

Determination of the Quality Characteristics of Fibers Obtained From Mulberry Bark



S. U. Patxullayev, N. M. Islambekova, M. Kulmetov, T. A. Ochilov, Z. F. Valieva

Abstract: This article presents and analyzes the indicators of the length, breaking load, fineness, elongation at break in a group of fibers of natural origin, such as cotton, silk, wool, as well as a comparative characteristic of crimp indices per 1 cm, components of the total deformation of fibers obtained from different parts of silkworm branches

Keywords: fibers, breaking load, elongation at break, cotton, silk, wool, length, diameter

Therefore, artificial fibers and threads are obtained from polymers created by nature, and man only modifies these polymers and forms fibers from them. Synthetic fibers and yarns prepared from synthetic organic gomotsang and hetero-high molecular weight compounds. Polymers for synthetic fibers, synthesized in the factory from simple substances, monomers (benzene, phenol, etc.), and then formed into fibers and threads. [1-3].

I. INTRODUCTION

Fibers used in the textile industry are divided into two groups: natural and chemical. Natural fibers are organic and inorganic origin. Textile fiber in accordance with GOST 13784-94 is an extended body that has flexibility and thickness and is suitable for the manufacture of threads and textiles. In appearance, the fibers are divided into elementary fiber, that is, a single fiber that does not divide in the longitudinal direction without destruction and a complex (technical) fiber-it consists of longitudinally bonded elementary fibers. In the modern range of textile materials applied in the manufacture of clothing, various types of fibers and their modifications are used. These are classic types of natural or natural fibers (cotton, linen, wool, silk), artificial (viscose, acetate, triacetate, copper ammonia, etc.) and synthetic polyamide (capron, anide), polyester (Dacron), polyacrylonitrile (Nitron), polyvinyl chloride (chlorin), etc. [1]. Chemical fibers consist of natural organic hetero- or carbon-chain and heterochain macromolecular compounds. A small part is produced from natural inorganic compounds. Chemical fibers and threads are divided into two classes: artificial - obtained from natural organic high molecular weight compound, mainly from cellulose and its derivatives, as well as in some cases from animal and vegetable proteins.

II. METHODOLOGY

In this research work, the following method was developed to obtain fiber from a mulberry bark.

I. For bark isolated from mulberry:

1) Microbiological method (lock in water for 15-20 days at a temperature of 30 °C, using the enzyme-Pancreatinum);

2) boiling for 5-6 hours in 2% sodium alkali;

3) boiling in an autoclave (boiling for 6 hours at atmospheric pressure of 2 atm. in a 4% soap solution);

II. For mulberry branches

4) Steaming mulberry branches in an autoclave at atmospheric pressure of 3 atm. within 6 hours or within 3 hours at atmospheric pressure of 5 atm.

While comparing several methods, it was determined that the biological method and the method of using alkali effectively cleans the fibers from pectin and other impurities.

The advantage of alkali treatment is that environmental influences are eliminated. The method of steaming mulberry branches without separation of the bark is considered as a more effective way. Fig.1 shows the sequence of fiber production from a mulberry tree.

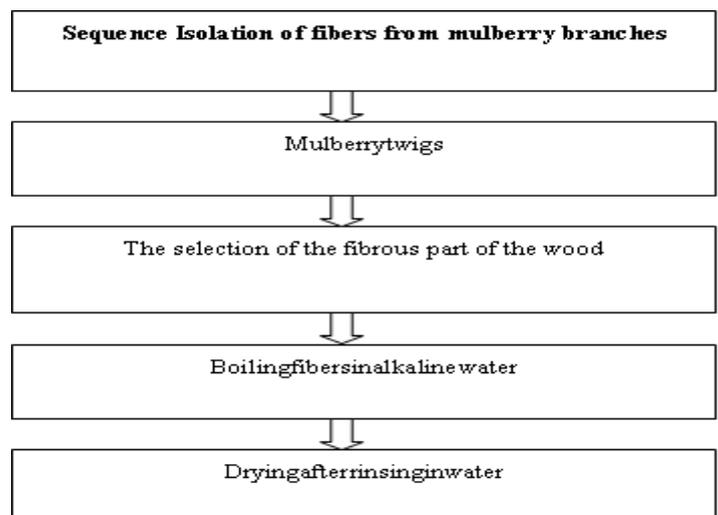


Fig. 1. Technological sequence of mulberry fiber production

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In figure 2 the images of the transformation of mulberry twigs into fibers are shown.

The results demonstrated that the duration of soaking to separate the bark from the wood lasts 28 days. While soaking using chemicals reduce the hardening time by 42%, and the selected fibers differ in color by whiteness. Here

highlighted mulberry fibers account for 16.3%. The influence of the method of producing fibers from mulberry wood on the strength and elongation at break of the fibers was also determined, the comparative results of which are shown in table 1.

Table I. The influence of fiber production methods on strength and elongation

Way to develop	Fiber breaking load cH	Elongation at break, %	Number of tests
Microbiological method	15	1.8	100
Alkali boiling	17.1	2.3	100
Autoclave boiling in alkaline medium	15.6	2.1	100
Steam Autoclave	20.7	2.1	100



Fig. 2. Preparation of mulberry fiber from mulberry branches

The results obtained above show that alkaline treatment increases the elongation at break in comparison with other methods. This means that the combination of boiling methods will increase the elasticity and resilience of the fiber.

Microscopic study of elemental fibers obtained from mulberry tree branches presented that the fibers have thicker parts in some areas that are uneven, while the ends of them are sometimes separated by two. These mulberry twigs were selected as the study objects because they were used more widely in the Republic of Uzbekistan. First, it was

determined how many leaves sprouted from the mulberry tree branches, and how many of the branches would remain. The research was carried out on newly cut mulberry tree branches. It was found that on average, each branch had 37% leaves. 63% of the leaves remains after its usage as feed. The branches, in turn, are made up of wood and bark. Determination of their quantity shows that the bark, in average, consists of 19.3% of the twigs.

To expand the range of produced textile products, the qualitative characteristics of various fibers were studied, the results of which are shown in table 2.

Table II. Quality characteristics of natural fibers

The name of the fiber	cotton	wool	silk fiber	made from mulberry wood
The length of the elementary fiber, mm	10-50	30-150	500-900	10-40
The breaking load of the fibers, N	22-38	10-12	22-35	12-17
Fineness of the fibers relative to cotton fibers	1	1.57	0.70	0.90
Breaking elongation, %	4-7	20-35	14-18	4

According to the requirements of the standard O'zdst 604: 2016, taking into account the staple length, cotton fibers are divided into 9 types: 1a, 1b, 1,2,3,4,5,6,7, while the fibers of each type, depending on the appearance, color and presence of spots, are divided into five varieties.

Wool has a complex of characteristics that describe its physical and technological properties. The main physical

and mechanical properties include length, thickness, crimp, strength, stretchability, color, gloss, resilience, elasticity and plasticity.

A uniform wool consists of downy or transitional hair fibers, while a non-uniform wool consists of downy, transitional hair, awn, and dead hair fibers. Homogeneous wool is classified into four groups: thin, half-thin, half-rough and rough; all groups are divided depending on the thickness (average diameter of the fibers) and uneven thickness on the gradation.

Wool fibers are divided by thickness into the following morphological types: downy-up to 30 microns, transitional-from 30 to 52.5 microns, thin-from 52.5 to 75 microns, medium-sized-from 75 to 90 microns, coarse – more than 90 microns. Depending on the structure of the fibers, wool is divided into thin (fiber diameter no more than 25 microns), semi-thin (25-31 microns), semi-coarse (31-67 microns) and coarse (up to 160 microns). [7-8].

The main qualitative characteristic of raw silk is unevenness in thickness.

Direct characteristic of the fiber thickness is square and the cross-sectional diameter of silk, but the measurements of these values are time-consuming, as the form of transverse cross section throughout the fiber length varies. Therefore, for an indirect characteristic of the silk thickness, a linear density and a number for the characteristic of the thickness are used. The unevenness of

the cocoon thread in linear density has a significant impact on the quality characteristics of the produced raw silk.

The breaking load and elongation of raw silk are also important quality characteristics. The increment of length to the moment of rupture is called elongation and for raw silk is equal to 16-18 %.

III. RESULTS AND DISCUSSION

From the results shown in the table, it is visible, that depending on the type of cotton fiber length is 10-50 mm, the breaking load of the fibers is 22-38 N, elongation at break 4-7%, length wool fiber is 30-150 mm, the breaking load of the fibers is 10-12 N, elongation at break 20-35%, length of raw silk is 50-900 m, breaking load is 22-35 N, elongation at break 14-17%, length of elementary mulberry fibers is 10-40 mm, the breaking load is 12 to 17 N, the elongation at break of 4.0%.

According to analyzing the test results, it is clear, that the raw silk indicators for length, breaking load and elongation were higher than the rest.

In addition, the length, linear density, strength and elongation of the elementary fibers obtained from thin and thick branches of the mulberry tree were determined and the test results are shown in the form of graphs in Fig.3-4.

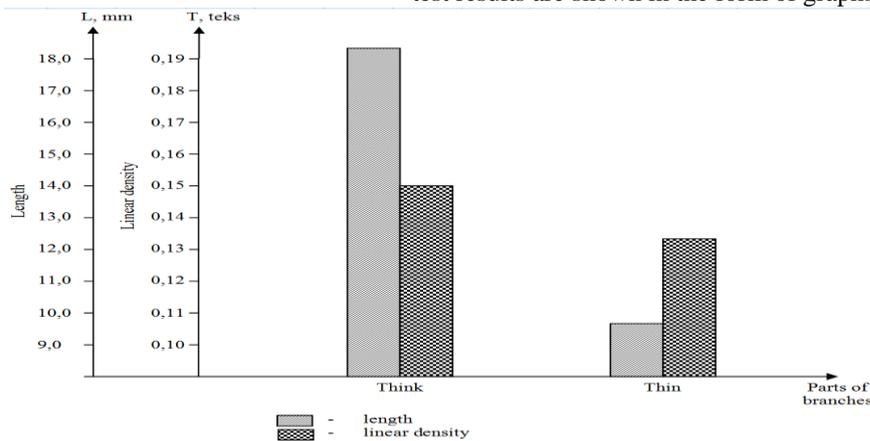


Fig. 3. Change in the quality indicators of fibers obtained from different parts

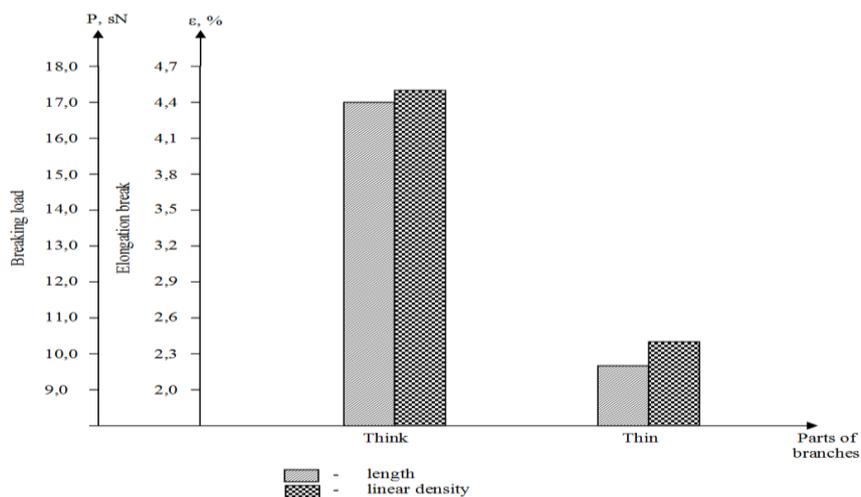


Fig.4. Change in breaking load and elongation of fibers obtained from different parts of the branch

The obtained test results demonstrate that the length of the elementary fibers obtained from the thin parts of the branch of the mulberry tree is 3-15 mm, meanwhile, the length of the fibers from the thick parts is 10-31 mm.

The linear density of the fibers is in the range from 0.12 to 0.18 teks.

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While analyzing the test results, it can be seen that such indicators as the length of fibers produced from thin parts of the mulberry tree in comparison with fibers produced from thick parts of the tree by 55.0%, linear density by 18.7%, the breaking load of fibers by 41.2% and elongation by 44.4% decreased.

The crimp of textile fibers is considered as an important indicator, because it provides the stickiness of the fibers, which gives the strength of the yarn produced. The convolution properties of the fibers are of a great importance, the more fibers are crimped, the greater the adhesion between them in the process of obtaining yarn. The tortuosity of textile fibers helps to reduce the elastic, volumetric and thermal conductivity.

The intensity of convolution is characterized by the number of convolutions per unit of length and also by their height. Indicators that characterize tortuosity are the frequency of convolutions of fibers and threads, the degree and resilience of tortuosity.

The number of convolutions per 1 cm of fiber or thread determines the degree of convolution.

Resistance of tortuosity, expressed in%, is defined as the ratio of the tortuosity degree after the application of force or deformation to the degree of initial tortuosity.

Tortuosity is characterized by such indicators as: the number of convolutions, the degree and intensity of tortuosity.

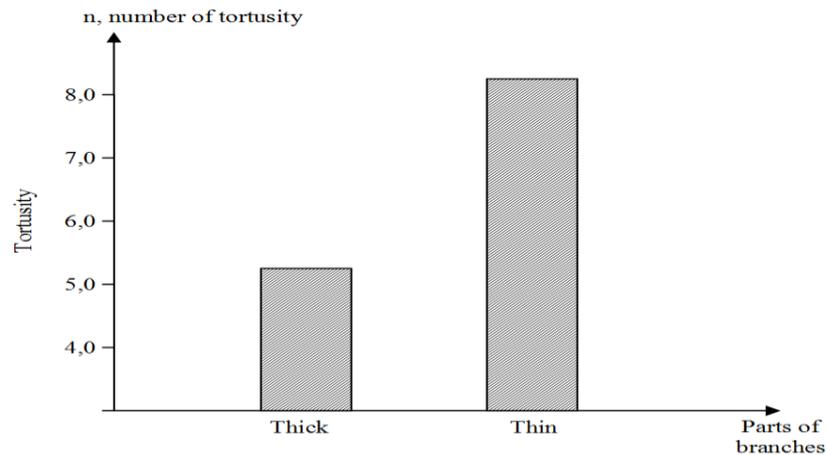


Fig.5.Change in the crimp of fibers obtained from different parts of a branch.

In the production of yarn, textile fibers are constantly subjected to tensile deformation. In other words, the fiber and thread are subjects of the periodic influence of loading and unloading for a certain interval of time.

If the yarn is stretched under the influence of the load, and it is not fully restored during the unloading, the finished products made of such kind of yarn have low elastic properties, that is, textile materials are easily crushed and do not have shape resistance. Therefore, the analysis of physical and mechanical properties of textile fibers are of a great importance.

Complete deformation of materials consists of the following parts: reversible (resilient and elastic) and irreversible (plastic).

Elastic deformation occurs because under the action of an external force, small changes in the average distances

Table III.Components of the complete deformation of the fiber obtained from the bark of the mulberry tree

Fiber	Complete deformation, %	Deformation components		
		resilient	elastic	plastic
Fiber from mulberry wood	4,3	0,26	0,24	0,50

Elastic deformation occurs at a speed close to the speed of sound propagation, so it is difficult to fix it. This part of the deformation disappears just as quickly as it occurs, so it is called fast-moving. According to the prof. I.V. Kragelsky in twisted yarn the speed of elastic deformation propagation is 1425 m/s, in linen yarn - 1900 m/s. Thus, the propagation rate of the elastic deformation in the 1 m long yarn is equal to 0.0007-0.0005 s.

between neighboring links and atoms in the macromolecules of polymers are appeared, consequently forming the materials. In this case, the intermolecular and interatomic bonds are preserved, and the valence angles are slightly increased. Elastic deformation can not be great: in case of removing particles over long distances, the connection between them is broken, and cracks and breaks occur.

Elastic deformation occurs due to the fact that under the influence of an external force, changes in the configurations of polymer macromolecules occur — this process is called rearrangement.

In this research work, the constants of the total deformation of the fiber obtained from the mulberry tree were determined, as shown in table 3.

The elastic part of total deformation is caused by reversible changes in configuration: macromolecules in polymers, fibres in threads and threads in textiles. The elastic part of deformation in textile materials due to their structural features manifests itself for a very long period of time. During the trial the rest is limited to a few hours. The part of deformation appearing during this time is called slowly reversible.

Plastic deformation arises due to the fact that irreversible displacements of macromolecular links over long distances occurring under the influence of external force. Since macromolecules have to overcome significant intermolecular bonds while developing this type of deformation in fibers, its development occurs even slower than elastic. In pure form, the process of its development, which is the flow of material, is stationary and continues for a long interval of time - until the material is destroyed. Plastic deformation is irreversible, as after the external force is removed there are no reasons that could cause it to disappear.

Along with the plastic deformation itself, another kind of irreversible deformation manifests in the yarn, which is formally referred to as plastic deformation. This is an irreversible deformation resulting from the displacement of poorly fixed whole fibers or large areas of them in the yarn. When the external force overcomes the frictional forces holding this part of the fiber clamped among the other fibers, it is immediately displaced. If stretching is done by the rapid application of significant force, irreversible displacements occur almost at the same rate. As fiber elongation increases, the proportion of elastic deformation decreases, meanwhile, the proportion of elastic and plastic deformations increases. Therefore, with large fiber elongation, creasing and loss of shape of the textile is more evident to happen. Wool fibers, capron are known to have greater elastic deformation. Finished textile products manufactured from yarn with high elastic deformation are less susceptible to creasing and more wear-resistant.

IV. CONCLUSION

From the obtained test results it is seen that the tortuosity of the fibers obtained from the thick places of the branches 4-6 crimps on 1 sm, the tortuosity of fibers, obtained from thin areas of the branches of 1 sm is 7-8 crimps. This demonstrates that there is a relationship between the thickness and convolution of the fibers. Since, for fibers with a linear density of 0.14-0.18 teks, the tortuosity is 4-6 convolutions per 1 sm, for fibers with a linear density of 0.12-0.15 teks, the tortuosity is 7-8 convolutions per 1 sm. It should be mentioned that the fibers obtained from the thin parts of the branches are thin with a large number of convolutions of fibers with a shorter length, which reduces the possibility of producing a yarn with a small linear density.

Analysis of the results of the study explains that the tortuosity of the fiber obtained from a thin branch of a mulberry tree 62.5% is higher than that of the fiber obtained from a thick branch of a that tree.

Thus, fibers derived from thick one-year branches of mulberry trees can be effectively used as raw materials for the textile industry in producing high linear density yarns.

During analysis of composite parts of complete deformation it was observed that elastic deformation is 0.26, elastic deformation is equal to 0.24 and plastic deformation is 0.50.

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