INFLUENCE OF SAMPLE MASS ON ACCURACY OF WOOL FIBER TONE MEASUREMENT ON AN ACOUSTIC DEVICE

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Article History:Received: 24.04.2022**Revised**: 22.05.2022 **Accepted**: 05.06.2022

Abstract: The commercial value of untreated wool is determined by its quality, which is assessed by a standard assessment of characteristics including average fiber diameter, coefficient of variation, staple characteristics, coefficient of variation in fineness and fiber yield. The characteristics of the wool are important in determining the price, the quality of the manufactured products and the end use. The development and availability of new technologies and equipment has made it possible to objectively measure many more characteristics of unprocessed wool than was possible in the past. In article the results of researches on studying the influence of mass sample frequency on the results of woolen fiber fineness measurements on the acoustic device are presented.

Keywords: Acoustic instrument, wool, average diameter, sound signal, error, frequency of sound oscillations, sample mass, determining factor.

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DOI: 10.31838/ecb/2022.11.03.004

INTRODUCTION

In the world, for the wool processing industry, research and development work is carried out aimed at the development of innovative techniques and technologies that provide for the effective use of modern achievements of science and technology, modernization of existing ones, research to rationalize the use of natural raw materials in the production of wool products.
Sound vibrations excited by generator and emitter are directed into the working chamber of the device, in which the test sample is placed . The sound waves passed through the fiber sample are converted into an electrical signal using a microphone installed inside the plunger. The signal value is proportional to the amplitude pressure of sound vibrations. The value of the output signal is measured by the measurement and display unit.
This article is a continuation of the work on the development of an acoustic method for measuring wool fineness published in [1, 2, 3 and 4]. This article discusses the influence of the change in the mass of the test sample on the measurement results of a wool diameter and assess the component of the measurement error from the variation of this parameter.
According to [1], the dependence of the output signal of the acoustic device U from a woolen fiber diameters d is described by the following relationship:

$$U = U_0 e^{-\frac{(1-\varepsilon) l}{\varepsilon \cdot d} \cdot k\sqrt{f}} \quad (1)$$

where, U_0 is the signal at the output of a device in the absence of a sample, mV;
l is the thickness of the measured sample, equal to the height of measuring cameras, sm;
k is a constant coefficient;
ε is the porosity of a sample being measured;
f - frequency of sound vibrations, Hz.

The porosity can be expressed in terms of a sample mass **m**, and by the geometric parameters of a measuring chamber as follows:

$$\varepsilon = 1 - \frac{m}{\frac{\rho \pi \phi^2 l}{4}} \quad (2)$$

where, ρ is the bulk density of the wool fiber, equal to [2];
ϕ isthe diameter of a measuring chamber, sm;
m is the mass of the sample, g.
After substituting (2) into (1) and simple transformations, we have

$$U = U_0 \exp[-\frac{l \cdot m}{(\frac{\rho \pi \phi^2 l}{4} - m)} \cdot \frac{C}{d}] \quad (3)$$

Here, $C = k\sqrt{f}$.

It can be seen from formula (3) that an increase in the sample mass leads to a change in porosity and a corresponding change in the output signal level according to the exponential law. Knowledge of this regularity will make it possible to formulate the requirement for the accuracy of maintaining this parameter in the measurement process with the necessary tolerance and to estimate the error component from the variation of this parameter.

$$\ln U = C_0 - C_1 \cdot x \quad (4)$$

Here, $C_0 = \ln U_0$, C_1=C/dand

$$x = \frac{l \cdot m}{(\frac{\rho \pi \phi^2 l}{4} - m)} \varphi \quad (5)$$

With the given parameters, l=3 sm, $\rho = 1.31 g/sm^3$, ϕ =4sm,expression (5) takes the form:

$$x = \frac{3m}{(49.4 - m)} . \quad (6)$$

.From expression (4) it follows that a linear dependence should be observed between the logarithm of the output signallnUand the parameter **x**.

To study the dependence of the output signal of the PAM-1 device on the wool diameter, experimental studies were carried out on 11 samples of wool fibers of various diameters. The tests were carried out according to the following procedure. Samples of woolen fibers are pre-unrolled by hand and straightened. From each sample, 1 sample was weighed with a mass of 6.5 g, 8 g, 10 g, and 12 g with an accuracy of 0.01 g, the sample was placed in the measuring chamber of the device and the output signal was measured, then, without removing the sample, a repeated measurement was carried out. The average value of two measurements was taken as the measurement result.Measurements were carried out in a similar manner on the remaining samples of wool fibers. Then, on the tested samples, tests were carried out to determine the diameter by a standard method on a microscope according to the interstate standard GOST 17514-93 Natural wool. Methods for determining fineness. The test results are shown in table 1 and table 2.

Table 1: The results of experimental data on the study of the sample mass influence on the output parameter of the device in the measurement range of the diameter of woolen fibers 24 - 36 μm

№	Name of woolen fibre rocks	Instrument readings, mV				Average diameter as per GOST 17514-93, d, μm
		mass of wool fiber sample, g				
		6,5	8	10	12	
1	Camel 1 selection	1500	1220,3	875,75	620,75	24
2	Camel 2 selection	1585	1300,3	950	665,75	25
3	Camel 4 selection	1650,5	1420,3	1136,8	850	25,7
4	Goatthin	1702,3	1504,3	1190,5	900,25	29,6
5	Sheepblack 1 selection	1774,8	1557,5	1230	966	31,7
6	Sheeplight 1 selection	1853,5	1609,8	1350	1075,3	35,3

Table 2: The results of experimental data on the study of the sample mass influence on the output parameter of the device in the measurement range of the diameter of woolen fibers 36 - 45 mkm

№	Name of woolen fibre rocks	Instrument readings,.mV				Average diameter as per GOST 17514-93, d,μm
		mass of wool fiber sample, g				
		6,5	8	10	12	
1	Sheep light 3 selection	1800	1602	1355	1160	36,3
2	Goat wool 4 selection	1907,3	1721,5	1513,4	1263,8	38,9
3	Camel 3 selection	1999	1831,3	1584	1314,3	42,0
4	Goat rough	2050	1882	1625	1380	43,7
5	Goat wool 5 selection	2104,3	1938,5	1713	1471,8	45,0

Based on the results of the measured values of the output signal at different masses of samples, the dependences of the value of the output signal on the parameter x were plotted for samples of wool fibers with different values of the diameter, which are presented in Figures 1 and 2 in the form of a graph and equations. Here, $\mathbf{y}_i = \ln U_i$ the index indicates the value of the diameter of the wool fiber.

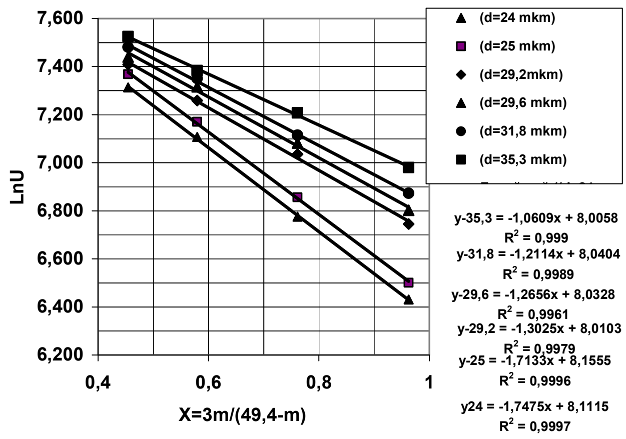

Figure 1: Dependence of the output signal on the parameter x for woolen fibers in the range of 24-36 mkm.

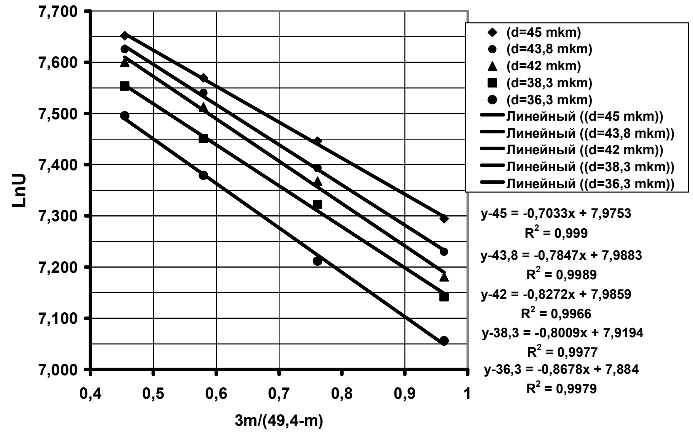

Figure 2: Dependence of the output signal on the parameter x for woolen fibers in the range of 36-45 mkm**.**

From the graphs and equations obtained in Figures 1 and 2, it can be seen that there is a linear relationship between the logarithm of the output signal lnU and the parameter x, which is a function of the sample mass m. The coefficient of approximation of the obtained dependences for all samples with different fineness values exceeds R2 = 0.98, which indicates good agreement between the theoretical conclusions according to formula (4) and the experimental results.

To calculate the error from the change in the sample mass, we substitute expression (6) into (4) and differentiating the resulting equation, we find the partial derivative, and we also find the partial derivative from the calibration equations of the device for wool [1]. The error from the change in the mass of the sample in 1g is determined by the ratio:

$$\frac{\Delta d}{\Delta m} = \frac{\dfrac{\partial \ln U}{\partial m}}{\dfrac{\partial \ln U}{\partial d}} = \frac{C_1 \cdot (-1) \cdot 148.2\, d^2}{a_1 \cdot (49.4 - m)^2} = -\frac{0.09547 \cdot C \cdot_1 d^2}{a_1}, \quad (7)$$

where, C1is the coefficient in the equations in Figure 1 and Figure 2 before the parameter x,

a1is the coefficient of the calibration dependence of the PAM-1 device with a mass of m = 10 g for woolen fibers, equal to 27.525 for the range (24 - 36) microns and 39.297 for the range (36-45) microns [1]. Substituting the values ofd, a1, in (7), we obtain the calculated value of the error presented in Table 3.

Table 3: Calculation of the error from the variation of the sample mass

wool diameter µm	Coefficient C1	Coefficient a1	Error rate $\frac{\Delta d}{\Delta m}$, µm /g
24	- 1,7475	27,525	3,49
25	- 1.7133		3,71
25,7	-1,3025		2,98
29,6	-1,2656		3,68
31,8	-1,2114		4.25
35,3	-1,0609		4.58
36,3	-0,8678	39,297	2,78
38,9	-0,8009		2,94
42,0	-0,8272		3,55
43,7	-0,7847		3,64
45,0	-0,7033		3,46

From the calculation data in Table 3, it can be seen that in the range of measurements of the wool diameter (24-36) µm, the error from a change in the sample mass in 1 g () increases with an increase in the wool diameter and is 3.49 µm / sm at d = 24 µm and 4, 58 µm / g at d = 35.3 µm. In the method for measuring t of the PAM-1 device, a tolerance for the deviation of the sample mass during weighing is 0.02 g. In this case, the error from the deviation of the sample mass for the indicated points of the measurement range is 0.069µm and 0.09 µm, respectively.
In the range of measurements of the wool diameter (36-45) µm, the error from a change in the sample mass of 1 g () also increases with an increase in the wool diameter and is 2.78 µm / g at d = 36.3 µm and 3.46 µm / g at d = 45 µm. With an error in weighing the sample mass of 0.02 g, the error in measuring the wool diameter from the inaccuracy of weighing the sample mass for these points of the wool diameter measuring range is 0.056µm and 0.069 µm, respectively. In this case, over the entire range, the relative error in measuring the diameter of the wool from the inaccuracy of weighing the mass of the sample is 0.15-0.25%.
The results obtained will be used to refine the metrological characteristics of the method for measuring the diameter of a woolen fiber on an acoustic device.

REFERENCES

i. G.B.Damyanov. Textile processes quality control and desing of experiment, Momentum press, New York

ii. D.J. Cottlea and B.P. Baxterb. Wool metrology research and development. School of Environmental and Rural Science, University of New England, Armidale, NSW 2350, Australia; b SGS New Zealand Ltd., P.O. Box 15062, Wellington, New Zealand (Received 5 March 2015; final version received 2 October 2015)

iii. G.N. Kukin. etc. "Textile Materials Science (Textiles)" M. "Legprombytisdat," 1989.

iv. A.I.Koblyakov. "Laboratory Workshop on Textile Materials Science." - M. Legprombytizdat, 1985.

v. A.G.Sebostyanov. Methods and tools for the study of mechanical and technological processes of the textile industry//MSTU,2007.

vi. GOST 10681-75. Textile materials. Climatic conditions for conditioning and testing of test methods of their determination

vii. GOST 17514-93. Natural wool. Method of determination of the fineness

viii. A.A.Ahmedov. Determining the grade of cotton fibre using an acoustic device// "Paxtasonoat Ilmiy markazi" Joint stock company.//Tashkent, 2002.

ix. Akhmedov, A. Density influence of a measured cotton fiber sample on repealabilitiy of measurememts of a micronaire index on an acoustic divice. In 2nd international scientific Conference" European Applied Sciences: modern approaches in scientific researches" Confernce papers (Vol. 3, pp. 18-19).

x. Ahmedov, A. A., & Valieva, Z. F. (2018). Investigating the geometric characteristics of wool fibers using an acoustic device. In Education and 21st century articles of the international scientific and practical conference november (Vol. 1).

xi. Fakhritdinovna, V. Z., AkhmedovAkmalAxmedovich, O., & UbaydullayevaDiloraXamidovna, K. (2021). Possibility to Use Acoustic Device Pam-1 to Determine Quality Characteristics of Wool Fiber. Annals of the Romanian Society for Cell Biology, 25(6), 10166-10173.

xii. Zaitceva, A. Y., Mazing, M. S., Akacevich, P. V., Sementsova, I. V., Cherednikova, A. A., & Kislyakov, Y. Y. (2022). Sensor Intelligent Systems for Monitoring the Oxygen Status of Human Tissues Under Functional Loads. Journal of Pharmaceutical Negative Results, 13(1), 6-6.

xiii. Gerdruang, A., Panwatanasakul, C., & Nurnazar, P. (2021). The Desirable Management Of Education In Urbanization Area Under The Office Of Non-Formal And Informal Education In Bangkok Thailand. 湖南大学学报(自然科), 48(10).

xiv. Tzu-Chia Chen, Shu-Yan Yu, Haiying Zhang, PirnazarovNurnazar; ,"Application of Sustainable Education Innovation in the Integrated Teaching of Theory and Practice Adopted in the Auto Chassis Course--A Case Study on the Auto Repair Specialty of a Secondary Vocational School in Suzhou, China","Tobacco Regulatory Science

(TRS) (TobRegulSci, Electronic ISSN 2333-9748)",7,6-1,7166-7189,2021,Tobacco Regulatory Science Group

xv. Nurnazar, P. (2020). Synergetic Analysis Of The Spiritual Being Of Man. Настоящи Изследвания И Развитие-2020, 13.

xvi. Vladimirovich, P. V. (2022). Study of the effectiveness of medicine no. 5 on a model of dry eye syndrome in rabbits. Journal of Population Therapeutics and Clinical Pharmacology, 29(01).

xvii. Uli, P. N. R. (2021). Development of a Person's Spirituality in Dialogue with Another. Zien Journal of Social Sciences and Humanities, 1(1), 133-135.

xviii. Nurnazar, P., & Islambek, S. (2022). Humanism of sociology and sociology of humanism. Uzbek Scholar Journal, 2, 11-14.

xix. Nurnazar, P., & Islambek, S. (2022). Humanity as an expression of the spiritual being of human. Uzbek Scholar Journal, 2, 15-19.

xx. Mousavi, E., Razavi, . N., Jamali, . S. & Nassaj, . A. E. (2022) Evaluate the Accuracy of the Diagnostic Test of Ultrasound Imaging for Endodontic: A Systematic Review and Meta-analysis. Journal of Complementary Medicine Research, 13 (2), 39-44. doi:10.5455/jcmr.2022.13.02.07

xxi. Nurnazar, P; ,"Ecology of the Soul: Culture, Morality, Spirituality",Indiana Journal of Agriculture and Life Sciences,2,2,5-8,2022,

xxii. Alimbetov, Y., & Kamalova, H. S. (2020). Qaraqalpaqstan Respublikasi Ta'lim Sistemasinin'iskerlik Ma'selesi Haqqinda. Journal of social research , 3 (2).

xxiii. Bugero n.v., Ilyina n.a., Alexandrova s.m. (2021) Laboratory Model of Molecular-Genetic Interactions of the Protose Blastocystis Spp. With Bacteria Enterococcus Faecalis. Journal of Complementary Medicine Research, 12 (4), 55-58. doi:10.5455/jcmr.2021.12.04.08