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RELATIONSHIP OF DIELECTRIC PROPERTIES OF THE HAIR COVER WITH ITS MORPHOPHYSIOLOGICAL AND BIOCHEMICAL CHARACTERISTICS IN FARMED FUR-BEARING ANIMALS

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Abstract

The hair cover of furbearing animals is a dielectric material able to electrify with accumulation of static electricity charges. Electrically charged surface attracts dust particles causing loss of fur shine, accelerated aging, destruction and a decrease in strength characteristics and the quality of raw materials, as well as the transfer of static electricity charges when in contact, for example, with the human body. In this paper, for the first time, we propose an empirical equation describing the dielectric properties of natural fur and the interrelations between the composition and quality of the skin and hair covers with its electrophysical characteristics for different species of furbearing farm animals. The work aimed to study the influence of morphophysiological characteristics, biochemical composition (mineral and amino acid), and the state of the skin and hair on dielectric properties and to reveal relationships to more correctly assess the quality of fur raw materials. In the work, we used fur raw materials obtained from physiologically healthy silver-black foxes (*Vulpes vulpes*), silver foxes (*Alopex lagopus*), and standard minks (*Mustela vison*) (Zverosovkhoz Saltykovsky, Moscow Province). Hair density per 1 cm^2 rump, the guard hair density per 1 cm^2 rump, the linear dimensions of various types of hair, their thickness, the thickness of the rump skin, and the pelt area were measured and Na, Ni, B, V, Se, Al, Fe, K, I, Ca, Co, Mg, Mn, Cu, P, Cr, Zn, Si contents were determined. Amino acid analysis of biosubstrate hydrolysates was carried out for 17 amino acids. The pelts were tested for dielectric properties. The discharge kinetics equations were obtained at 20° C, 62 % relative humidity and voltage of 10.0, 18.5, and 28.5 kV (a HT-705 5kVA 50KV AC/DC high-voltage charge generator, Wuhan Huatian Electric Power Automation Co., Ltd., China). When assessing the quality of fur raw materials, a voltage of 9.5, 12.5, 15.5 and 18.5 kV was used. The charge leakage time constant and the change in the magnitude of the static electric field strength at certain time intervals were determined. A comparison of the morphophysiological parameters of the skin and hair in different species of furbearing animals with the data on electrizability allowed us to derive an empirical equation reflecting the dielectric properties of the skin and hair — $E = E_0 \cdot e^{-t/\tau}$, where E_0 is the maximum value of the tension and τ is the charge leakage time constant. Correlation analysis showed close interrelations between the rate of charge runoff and the length and thickness of the guard hairs ($r = 0.83$-0.90 at $p < 0.05$), the density of the guard and down hair ($r = 0.92$-0.98 at $p < 0.001$), and the length of the down hairs ($r = 0.94$ at $p < 0.001$). The charge leakage closely correlated with the total mass of chemical elements in the hair and skin ($r = 0.97$; $r = 0.97$ at $p < 0.05$) and the total amino acid composition of the hair cover ($r = 0.95$ at $p < 0.05$). The E_0 value closely correlated with the total mass of elements in the hair and skin, and with the amino acid composition of the hair cover ($r = 0.90$; $r = 0.86$; $r = 0.99$ at $p < 0.05$). Therefore, the dielectric properties of the skin and hair of furbearing animals depend on both the morphophysiological characteristics and biochemical composition. The skin and hair cover defects were established to affect the electrophysical parameters (τ and E_0). Decreased fur density, haircut, broken awn, fur mattedness reduce the E_0 index by 25-90 % and change the charge leakage time constant τ by 15-70 %

compared to defect-free skins. The dielectric parameters E_0 and τ provide more accurate fur quality estimates in silver-black fox, silver fox, and standard mink. The technology uses electrophysical measurements instead of not subjective organoleptic analysis.

Keywords: furbearing animals, *Vulpes vulpes*, silver fox, *Alopex lagopus*, Arctic fox, *Mustela vison*m, mink, skin cover, hair cover, dielectric properties, electrizability, mineral composition, amino acid composition, fur defects

At fur auctions and enterprises, the quality, integrity, and condition of the skin and hair covering of fur animals, as well as their physical and mechanical characteristics, as a rule, are determined by outdated methods — manually and organoleptically [1, 2]. Assessing the quality of fur raw materials and semi-finished products by this method is time-consuming, subjective, often controversial, and inaccurate. It depends on the experience and professionalism of the sorter, his/her well-being, fatigue.

The skin and hair of fur animals are dielectric materials, accumulating a significant static charge [2-4]. Electrification of fur raw materials and semi-finished products leads to their rapid dust pollution, which deteriorates the quality of fur products e.g., reduces luster, accelerates aging and destruction of the hair, increases its fragility [2].

Studying the static characteristics of the skin and hair covering and their causes is also necessary to establish factors that would reduce it to safe values for humans. Unfortunately, in Russia and abroad, such works are not carried out to date. There are no methods or devices that would make it possible to study electrification processes. Unlike textile materials, animal hair has a heterogeneous and uneven surface, consisting of different hair categories with unequal structure, linear parameters, and geometric shapes. Developing a physical and mathematical model of the static characteristics of hair covering is necessary to take into account all the many nuances associated with its complex architectonics.

The hair cover of fur animals, differing in height, density, hair color, and skin of animals, has different mineral and biochemical compositions [5-7]. Hair covering quality depends on complete feeding: balance of proteins, fats, carbohydrates, vitamins, minerals [8-10], and other feed ingredients [11-13]. The influence of the above factors on fur electrification (tribocharging or surface charging by friction) has so far been impossible.

The present work first revealed correlations between biochemical, mineral composition, state, morphophysiological characteristics, and dielectric properties of the skin and hair covering in caged fur animals. Based on these data, the decrease in the electrostatic field strength on the electrified pelt surface with time occurring according to the exponential law was found and described by the formula $E = E_0 \cdot e^{-t/\tau}$.

The work aimed to study the influence of morphophysiological characteristics, biochemical composition (mineral and amino acid), and the state of the skin and hair covering on its dielectric properties, furthermore, establish the relationships that can be used for a more accurate and objective assessment of the quality of raw and semi-finished fur raw materials.

Materials and methods. In this work, the research team used fur raw materials obtained from physiologically healthy animals: silver-black foxes (*Vulpes vulpes*), silver arctic foxes (*Alopex lagopus*), and standard minks (*Mustela vison*) (JSC Saltykovsky fur farm, Moscow Region). The animals were kept in standard sheds under conditions accepted by the farm for each species, complying with zootechnical and veterinary requirements. Diets were generally accepted, provided for the corresponding physiological condition and age of animals, a season of the year. The animals received meat and fish feeding under the recommendations of

Afanasyev NIIPZK. The mineral composition of the diet was analyzed according to the recommendations [14].

Skin and hair covering characteristics, the hair density per 1 cm^2 (averaged values of the total number of hairs per 1 cm^2 of the rump, thousands), hair density per 1 cm^2 of the rump, linear dimensions of different hair categories, their thickness, and the skin tissue thickness of the rump and pelt area were determined according to the methodical recommendations [15]. Mineralization of hair and skin samples, decomposition of prepared biomaterial, and determination of mineral composition (total concentration, mg%) of 18 elements were performed (Na, Ni, B, V, Se, Al, Fe, K, I, Ca, Co, Mg, Mn, Cu, P, Cr, Zn, Si) (15). The total mass of elements in the hair and skin biosubstrates per 1 cm^2 of the rump (rg/cm^2) was also determined.

Acid hydrolysis of hair covering and skin biosubstrates was performed according to the method of Balakirev et al. [15]. Hydrolysates were analyzed for 17 amino acids: cysteine, threonine, serine, asparagic and glutamic acids, glycine, proline, alanine, methionine, isoleucine, leucine, arginine, valine, tyrosine, phenylalanine, histidine, and lysine [15]. Total concentrations of amino acids (mol%) present in hydrolysates of biosubstrates were determined.

Defect-free belts of standard mink (12 pieces), silver arctic fox (12 pieces), and silver-black fox (12 pieces), and belts of grades I and II with different types of defects (2 pieces each), obtained after slaughter of animals at 7 months of age and subjected to standard primary processing, were used to study dielectric properties [2, 16]. Discharge kinetics equations for hairs of different species of fur animals were obtained at 20 °C, 62% RH and voltage 10.0; 18.5, and 28.5 kV on an HT-705 5kVA 50KV AC/DC high voltage charge generator (Wuhan Huatian Electric Power Automation Co., Ltd., China). When assessing the quality of fur raw materials, voltage of 9.5, 12.5, 15.5, and 18.5 kV was used. Based on the experimental data, the time dependence of the static electric field (SEF) strength (discharge kinetics) was plotted, which was used to determine the leakage time constant and the rate of charge leakage, and the maximum value of SEF strength [16]. The charge and SEF strength were measured until the charge on the sample completely disappeared. Repeated measurements were performed five times.

The results were processed according to GOST 8.207-76 (Moscow, 1986). Statistical analysis was performed in the Microsoft Excel package. The arithmetic mean of the measured value (M) and the standard error of the mean (±SEM) were determined. Student's t-test ($p \le 0.05$) was used to assess the reliability of differences between the compared averages. Correlations between the electrophysical quantities influencing the static characteristics of the skin and hair covering and its morphophysiological characteristics, and biochemical composition were established using correlation analysis. The correlation relationship was considered weak positive or negative at $r < 0.3$ or $r > -0.3$, strong positive or negative at $r > 0.69$ or $r < -0.69$, medium positive or negative at $0.3 < r < 0.69$ and $-0.69 < r < -0.3$. For the medium and strong relationship, the correlation coefficient values were significant at $p < 0.0$, $p < 0.01$, $p < 0.001$.

Results. It is known that the dielectric properties of materials depend on their chemical composition [2, 21]. Since the static characteristic of various dielectrics, including natural fur, refers to contact electricity and is a surface phenomenon, the research team determined the morphophysiological parameters of the skin and hair covering (Table 1) and the surface concentration of macro- and microelements (Table 2), i.e., the total masses of elements in the hair and skin coverings biosubstrates per 1 cm^2 of the rump, and the amino acid composition of biosubstrates (see Table 2).

1. **Morphophysiological characteristics of the skin and hair covering in silver-black foxes (*Vulpes vulpes*), silver arctic foxes (*Alopex lagopus*), and standard minks (*Mustela vison*)** (n = 12, M±SEM; JSC Saltykovsky fur farm, Moscow Region, 2014)

Parameter	Silver-black foxes	Silver arctic foxes	Standard minks
Hair density, thousand/cm^2	20.5±0.5	35±1	9.5±0.3
Guard hair density, hairs/cm^2	420±20	540±30	240±20
Length of guard hairs, mm	69.1±0.3	66.7±0.3	29.7±0.2
Length of fur hairs, mm	42.7±0.2	43.5±0.1	13.7±0.2
Thickness of guard hairs, mm	45.9±0.4	47.6±0.3	60.1±0.4
Thickness of fur hairs, μm	10.5±0.3	10.6±0.1	9.3±0.2
Leather thickness, mm	0.63±0.04	0.72±0.01	0.82±0.01

2. **Mineral and amino acid composition of the skin and hair covering in silver-black foxes (*Vulpes vulpes*), silver arctic foxes (*Alopex lagopus*), and standard minks (*Mustela vison*)** (M±SEM; JSC Saltykovsky fur farm, Moscow Region, 2014)

Parameter	Silver-black foxes	Silver arctic foxes	Standard minks
Mineral composition (n = 20)			
Total concentration of macro- and microelements in the hair covering, mg%	107.8±1.9	99.1±1.7	59.1±1.5
Total concentration of macro- and microelements in the skin covering, mg%	148.0±2.0	183.0±3.0	116.3±1.9
Total weight of elements in the hair covering from 1 cm^2 of the rump, μg/cm^2	106.09±0.70	161.41±0.15	25.02±0.14
Total weight of elements in the skin covering per 1 cm^2 of the rump, μg/cm^2	75.83±0.05	108.78±0.11	77.16±0.03
Amino acid composition (n = 12)			
Amino acid composition of hair, mol.%	90.76±0.18	94.50±0.20	86.67±0.19
Amino acid composition of skin, mol.%	88.40±0.10	89.50±0.10	89.30±0.10

The electrified samples of fur raw materials showed the charge leakage from the surface into the surrounding space, i.e., the value of the charge decreased over time. It led to a SEF weakening and, consequently, to a decrease in this field strength (E) compared to the original value (E_0).

For the convenience of comparing materials of different composition and dielectric properties, the value of volume resistance (R) under the same atmospheric conditions (relative humidity and temperature) is used. Fibrous natural protein materials (wool, natural fur, silk) have R = 10^9-10^{13} Ohm·m, whereas synthetic fibers used for artificial fur production have R = 10^{10}-10^{18} Ohm·m [2]. Therefore, products made of artificial fur accumulate on the surface a bigger charge, that is, are more electrified than natural fur, and require additional antistatic treatment. In addition, the safe disposal of artificial fur, which is not subject to natural decomposition, requires additional costs. It is also important to note that materials made of natural fibers (as opposed to synthetic) in the tribocharging contribute to the accumulation of negative charges on human skin, a beneficial effect on health [2]. Consequently, natural fur is aesthetically, hygienically, and environmentally preferable to artificial fur.

We compared the research data with those known from the literature on the effect of the material nature (polytetrafluoroethylene, polyurethane, stainless steel, and latex in contact with one another) [17], its structure (fibrous or granular) [18, 19], and the surface shape [20, 21] on dielectric properties. This fact made it possible to derive the discharge kinetics equation describing the change in the SEF strength of the skin and hair coverings of fur animals with time. It turned out that the change occurred according to an exponential law: $E = E_0 \cdot e^{-t/\tau}$. After taking logarithms, the equation becomes $\lg E = \lg E_0 - t/\tau \cdot \lg e$, or $\lg(E/E_0) = -0{,}434t/\tau$, where E is the magnitude of the SEF at time t; E_0 is the magnitude of the SEF at time t = 0 (parameter b, Table 3). is the time constant of the charge sink, or the charge retention time, defined as a time of the electric field strength magnitude decrease by half. The charge sink rate was determined by the slope value of the linear dependence (parameter a, see Table 3), equivalent to the change in lgE from time to the time axis. At the same time, for all types of fur raw materials, there was a general tendency: with an increasing degree of electrification of the hair cover (E_0), the charge leakage rate decreased (see Table 3). It should be noted that the above papers discuss different mathematical models for the charging (tribocharging) of materials depending on the composition, nature, and shape of the contacting materials [17-21] and provide techniques for obtaining reproducible data [20, 21]. However, all these works consider simpler objects in structure and composition compared to the hair covering of fur animals.

3. Analytical view of the discharge kinetics equations $y = \lg E$ at different voltages on the charge generator (U) for hair covering of silver-black foxes (*Vulpes vulpes*), silver arctic foxes (*Alopex lagopus*), and standard minks (*Mustela vison*) ($n = 12$, $M \pm SEM$; JSC Saltykovsky fur farm, Moscow Region, 2014)

Animal species	U, kV	$y = -at + b$ where $b = \lg E_0$	E_0, kV/m
Silver-black foxes	10.0	$y = -0.0064t + 5.34$	219±11
	18.5	$y = -0.0049t + 5.58$	380±20
	28.5	$y = -0.0014t + 5.77$	590±30
Silver arctic foxes	10.0	$y = -0.0031t + 5.14$	138±11
	18.5	$y = -0.0026t + 5.37$	234±15
	28.5	$y = -0.0008t + 5.57$	370±20
Standard minks	10.0	$y = -0.0081t + 5.37$	234±15
	18.5	$y = -0.0061t + 5.57$	372±19
	28.5	$y = -0.0040t + 5.82$	660±20

Note. E_0 is the maximum value of the static electric field strength; E is the value of the static electric field strength at time t. The R^2 values characterizing the approximation reliability were 0.83-0.98. Repeated measurements were performed five times.

Since skin and hair covering of different species of fur animals differ markedly in the set of morphophysiological and biochemical characteristics, a correlation analysis was conducted to identify the main parameters that have the greatest effect on the dielectric properties of raw fur. A strong correlation was observed between the charge sink rate and the guard hair length and thickness ($r = 0.83$-0.90 at $p < 0.05$), the fur hair length ($r = 0.94$ at $p < 0.001$), and the density of protective and fur hair ($r = 0.92$-0.98 at $p < 0.001$). Strong positive and negative correlations occurred between the charge sink rate and the total mass of elements in the skin and hair, the total amino acid composition of the hair covering ($r = 0.97$; $r = 0.97$; $r = 0.95$ at $p < 0.05$), and between the E_0 value and the parameters mentioned above for skin and hair ($r = -0{,}90$; $r = -0.86$; $r = -0.99$ at $p < 0.05$). Medium to weak correlations were noted between the mineral composition of the hair covering (total concentration of macro-, microelements in the hair coat), the total amino acid composition of the skin coat, and the rate of flow of the charge ($r = 0.64$; $r = 0.29$ at $p < 0.05$) and E_0 ($r = -0.43$; $r = -0.54$ at $p < 0.05$). Consequently, the dielectric properties of the skin and hair covering, its morphophysiological characteristics, and its biochemical composition are interrelated.

Defect-free belts of fur animals can be obtained only with balanced and adequately organized animal feeding and housing. Otherwise, the lack of nutrients (proteins, fats, carbohydrates) [22], minerals [23-25], and vitamins [26] in feed leads to the disease development (mineral, immune deficiency, various avitaminosis) associated with the hair covering growth damage [22, 27]. Usually, intravital defects that reduce the quality and value of fur raw materials arise due to disturbed molting, mechanical damage, excessive contamination of the hair covering, skin diseases, malnutrition, and mismanagement of fur animals.

Thus, the sparsity of hair covering in which the belts have areas of reduced hair density compared with the standard is caused by a lack of vitamins B, B_9, folic acid [22, 28, 29], and vitamin C [22, 30, 31]. As a result of scabies, ringworm, and mechanical damage due to inconvenient for the animals' access holes in the sheds, areas free of hair (hairless spots) appear on the skin and hair covering [22]. In many farms, the frequency of hair biting from the neck, back, and tail in animals is up to 30%. This behavior (so-called, haircut) is usually observed in minks and arctic foxes, less often in foxes. The cause is considered violations in the technology of feed preparation, which contains oxidized by-products, undernutrition of animals, use of feed mixtures with an imbalance of amino acids, biotin deficiency, and feeding large amounts of bones to fur animals [15, 22]. Lack of sulfur-containing amino acids, B vitamins, sulfur, magnesium, copper, and cobalt in fur animals' diets leads to the occurrence of growth damages such as guard hair breakage or cutting (breakage of the upper part of the outer-coat fiber stem of the hair covering). Previously, the authors of this paper showed that the mineral composition of the hair covering in sick foxes differed significantly in the elements mentioned above from that in healthy animals [32]. These elements may affect the processes of hair keratinization. Due to defective keratinization of the hair shaft, hair loses elasticity, accompanied by spontaneous brittleness, reducing the quality of the down and the value of fur raw materials [22]. The guard hair cutting, as a rule, subsequently leads to felting hair, i.e. the appearance of areas with tangled felt-like hair and the disturbed ratio of hair of certain categories. This disease is caused by poor housing conditions and poor nutrition of fur animals [22].

The listed lifetime defects of fur raw materials are only a tiny part of the defects associated with poor feeding and housing of animals and errors in the storage and processing of skins after slaughter and receipt of fur raw materials. In the authors' opinion, an objective assessment of the quality of fur raw materials (huge volumes) on the whole set of characteristics is convenient to carry out with the electrophysical equipment.

4. Influence of skin and hair covering defects on its electrophysical parameters in silver-black foxes (*Vulpes vulpes*), silver arctic foxes (*Alopex lagopus*), and standard minks (*Mustela vison*) (*M*±SEM; JSC Saltykovsky fur farm, Moscow Region, 2014)

Animal species	U, kV	Grade, fault group	$y = -at + b$, where $y = \lg E$, $b = \lg E_0$	E_0, kV/m	τ, s
Silver-black foxes	9.5	Grade I, fault-free	$y = -0.0015t + 5.00$	97±7	289±7
	12.5	Grade I, fault-free	$y = -0.0019t + 5.13$	140±10	219±10
	15.5	Grade I, fault-free	$y = -0.0024t + 5.21$	160±10	180±10
	18.5	Grade I, fault-free	$y = -0.0031t + 5.28$	190±10	140±7
	9.5	Grade I, Group 1	$y = -0.0013t + 4.47^{\text{г}}$	31±7	340±20
	12.5	Grade II, Group 2	$y = -0.0009t + 4.57^{\text{в}}$	35±9	340±20
	15.5	Grade I, Group 1	$y = -0.0020t + 4.44^{\text{а}}$	31±8	220±30
	18.5	Grade I, Group 2	$y = -0.0023t + 5.08^{\text{д}}$	120±10	190±20
Silver arctic foxes	9.5	Grade I, fault-free	$y = -0.0029t + 5.23$	180±20	144±8
	12.5	Grade I, fault-free	$y = -0.0024t + 5.27$	197±19	185±9
	15.5	Grade I, fault-free	$y = -0.0019t + 5.31$	201±19	210±10
	18.5	Grade I, fault-free	$y = -0.0014t + 5.34$	230±20	324±17
	9.5	Grade I, Group 1	$y = -0.0024t + 4.41^{\text{г}}$	32±9	181±17
	12.5	Grade II, Group 2	$y = -0.0012t + 4.64^{\text{в}}$	38±9	360±20
	15.5	Grade I, Group 1	$y = -0.0017t + 4.86^{\text{а}}$	77±9	255±15
Standard minks	18.5	Grade I, Group 2	$y = -0.0012t + 5.11^{\text{д}}$	130±15	378±19
Standard minks	9.5	Grade I, fault-free	$y = -0.0037t + 5.22$	164±8	126±6
	12.5	Grade I, fault-free	$y = -0.0028t + 5.30$	200±9	159±8
	15.5	Grade I, fault-free	$y = -0.0026t + 5.28$	178±10	171±8
	18.5	Grade I, fault-free	$y = -0.0017t + 5.45$	290±10	271±11
	9.5	Grade I, Group 1	$y = -0.0018t + 4.18^{\text{а}}$	18±3	250±50
	12.5	Grade II, Group 1	$y = -0.0008t + 5.40^{\text{б}}$	263±15	531±19
	15.5	Grade II, Group 2	$y = -0.0017t + 4.72^{\text{в}}$	57±11	275±18
	18.5	Grade I, Group 1	$y = -0.0013t + 5.12^{\text{г}}$	143±15	319±16

Note. For defect-free belts $n = 12$, for belts with each type of defect $n = 2$; ^{a} — sparsity of hair covering, ^{b} — hairless spot, ^{c} — "haircut", ^{d} — broken hair cutting, ^{e} — felted hair. U — voltage at the charge generator. E_0 is the maximum value of the static electric field strength; E is the value of the static electric field strength at time t, τ is the charge leakage time constant. The R^2 values characterizing the approximation reliability were 0.77-0.99. Repeated measurements were performed five times.

The dielectric properties of fur raw materials (belts of silver-black fox, silver arctic fox, and standard mink) turned out to be very sensitive to the integrity of the skin and hair covering and the presence of various defects on it. Samples with different types of defects (sparsity, felted, haircut, sparsity, hairless spots, guard hair cutting) and defect-free samples were exposed to static electricity. The results showed that the presence of these defects affected the static characteristics of fur raw (Table 4). In this case, there was a change in both the analytical form of the discharge kinetics equations ($y = –at + b$, where $y = lgE$, $b = lgE_0$) and electrophysical quantities characterizing dielectric properties (maximum value of strength E_0 and time constant of charge leakage τ).

For all types of fur raw materials, the sparsity of hair covering reduced the values of E0 by 60-90% and τ by 20-50% in comparison with defect-free belts, guard hair cutting by 50-80 and 15-20%, accordingly, haircut by 70-80 and 40-50%, hairless spots by 25-70% for minks, felted hair covering by 40 and 15-25% for arctic foxes and foxes (see Table 4).

Thus, the morphophysiological and biochemical characteristics of the skin and hair covering of fur animals have a strong influence on the dielectric properties of fur raw material. Correlation analysis showed a close dependence of the charge leakage and the maximum strength of the static electric field (E_0) of the skin and hair covering on the density, length, thickness of the protective and fur hair and on its mineral and amino acid composition. Dielectric properties also depend on the quality of fur products and defects. Intrinsic defects (sparsity, haircut, guard hair cutting, felted hair covering) reduce E0 by 25-90% and change the charge leakage time constant τ by 15-70% compared to defect-free belts. Hairless spots, on the contrary, increase the charge leakage time and the maximum value of strength E0. Based on the results presented, one can recommend the dielectric values E_0 and τ for quality control of furry raw materials obtained from silver-black foxes, silver arctic foxes, and standard minks. This approach is based on electrophysical equipment and (in contrast to the subjective organoleptic determination) allows an objective and more accurate assessment of the marketable properties of fur products.

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