http://www.moderntechno.de/index.php/meit/article/view/meit28-01-008
DOI: 10.30890/2567-5273.2023-28-01-008

**УДК 636.2.084/087.074**

# SPECIFIC FEATURES OF USING INORGANIC SULFUR FOR KERATIN SYNTHESIS AND SEASONAL CHANGES IN WOOL

## ВИДОВІ ОСОБЛИВОСТІ ВИКОРИСТАННЯ НЕОРГАНІЧНОЇ СІРКИ ДЛЯ СИНТЕЗУ КЕРАТИНУ ТА СЕЗОННІ ЗМІНИ ШЕРСТІ

**Koval T.V., / Коваль Т.В.**
*c.a.s., as.prof. / к.с.н., доц.*
*ORCID: 0000-0002-7132-5887*
**Prylipko T.M. / Приліпко Т.М.,**
*d.a.s., prof. / д.с.н.. проф.*
*ORCID: 0000-0002-8178-207X*
*Publons: AAF-5445-2019*
*Higher education institution « Podolsk State University»,*
*Kamianets-Podilskyi, Shevchenko,13,32300*
*Заклад вищої освіти «Подільський державний університет»*

***Abstract.*** *The high lability of the composition of the skin, its content of sulfur and nitrogen, the dependence of the composition of the skin on the nature of the diet, allows us to talk about its significant depositing role. Deposition of sulfur-containing compounds in the skin was also shown using autoradiographic examination of tissues of animals treated with S35. Sulfur-containing compounds enter the skin immediately after their introduction to the animal in its native form or after recovery and peresulfonation. They are deposited in large quantities in the subcutaneous tissue, in hair follicles. In rodents, the largest primary deposition is observed in the neck of the follicle, surrounded by a dense network of capillaries, blood sinuses, and in adult sheep, lambs, saigas - mainly in the bulbs. Active processes of sulfur exchange take place in the skin, its oxidized compounds are reduced to sulfides, then passes their inclusion in the composition of organic molecules. The reduction of sulfur sulfate and its incorporation into amino acids is rapid. In lambs that received per os radioactive methionine or sodium sulfate S35, the composition of methionine and cystine was detected in the skin already 5-10 minutes after administration.*

***Key words:*** *organic sulfur, amino acid, methionine, hair follicles, animals*

Seasonal changes in the sulfur content in the skin and blood are reflected in the seasonal delay in wool growth, which coincides with periods of poor feeding, as is known from practice and described by a number of researchers [4], as well as in the seasonal cessation of activity of some follicles. Seasonal changes in wool growth were detected in Romanov and other sheep using radioactive sulfur.

The high lability of the composition of the skin, its content of sulfur and nitrogen, the dependence of the composition of the skin on the nature of the diet, allows us to talk about its significant depositing role. Deposition of sulfur-containing compounds in the skin was also shown using autoradiographic examination of tissues of animals treated with S35.

Sulfur-containing compounds enter the skin immediately after their introduction to the animal in its native form or after recovery and peresulfonation. They are deposited in large quantities in the subcutaneous tissue, in hair follicles. In rodents, the largest primary deposition is observed in the neck of the follicle, surrounded by a dense network of capillaries, blood sinuses, and in adult sheep, lambs, saigas - mainly in the bulbs.

**Table 1 - Seasonal changes in mass and growth of wool in fine-wool sheep**

| Indexes | July | July - August | September-November | December-February | May-June |
|---|---|---|---|---|---|
| Live weight of sheep (kg) | 42,7 | 46,6 | 48,9 | 48,1 | - |
| Wool growth per month (mm) | - | 9,3 | 10,4 | 6,3 | 8,0 |

**Table 2 - Seasonal variability of the intensity of wool growth in Romanov sheep (% of growing hairs from the number of investigated)**

| Fibers | October | November December | January February | March | April |
|---|---|---|---|---|---|
| Rude | 100 | 85 | 0 | 0 | 0 |
| Transitional | 100 | 92 | - | 18 | 3 |
| Fluffy | 100 | 100 | 100 | 72 | 40 |

**Table 3 - Seasonal changes in wool growth rate in Romanov sheep (mm per day)**

| Fibers | September-December | January- February | May-August |
|---|---|---|---|
| Rude | 0,63 | 0,44 | 0,49 |
| Transitional | 0,81 | 0,61 | 0,71 |
| Fluffy | 0,61 | 0,48 | 0,54 |

Active processes of sulfur exchange take place in the skin, its oxidized compounds are reduced to sulfides, then their inclusion in the composition of organic molecules takes place. The reduction of sulfur sulfate and its incorporation into amino acids is rapid. In lambs that received per os radioactive methionine or sodium sulfate S35, the composition of methionine and cystine was detected in the skin already 5-10 minutes after administration. The ratio of newly formed sulfur-containing amino acids was typical for the composition of the skin and equaled 1:1 [1,2] .

Elucidation of the effect of various additives is important for the development of methods of increasing the wool productivity of sheep with fodder factors. From the point of view of biochemistry, the formation of wool fiber is a peculiar type of excretion of morphologically stabilized protein keratin, which is characterized by a high content of sulfur. It is synthesized and takes a certain form in the hair follicle [7].

Sheep that produce up to 30 kg of wool per year deposit up to 400-500 g of sulfur in the pure fiber, not taking into account the loss of sulfur in the keratinized cells of the inner hair sheath, which is rejected [1, 6].

Numerous experiments show that in some cases, feeding sheep with keratin concentrates (wool hydrolysates), blood meal, which contains a high percentage of protein and sulfur, and even sulfates or elemental sulfur increases wool shearing [4, 5] .

In our research on fine-wool sheep in the Chernivtsi region, it was shown that in case of introduction of sulfate, hyposulfite in sheep's feed, shearing of wool was increased by 5-15%.

**Table 4 - Effect of mineral supplements on wool growth in sheep**

| Additive composition | Hair growth on the cut area for 30 days of the experiment (mm) | | | | | Wool shearing (kg) |
|---|---|---|---|---|---|---|
| | Askanian | local prekos | | | | |
| | | July-August | September-November | December-February | May-June | |
| No feeding (control) | 7,7 | 8,9 | 10,9 | 6,7 | 7,8 | 2,9 |
| $Na_2SO_4$ | 77 | 9,9 | 11,6 | 7,3 | 8,0 | 3,4 |
| $(NH_4)_2SO_4$ | 8,7 | 9,4 | 9,9 | 6,0 | - | 3,0 |
| $Na_2S_2O_3$ | - | 9,6 | 10,2 | 7,3 | - | 3,5 |

The stimulating effect of mineral fertilizers on wool growth is due to the fact that sheep have the ability to use inorganic sulfur compounds for keratin synthesis. The use of radioactive drugs that contain S35 [6] showed that sheep are able to use not only protein sulfur or slot amino acids, but also oxidized compounds - sulfate, sulfide, hyposulfite, elemental sulfur, for the synthesis of wool keratin, and include the sulfur of these compounds in the composition wool fiber.

Sulfur-containing mineral fertilizers, entering the exchange, take part in the synthesis of cystine and methionine, that is, the most valuable protein amino acids, increase valuable metabolic reserves of sheep and have a significant effect on ensuring their sulfur balance.

To be used in the synthesis of amino acids, oxidized sulfur must undergo reduction. Regenerative processes can be carried out by the enzyme systems of some microorganisms that fill the digestive tract and canal of ruminants. However, [7] found tissue enzymes in the liver and muscles of rats and birds that ensure the reduction of oxidized sulfur to hydrogen sulfide and its inclusion in the carbon skeleton of serine, which leads to the formation of cystine. Tissue enzymes that reduce sulfur and ensure its inclusion in serine with the formation of cystine are also found in the skin of sheep and rabbits. [5] showed that cystine can be formed in the skin of sheep and with the epidermal use of inorganic sulfur compounds (sulfate, hyposulfite)

Specific features in the use of sulfur-containing compounds for the formation of wool fibers, the inability of rabbits, saigas, and minks to synthesize wool keratin with the participation of inorganic sulfur and, conversely, its assimilation by sheep, cats, dogs, donkeys, foxes, and foxes emphasize the role of specific tissue enzymes of sulfur metabolism, the absence which are not always replaced by the activity of the microflora of the gastrointestinal tract.

The metabolic ability of young animals in the first days of life to use mineral sulfur-containing compounds for the synthesis of amino acids is sharply reduced or absent. Similar results were obtained in relation to the use of nitrogen from ammonium salts and urea labeled with heavy nitrogen [7].

In the case of a violation of the enzymatic activity of the skin, a decrease in the activity of sulfide oxidase, which takes part in the oxidation of toluene groups and the closing of disulfide bonds. What is necessary for the formation of keratin, the

formation of hair is disturbed. The activity of this enzyme largely depends on the balance of some trace elements in the skin of sheep [2].

**Table 5 - Specific features of using inorganic sulfur (sulfate) for wool keratin synthesis**

| Animals | Inclusion in wool keratin | Animals | Inclusion in wool keratin |
|---|---|---|---|
| Sheep (various breeds) | + | Newborn kitten | - |
| Newborn lamb | - | Fox | - |
| saiga | - | Polar fox | + |
| saiga lamb | - | Mink | - |
| Ass | + | Guinea pig | + |
| Dog | + | Rabbit | - |
| Cat | + | Rat | - |
| | | The rat is ten days old | - |

In the biochemical copper provinces, which are characterized by a low content of copper in the soil, plants and water, in Karakul sheep, a violation of keratinization of the hair shaft, an extension of the zone of keratinization, was detected, which was eliminated by introducing copper sulfate into the feed. Similar wool deterioration is observed in molybdenum provinces, which are distinguished by an excess of molybdenum, a biochemical antagonist of copper. An excess of molybdenum, caused by molybdenum ammonium fertilisers, also leads to a lengthening of the sulfhydryl zone in the hair follicle. The effect of a lack of copper or an excess of molybdenum is related to their effect on sulfide oxidase and is corrected by the use of supplements that replenish the deficiency or contribute to the removal of an excess of the corresponding element from the body [7].

**Conclusion**

The stimulating effect of sulfur-containing fertilizers on the growth of wool has been established. With the use of S35, the peculiarities of the use of various sulfur-containing compounds for the formation of wool fiber were studied, the relatively high use of inorganic sulfur by sheep was shown, as well as its use for this synthesis by dogs, cats, foxes, foxes, donkeys, in contrast to minks, rabbits, rats and saigas. Experiments with tissue homogenates in vitro showed the presence of enzymes in the skin of sheep that reduce sulfur and ensure its inclusion in serine with the formation of cystine. The metabolic features of young animals were revealed, and their ability to use inorganic compounds of sulfur and nitrogen for organic synthesis was established.

**References**

1. Ibatullin I., M.I. Bashchenko, O.M. Zhukorsky Handbook on complete feeding of farm animals. Agar science. Kyiv. 2016. 336 p.

2. Prylipko T.M. Effectiveness of using hyperbranch aquaculture in ditch diets. Animal husbandry of Ukraine. No. 6. 1997. P. 13-15.

3. Novostavska A.V. Global trends in animal husbandry development. Scientific Bulletin "Askania-Nova". Askania-Nova, 2009. Vol. 2. P. 3-7.

4. Tetiana Prylipko, Yevhen Dulkay, Volodymyr Kostash, Volodymyr Tkachuk, Tetyana Verbelchuk. Sergii Verbelchuk Metabolism, productive performance of bright breeds of lacquer for feeding in the diet of aquaculture supplements. *Independent journal of management & production (IJM&P).* v. 13, n. 3, Special Edition ISE, S&P. May 2022. p.p. 241-251.

5. Prylipko T.M. Dynamics of live and wool productivity of young sheep for feeding aquaculture additives/ T.M.Prylipko. Dulkay Y, I**.** *Modern engineering and innovative technologies. International periodic scientific journal (online).* December 2021. Issue Nr. 18 Part 5. Karlsruhe, Germany 2021. P. 40-43.

6. Shapovalov S. O. Regulation of the resistance of the animal organism to adverse environmental factors by essential microelements: autoref. thesis for obtaining sciences. degree of doctor of biol. Sciences: spec. 03.00.13 "Physiology of man and animals". Kharkiv, 2011. 38 p

7. Yanovych V. G. Biological basis of transformation of nutrients in ruminants. Lviv: Triada plus. 2000. 384 p.

***Анотація.*** *Встановлена висока лабільність складу шкіри, вмісту в ній сірки та азоту, залежність складу шкіри від характеру годівлі дозволяє говорити про її значну депонуючи роль. Депонування сірковмісних сполук в шкірі було показано також з використанням авторадіографічного дослідження тканин тварин, що отримували $S^{35}$. Сірковмісні сполуки надходять в шкіру зразу ж після введення їх тварині у нативному вигляді або після відновлення і пересульфування. Вони у великій кількості відкладаються в підшкірній клітковині, у волосяних фолікулах. У гризунів найбільше первинне відкладення спостерігається в шийці фолікула, оточеного густою сіткою капілярів, кров'яними синусами, а у дорослих овець, ягнят, сайгаків – переважно в цибулинах. В шкірі проходять активні процеси обміну сірки, окиснені її сполуки відновлюються в сульфіди, потім проходить їх включення в склад органічних молекул. Швидко проходить відновлення сірки сульфату і включення її в амінокислоти. У ягнят, які отримували* ***per os*** *радіоактивний метіонін або сульфат натрію $S^{35}$ в шкірі виявлялась в складі метіоніну та цистину вже через 5-10 хвилин після введення.*

***Ключові слова:*** *органічна сірка, амінокислота, метіонін, волосяні фолікули,тварини*