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INFLUENCE OF INTERNAL LIPIDS ON THE HYGROSCOPICITY OF SHEEP WOOL DAMAGED BY FLEECE MICROORGANISMS

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A prerequisite for the life of microorganisms is the simultaneous presence of air, heat, and free moisture. Given this, sheep fleece is an ideal environment for their growth and development. The microflora of the fleece, during its lifecycle, utilizes both its environment, i.e. the wool grease, and keratin itself as substrates, which leads to damage to the fiber's structure and, in some cases, even to its complete degradation. Microbiological degradation of fibers is the most common type of wool damage [1,2].

Representatives of these bacteria secrete proteolytic enzymes (primarily pepsin), which can hydrolyze keratin into individual amino acids [3]. The process of fiber degradation begins with the cuticular layer, gradually progressing to the cortical layer. As a result, the fiber structure is disrupted, the cuticular scales and cortical layer cells separate, ultimately leading to fiber disintegration [4].

The structure of hair contains a small amount (up to 3%) of lipids, which exist in both free and protein-bound states. These lipids are an integral component of the fiber, and most of them cannot be isolated using organic solvents without prior alkaline hydrolysis. Therefore, they are referred to as structural, internal, or integral lipids [5].

Internal lipids play a key role in shaping the surface properties of hair and its ability to protect against external negative factors [6]. They have the ability to alter the fiber structure, reducing moisture content and permeability while increasing its tensile strength [7].

Accordingly, the aim of our study was to investigate the influence of fleece microflora on the hygroscopicity of wool fibers before and after the extraction of internal lipids.

The subject of the research was wool samples from ewes of the Askanian fine-wool breed, which belonged to the M.F. Ivanov Institute of Animal Husbandry of Steppe Regions, “Askania Nova”. All animals were kept under identical housing and feeding conditions. For the study, wool was collected from the fleece in the shoulder blade area after the spring shearing of the sheep. The selected samples were divided into wool in normal condition and wool damaged by microorganisms.

To determine hygroscopicity, clean and defatted samples were used. They were dried in a drying cabinet at 105^{0}C before and after lipid extraction and then weighed. Afterward, the samples were kept at room temperature for 90 hours and reweighed. The difference in wool mass was used to determine its hygroscopicity, expressed as a percentage.

The obtained data were processed using Microsoft Excel. The research results were statistically processed using the arithmetic mean and standard error (M ± m), along with a confidence interval to estimate the degree of probability (p), applying Student’s t-test.

One of the key physical properties of wool fibers is their ability to absorb and retain moisture, i.e., hygroscopicity. Studies on wool hygroscopicity have established an inversely proportional relationship between the content of internal lipids and the fibers' ability to absorb moisture. The numerical data in Table 1 clearly show that after lipid extraction, wool hygroscopicity nearly doubles. This applies to both damaged and normal wool.

Furthermore, in damaged wool, hygroscopicity significantly increases ($P<0.05$), both before and after the extraction of internal lipids. These findings clearly indicate that the hygroscopicity of wool fibers is closely related to their lipid components and is also strongly influenced by the degree of fiber damage, including the depth and nature of their destructive changes.

Table 1

Hygroscopicity of normal and damaged wool, % (M±m, n=5)

Hygroscopicity	Wool	
	normal	damaged
Before extraction of free internal lipids	5,18±0,15	7,09±0,14*
After extraction of free internal lipids	9,39±0,17	13,02±0,12*

*Note: statistically significant differences * – P<0.05*

Conclusions. An inversely proportional relationship has been established between the content of internal lipids and the ability of wool fibers to absorb moisture. A significant (P<0.05) increase in the hygroscopicity of wool damaged by microorganisms has been demonstrated, which ultimately leads to a decline in the overall quality of wool raw material.

REFERENCES:

[1] Ghimis S.B., Mirt A.L., Vlaicu A., Zaharia E., Bomboş M.M., & Vasilievici G. (2023). Impregnated sheep wool fibers with an antimicrobial effect. *Chem. Proc,* 13(1): 1.
[2] Sanders D., Grunden A., & Dunn R.R. (2021). A review of clothing microbiology: the history of clothing and the role of microbes in textiles. *Biol. Lett,* 17(1): 20200700.
[3] Queiroga A.C., Pintado M.E., & Malcata F.X. (2013). Wool-associated proteolytic bacteria, isolated from Portuguese Merino breed. *Small Ruminant Research,* 109(1): 38-46.
[4] Caven B., Redl B., & Bechtold T. (2019). An investigation into the possible antibacterial properties of wool fibers. *Textile Research Journal,* 89(4): 510–516.
[5] Csuka D.A., Csuka E.A., Juhász M.L.W., Sharma A.N., & Mesinkovska N.A. (2023). A systematic review on the lipid composition of human hair. *Int J Dermatol,* 62(3): 404–415.
[6] Tkachuk V.M., Havrylyak V.V., Stapay P.V., & Sedilo H.M. (2014). Internal lipids of felted, yellowed and pathologically thin wool. *Ukr Biochem J,* 86(1): 131–138.
[7] Coderch L., Alonso C., García M.T., Pérez L., & Martí M. (2023). Hair lipid structure: effect of surfactants. *Cosmetics,* 10(4): 107.