       | 16.85±0.3           | 18.39±0.19          |
| Urea, mmol/l     | 5.08±0.5           | 4.93±0.3            | 4.21±0.12           |
| Creatinine, μmol/L | 125.8±4.0        | 122.2±5.7           | 117.8±1.9           |
| **Total protein, g/l** | **Two months old** |                     |                     |
| Albumin, g/l     | 31.38±0.52         | 34.92±0.44          | 35.73±0.38          |
| Globulins, g/l   | 34.46±0.18         | 39.74±0.37          | 40.47±0.43          |
| Globulin fractions, g/l | α 10.10±0.4     | 10.31±0.4           | 10.19±0.6           |
|                  | β 6.82±0.2         | 9.39±0.1            | 9.45±0.3            |
|                  | γ 17.54±0.46       | 20.04±0.37          | 20.83±0.5           |
| Urea, mmol/l     | 4.12±0.18          | 3.75±0.20           | 3.61±0.11           |
| Creatinine, μmol/L | 119.4±4.0         | 116.52±1.03         | 113.80±1.10         |
| **Total protein, g/l** | **Four months old** |                     |                     |
| Albumin, g/l     | 32.13±0.36         | 33.77±0.82          | 34.77±0.51          |
The results of studies of the qualitative composition of the globulin fraction (α, β, γ) of the blood of animals of different groups, to varying periods of their life and development, indicate that the concentration of α-, β-, γ-globulins underwent certain changes. The degree of these changes depended on the lambs' age and the factors influencing their body. There was an increase in the concentration of globulin fractions in the blood of the studied groups of animals with age, reaching a maximum by two months of age. However, this increase in the experimental groups of sheep was more intense than in control.

As for the end products of nitrogen metabolism (urea, creatinine), the studied metabolites' concentration in the studied animals' blood decreased as they grew and developed. During the neonatal period, the blood's urea level varied within 5.19-5.38 mmol/l, creatinine 121.0-131.6 mmol/l, respectively, gradually decreasing by the age of 4 months.

It is characteristic that the concentration of end products of nitrogen metabolism in the control group's lambs' blood was higher than in the experimental animals. The lower content of these parameters in the blood of young animals of the experimental groups (groups II and III) can be explained by the increased inclusion of protein in metabolic processes.

**Figure 1.** Blood sampling from the jugular vein in sheep.

### Table 1

| Component         | Group I | Group II | Group III |
|-------------------|---------|----------|-----------|
| Globulins, g/l    | 32.81±0.25 | 35.03±0.12 | 36.09±0.21 |
| Globulin fractions, g/l | α 9.69±0.7 | 8.93±0.35 | 9.48±0.9 |
|                   | β 6.60±0.8 | 8.02±0.6  | 7.79±0.67 |
|                   | γ 16.52±0.51 | 18.08±0.36 | 18.82±0.43 |
| Urea, mmol/l      | 3.47±0.20 | 3.01±0.17 | 2.86±0.14 |
| Creatinine, μmol/L| 110.2±5.7 | 102.41±0.93 | 93.8±1.9 |

4. **Conclusion**

Summing up the comparative study of the age-related dynamics of protein metabolites in the studied groups of sheep, it should be noted that the nature of changes in the content of total protein and its fractions is the same for all studied animals during all periods of their growth and development. It boiled down to an increase in whey protein level with age with a decrease in the albumin fraction and an increase in globulin, a decrease in the content of urea and creatinine in the blood.

However, the animals of the experimental groups differed from the control group by a significant superiority in the level of total protein and its fractions at all age periods, but by a lower concentration of the end products of nitrogen metabolism, which indicates a higher level of synthetic processes in their bodies.
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