UDC.677.024.017.

INVESTIGATING THE GEOMETRIC CHARACTERISTICS OF WOOL FIBERS USING AN ACOUSTIC DEVICE PAN-1

ОПРЕДЕЛЕНИЕ ГЕОМЕТРИЧЕСКИХ ХАРАКТЕРИСТИК ШЕРСТЯНЫХ ВОЛОКОН С ИСПОЛЬЗОВАНИЕМ АКУСТИЧЕСКОГО ПРИБОРА ПАН-1

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ABSTRACT

FIBERS, WOOL, LENGTH, DIAMETER, UNEVENNESS, ACOUSTIC DEVICE, COMB ANALYZER, MOISTURE

In this article we consider the geometric properties of local wool, determined by the standard length method on a comb analyzer and thickness using a micrometer, and also on an acoustic PAN instrument. The results of the experiments using the standard procedure showed that the weighted average length and thickness index is higher for the wool fibers of the sheared breed of sheep. The results of the experiments on the acoustic device showed that the coarser and irregular fibers, the less the density of the fibers in the chamber, and consequently the more intense passage of the sound pulse. The result obtained on the PAN-1 device is an affirmation of the fact that fibers of the sheared breed of sheep are coarser and irregular, that is, with two methods

АННОТАЦИЯ

ВОЛОКНА, ШЕРСТЬ, ДЛИНА, ДИАМЕТР, НЕРОВНОТА, АКУСТИЧЕСКИЙ ПРИБОР, ГРЕБЕННОЙ АНАЛИЗАТОР, ВЛАЖНОСТЬ

В данной статье рассмотрены геометрические свойства волокон различных видов местной шерсти, определённые стандартным методом (длина на гребенном анализаторе и толщина при помощи микрометра), а также на акустическом приборе ПАН. Результаты экспериментов по стандартной методике выявили, что показатель средневзвешенной длины и толщины выше у шерстяных волокон помесной породы овец. Результаты экспериментов на акустическом приборе показали, что чем более грубое и неравномерное волокно, тем меньше плотность массы волокон в камере, а следовательно, более интенсивное прохождение звукового импульса, то есть при двух способах оценки шерстяных волокон, были полу-

for evaluating wool fibers, similar results were obtained.The influence of mass, humidity and diameter of the samples on the transmission of the sound signal is analyzed with the use of the PAN-1 device.

чены аналогичные результаты. Изучено влияние массы, влажности и диаметра образцов на прохождение звуковых сигналов.

Wool is characterized by a large heterogeneity in physical and mechanical properties, which complicates its processing. The world has departed from the subjective assessment of the characteristics of raw wool and entered the era of objective measurements and specifications, and the trade in raw wool quickly goes on to the sale according to a general description, which requires accurate, rapid and cost-effective measurement of the entire raw material. Wool characteristics are important for price determination, and end use. The development and availability of new technologies and equipment allowed to objectively measure more characteristics of woolen fibers than it was in the past [1].

Comparative analysis of methods for determining the geometric characteristics of woolen fibers. The results of tests carried out to determine the geometric characteristics (fineness, length) of wool fibers of different breeds by the standard method are shown in Table 1.

Table 1 – Indicators of fineness, length of woolen fibers

№	Name of the characteristic	Samples of woolen fibers		
		Hissar	Karakul	Crossbreed
1.	Weighted average length, mm	48	53,6	66,1
2.	Modal length, mm	59,8	58,4	65
3.	Staple length, mm	64,8	65,1	81
4.	Standard deviation in length, mm	3,52	3,50	3,2
5.	Coefficient of variation in length, %	7,9	6,5	4,8
6.	Average diameter, micron	029	33	44
7.	Coefficient of variation thickness, %	37,9	51,5	40,9

The results of determining the average diameter of the wool are shown in Figure 1.

The analysis of the results showed that the coarsest of the three samples of wool fiber is Crossbreed wool with an average diameter 34 % larger than that of the Hissar breed and 25 % larger than that of the Karakul breed of sheep. Indirect characteristics of tones and roughness of wool fibers of selected breeds were also determined on the PAN-1 unified acoustic device. Acoustic device PAN-1, designed to determine the grade of raw cotton and

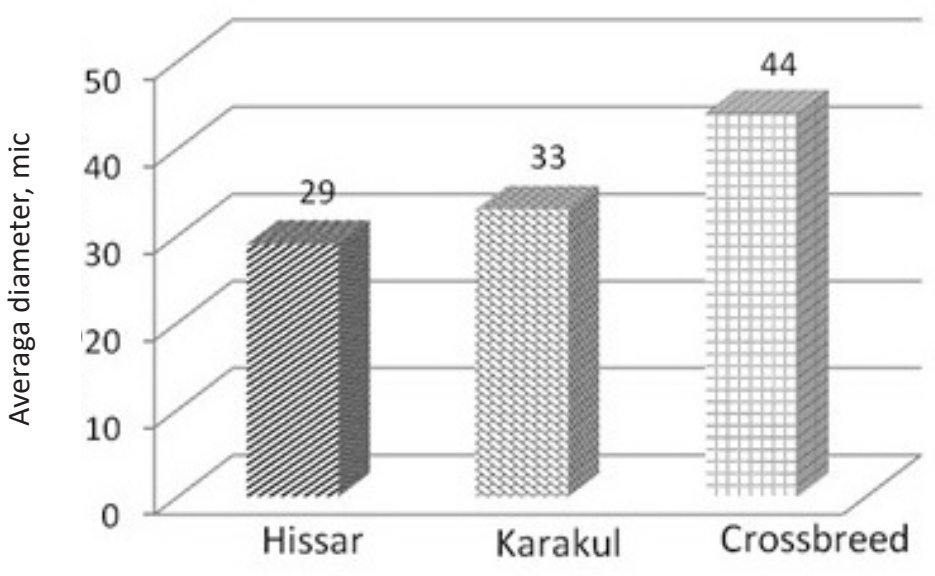

Figure 1 – Average diameter of wool fibers of different breeds

cotton fiber by the express method. The principle of the device is based on the ability to transmit sound pulses through textile fibers, depending on their structure. The method is an indirect method of estimating the fineness and roughness of the fibers. To evaluate the wool fibers on the PAN-1 device, an experimental study was carried out using an express method. The results of the determination of the signals propagation of sound pulses through wool fibers on a PAN-1 device with samples mass of 10 grams and 17 % humidity. The results of the passage of sound pulses are shown in Figure 2.

Analysis of the results shows that the largest value of the sound pulse transmission is characteristic of the coarse cross-hair coat, which has the highest fiber thickness and uniformity in length, which facilitates a uniform laying of the fibers in the measuring chamber and the passage of the highest value of the sound pulse. The smallest value of the passage of the sound signal is in the sample of Hissar wool. It is 48 % and 56 % respectively less than Karakul and Crossbreed wool, which can probably be explained by the higher density of fiber laying in the chamber of the device. This can be explained by the fact that Hissar's wool has the smallest diameter, greater uniformity in tin and the presence of short fibers, gives a strong seal and prevents the penetration of sound.

In general, it can be noted that the readings of the PAN-1 device correlate well with the results of the geometric properties of the fibers determined by the standard method and can be used to indirectly assess the fineness of the wool, provided that the gradation of the fineness of the wool is determined depending on the magnitude of the sound pulse.

To determine the influence of different moisture values and geometric characteristics of wool fiber on the passage of a sound signal on the PAN-1 device, an experiment was

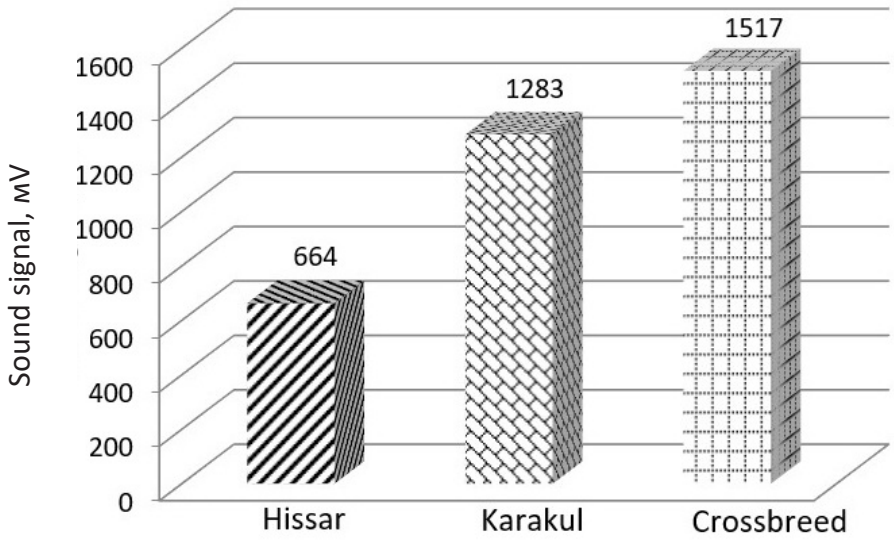

Figure 2 – Passing sound pulses through wool fibers on the PAN-1 device indication

performed that realizes all possible non-recurring combinations of the levels of the investigated factors, called a full-factor experiment.

To solve the problem of optimizing the tuning parameters of the improved drafting system, a 3^2 full factorial design – 9 experiments, i.e. a complete search of all possible combinations, all levels of factors, as in textile research the usual search is the most effective method of searching for an optimum.

Three factors are affected: the mass of wool fiber (X_1) at levels: 8, 9, 10 grams, wool fiber moisture (X_2) at levels: 7 %; 12 %; 17 %, wool fiber diameter (X_3): 22 micron, 33 micron, 44 micron.

As a result of the calculation, we obtain a regression multivariate model
The significance of the regression coefficients was checked. For this, he Student's test

$$Y_R = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_{12}x_1x_2 + b_{13}x_1x_3 + b_{23}x_2x_3 + b_{123}x_1x_2x_3;$$

$$Y_R=1253,2917-199,9583x_1+27,2083x_2+336,9583x_3+9,9583x_1x_2+88,375x_1x_3+9,875x_2x_3-$$
$$-8,7083x_1x_2x_3$$

was used, where calculated value tR {bi} was compared with the tabulated tT. If tR > tT, then the hypothesis about the significance of regression coefficients is not rejected. Thus, the attainment of maximum values of the sound pulse of wool fiber samples is possible

when the values of the factors approach the upper level of the chosen variation interval.

Based on the results of the experiment planning, the following conclusions can be drawn:

• the sound impulse of the samples increases with increasing diameter, mass and humidity in the selected ranges of variation;

• comparison of regression coefficients with the corresponding factors shows that the greatest influence in the conducted experiments is the diameter of the woolen fiber.

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