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The Effective Method for Preparing Textile Materials from “Porlok” Cotton Fiber Varieties

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Abstract

To ensure high competitiveness of cotton products in Uzbekistan, modern approaches are used to increase the yield and quality of cotton fiber. Gene knockout is a technology developed by Uzbek scientists and patented in many cotton-growing countries, which made it possi-ble to create unique varieties of genetically modified cotton of the Porlock (P) series with improved characteristics both in terms of cul-tivation and vegetation, and in terms of fiber quality. New genetically modified selection varieties of cotton fiber, having distinctive struc-tural and volumetric properties compared to zoned varieties, require certain changes in the technology of chemical finishing.

Technological parameters of the processes of preparation for chemical finishing have been developed considering the structural and sorption properties of textile materials based on selected varieties of cotton fiber "Porlock". Eco-nomical technological modes and compositions of baths for preparation for dyeing and printing for textile materials (yarn and fabric) from new varieties of cotton fiber considering their structural features have been proposed. The technological mode of preparation for dyeing of cotton yarn of the selection varieties "P-2" and "P-4" has been put into practice at the enterprise LLC "OSBORN TEXTILE". As a result, high whiteness, capillarity and improved phys-ical and mechanical properties were ensured considering the structural features of cotton yarn. The process of preparing yarn from the P-2 selection variety with a denser structure for dyeing requires relatively high concen-trations of an alkaline agent (up to 10%) and a low con-centration of hydrogen peroxide (up to 17%), while the P-4 selection variety with high volume properties requires a smaller amount of an alkaline agent (by 20%).

Keywords: Genetically Modified, Cotton, Process of Preparation for Chemical Finishing and Dyeing, Structural and Sorption Properties.

Introduction

Natural fibers have unique physical-chemical and physical-mechanical properties that have not yet been fully implemented in technical pro-cesses in the world. In general, natural properties increase the comfort of using textile goods. Many cotton-producing countries use genetical-ly modified seeds and synthetic fertilizers to produce regular cotton fiber designed for maximum yield. Scientists expected to increase cot-ton yields and resistance to various types of pests with the help of ge-netic modifications: the share of genetically modified varieties is more than 68% of the total volume. Cellulose of cotton fiber also has the highest molecular weight among all plant fibers and the highest structural order, i.e.., highly crystalline, oriented, and fibrillar. There-fore, cotton with such a large amount and structural order of the most common natural polymer is considered the main natural textile raw material [1-2]. Cellulose in its finishing processes can be considered as a polymeric polyhydric alcohol, which in the elementary links of the macromolecule contains three hydroxyl groups: one primary – at the sixth carbon atom and two secondary – at the second and third car-bon atoms. In the structural position of native cellulose in the confor-mation C1, hydroxyl and hydroxymethyl groups are located equatori-ally.

This ensures high reactivity in various chemical reactions showing sorption of 8-14% and swelling of 60-130%, however, these indi-cators are not enough to obtain high-quality textile products [3].

In recent years, a large number of experimental and theoretical works to clarify the structural features of ordered, crystalline phases of cellu-lose have been carried out. The amorphous state was studied on pow-der samples prepared from ground cellulose [4].

Natural fibrous materials are of particular importance in the textile industry. Intensive development of the production of a wide range of chemical fibers does not reduce their importance. According to the forecast, the production of all types of natural fibrous raw materials by 2025 will reach 30.8 million tons. In the Republic of Uzbekistan, up to 3.1 million tons of raw cotton are grown annually.

Unique properties of textile materials from natural fibers, such as hy-groscopicity, air permeability, heat capacity, etc., are qualitative fea-tures inherent in cotton fiber, necessary for the production of clothing and technical products and determining their high demand [5-6].

The first gene-knockout technology in the world has allowed creating unique domestic varieties of genetically modified cotton of the "Por-lok" series with improved characteristics both in terms of cultivation and vegetation, and in terms of fiber quality [7-10].

The origins of cotton fiber use in the textile industry go back to the distant past. One of the most important and most common natural pol-ymers is cellulose, which forms the basis of cotton fiber. Its chemical composition and structure of macromolecules are determined by the features of the biochemical synthesis process.

It should be noted that the nature of the fiber and various effects on it during processing determine the complex of properties of textile mate-rials, i.e., appearance, smoothness, shine, strength, stretchability, elas-ticity, dyeability, thermal conductivity, hygroscopicity, dimensional stability and durability.

According to modern trends in fiber quality requirements, the fiber must satisfy the consumer not only in terms of the main mandatory parameters considered during sale, but also in terms of textile-technological indicators. The chemical composition, structure and presence of numerous functional groups of cloths from natural fibers determine the sequence of chemical technology and the reagents used.

As is known, the processes of chemical finishing of textile materials, including cotton cloths, take place mainly in a liquid medium. In this regard, the interaction of cellulose with these solutions, depending on the state of its structure, is of great importance [11].

Cotton yarn of high linear density is intended for the production of thin cloths of various weaves, treated with liquid ammonia using spe-cially selected surface-active substances (SAS). The proposed compo-sition of the preparation of cotton yarn aimed at improving its ability to textile processing and technology providing high-quality dyeing [12]. This research is aimed at processing cellulose-containing yarn to improve its quality using enzymes. The object of the test was the yarn Combed 13/1. which after being kept in water for 24 hours was sub-jected to biopolishing. Preliminary water treatment leads to swelling and accelerates the process of interaction with the enzyme. As a result, without pretreatment, the yarn has a decrease in shrinkage by about 18%, and by 22% after pretreatment [13].

The cloth based on organic cotton fiber was degreased using the pecti-nase alkaline enzyme. Enzymatic degreasing effectively removes fat and wax, since the rate of pectin decomposition increases with the use of the alkaline enzyme compared to the traditional method. The pro-cess parameters were selected based on the Box-Behnken plan, data on weight loss, wax content and pectin decomposition on the cloth. The quality of biological degreasing was also assessed using the colorimet-ric method in the presence of ruthenium red dye and IR with Fourier transform [14].

During the boiling of cotton cloth, wetting agents are introduced to accelerate the process of capillary sorption of reagents, which prevents oxidative destruction of cellulose. The treated cloth is impregnated with a cooking solution without intermediate washing to remove starch sizing [15]. Cotton cloths were bleached using a bleaching sys-tem consisting of thiourea-activated hydrogen peroxide. The influence of the main parameters on bleaching was studied by changing the con-centration of hydrogen peroxide and thiourea, as well as the tempera-ture of the bleaching medium. The results showed that bleached cotton cloths with a satisfactory whiteness index and acceptable tensile strength can be obtained by treating the cloth at a material-to-liquid ratio at 90 °C in a bleaching bath containing 6 g/l hydrogen peroxide, 1.5 g/l thiourea and 1 g/l non-ionic wetting agent at a temperature of 1:20 °C. Optimum conditions allow the bleaching process to be com-pleted in 1 hour. High concentrations of activators were found to lead to premature termination of oxidation and a decrease in the whiteness index [16].

The proposed effective composition based on H2O2/TAED was used for bleaching a blended cloth based on viscose and acrylonitrile-casein copolymer fibers. The bleaching solution was prepared using an acti-vating system. Compared with conventional H2O2 bleach under alka-line conditions, the activated bleach significantly reduced the loss of the protein component, i.e., casein in the fiber [17].

The proportion of various voids and leaks in the packaging of cellu-lose from different sources, which are necessary components of the structure that improve the performance properties of the fiber, is on average about 12% [18]. Numerous experimental works using modern research tools showed that natural fibers are characterized by a devel-oped internal surface. Reagents of dye molecules and textile auxiliary substances (TAS) used in chemical finishing are commensurate with the pore sizes of the fibers, capable of providing their diffusion under normal conditions and during operation through free volume [19]. The mechanical properties of textile materials are significantly affected by the porosity of the fiber, which is an important component of its struc-ture. The proportion of various voids and packaging deficiencies for cellulose from different sources, which are necessary components of the structure that improve the performance properties of the fiber, is on average about 12% [18].

Preparation of textile materials for dyeing and printing requires large amounts of water, which leads to wastewater pollution. Performing preparatory finishing, i.e., de-sizing, washing, using "green chemis-try", i.e., non-toxic enzymatic treatments is cost-effective and reduces the impact on the environment. The authors [20] obtained a mixture of α-amylase (Am) and polygalacturonase (PG) enzymes from Tricho-derma harzianum induced by orange peel to achieve an effective prep-aration method. Various factors were studied, including temperature, pH and the nature of surfactants and their effect on enzyme activity. The treatment of cotton cloth was carried out in a single de-sizing bath. Optimum treatment conditions were established by varying the enzyme concentration, pH value, treatment temperature and duration. The efficiency of the process was assessed by weight loss, violet scale shades, residual starch in the cloth, copper number, tensile strength and water absorption (wettability) [21]. Modern coloristic design of cotton cloths requires preparation not so much of high whiteness, but of strength characteristics and capillarity. Selective action of enzymes on sizing and accompanying impurities allows obtaining cloths that are tear-resistant and have satisfactory capillarity with lower consumption of process water and chemicals. Unlike alkaline boiling processes, biochemical treatment can exclude the acidification operation and 2-4 washes [22, 23].

The study [24] describes a method of bleaching cotton cloth with en-zymes acting as biocatalysts. Using SEM (scanning electron micros-copy), it was studied how bleaching agents affect the microstructure of cloths bleached with chemical and enzymatic agents. According to the study, cloth bleached using enzymatic agents had a denser, softer and smoother structure than cloth bleached with chemical agents.

Additional effects of enzymatic agents lead to an increase in the inter-nal volume of fibers and thereby to an improvement in their proper-ties. The authors carried out a visual assessment based on photographs of the fiber surface and shape changes obtained using an electron scanning microscope, which are important in dyeing and printing cloths [24].

The aim of research was an effective method for preparing "Porlok" cotton fiber varieties and introducing them into the textile industry. Research objectives were to study the structural features of new selec-tion varieties Porlok-1. Porlock-2. Porlock-4 and compare with the zoned variety; to study the physical, mechanical and operational prop-erties of yarn from new cotton varieties through a comprehensive as-sessment of quality indicators; to develop a technology for preparing textile materials from Porlok selection varieties considering their structural features.

Methods

Genetically modified cotton fibers of Porlok-1 (P-1), Porlok-2 (P-2), Porlok-4 (P-4) cotton varieties and for comparison S-6524 zoned vari-ety were selected. Determination of the following parameters: length, fineness, ripeness, strength, color and contamination were performed on a USTER HVI-1000 system, in accordance with US standards. De-termination of the number of fatty substances in the fiber was deter-mined by the SOKSLET SOX406 extraction method. Bound fatty sub-stances in the fibers are extracted with organic solvents in the SOKSLET SOX406 device.

In order to study the sorption of water vapor, a study was carried out using a MacBen spring tungsten balance with a sensitivity of 1.5 mg/mm at 25±0.1 °C and a residual pressure of 10-5 mm Hg. The rela-tive measurement error was 1.5%. The pore radius was estimated ac-cording to the method [25].

SEM photographs were obtained by scanning electron microscopy (SEM) on a SEM ZEISS SIGMA microscope. Before the study, the samples were treated with Au for 300 min at 10 Å. Then they were viewed under a microscope at 7.5 Torr (mm Hg) and photographed. Pictures were taken in 90 s at a resolution of 960x720.

X-ray studies of the samples were carried out on a DRON-3M X-ray diffractometer with monochromatic CuKα-radiation at 22 kV and a current of 16 mA. Determination of the capillarity of textile materials was carried out in accordance with ISO 811-81. The degree of white-ness of textile materials was determined on a CM-3600D Minolta de-vice in accordance with ISO 105-J02-87. The breaking load and break-ing elongation of textile materials were determined in the certification laboratory of the Tashkent Institute of Textile and Light Industry (TITLI) on an AG-1 "Shimadzu" machine (Japan) according to ISO 5082-82 [26].

Results and Discussion

At the first stage, studies were conducted in order to identify dif-fer-ences in the quality indicators of raw cotton fiber of different selection varieties.

Table 1: Characteristics of cotton fiber of different selection varieties

Cotton fiber indicators	P-1	P-2	P-4	S-6524
Micronaire, mic	4.5	4.2	4.2	4.6
Ultra-high mill length (UHML), mm	31.5	30.9	31.0	28.2
Uniformity index, %	83.5	83.1	82.9	82.6
Specific breaking load, gf/tex	29.5	28.9	29.4	28.4
Elongation at break, %	7.4	6.3	6.5	6.8
Short fiber index, %	6.4	6.7	7.6	8.0
Fat content, %	0.65	0.67	0.59	0.69

It has been determined that the micronaire index of the P-2. P-4 selec-tion variety is at the level of the international ISO standard (Universal HVI® Standards), corresponds to the 3rd type, and the uniformity in-dex by length was above the average uniformity level. The micronaire index of the "S-6524" selection variety is 4.6. and the ultra-high mill length is 28.2 mm, corresponding to the 4th type.

New varieties of cotton fiber of the "Porlok" varieties differ from zoned varieties in quality indicators that are inextricably linked with their structural characteristics the sorption characteristics were studied and X-ray structural analysis was carried out considering the structural features of the selected fibrous raw materials.

The sorption characteristics of the studied selection varieties, depend-ing on their origin, are different. Based on the results of the water va-por sorption isotherm, the surface and volume characteristics of the original raw materials were calculated [27].

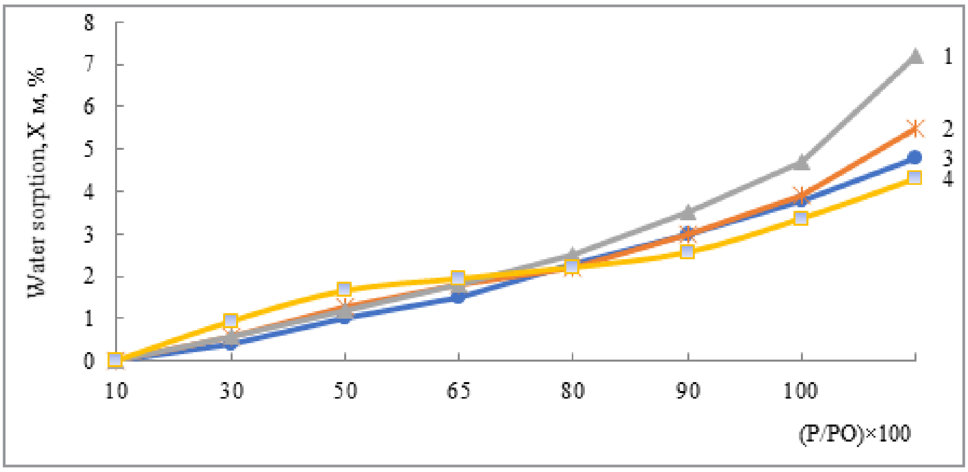

Figure1: Water vapor sorption isotherms at 25±0.1 °C for samples: 1- Porlok-1, 2- Porlok-2, 3- Porlok-4, 4- S-6524

Table 2: Surface and volume properties of cotton fibers of various selection varieties

Quality indicators	Cotton fiber variety			
	P-1	P-2	P-4	S-6524
Monolayer capacity Xm, g/g	0.0219	0.0118	0.0109	0.0105
Specific surface area Ssp, m2/g	76.98	41.52	70.97	36.75
Total pore volume W0. cm3/g	0.072	0.058	0.077	0.048
Capillary radius Pc, Å	28.18	18.71	21.91	26.12
Degree of crystallinity, %	84	86	85	84

The specific surface area of the P-1 and P-4 varieties is 2 and 1.9 times higher, and the total pore volume of the new varieties of cotton fiber under study is 1.5. 1.2 and 1.6 times higher, respectively, com-pared to the "S-6524" variety. The structure of the new P-2 cotton fi-ber variety has smaller pore sizes compared to other samples.

Table 3: Interplanar distances and crystallite sizes of various selection varieties of cotton fibers

Cotton fiber va-rie-ties	Interplanar distances d (A)					Crystallite sizes (A)			
	d(101)	d(101-)	d(002)	d(040)	λ	L3	L4	L5	L7
P-1	6.026	5.539	3.952	2.578	1.5418	80.163	80.286	115.803	83.317
P-2	6.026	5.539	3.892	2.571	1.5418	80.163	80.286	115.874	119.057
P-4	6.326	8.043	3.986	2.622	1.5418	20.025	26.624	115.763	83.182
S-6524	6.109	5.47	3.892	2.564	1.5418	80.146	80.306	135.187	83.363

The observed ratio of interplanar distances suggests a change in the packing of macromolecular chains, although the measured interplanar distances suggest that the monoclinic cell (phase) is characteristic of cellulose of many types of cotton. This change is associated with ge-netic variations and the vegetative process of cotton fiber. The crystal-lite diameters, which are a feature of both the supramolecular struc-ture and the physicochemical characteristics of cellulose, directly cor-relate with the observed changes.

During the process of opening the boll, the fiber comes into con-tact with air, dries out and the fiber twists in the S or Z directions around its axis. The results of microscopic studies of cotton fiber samples are shown in Fig. 2.

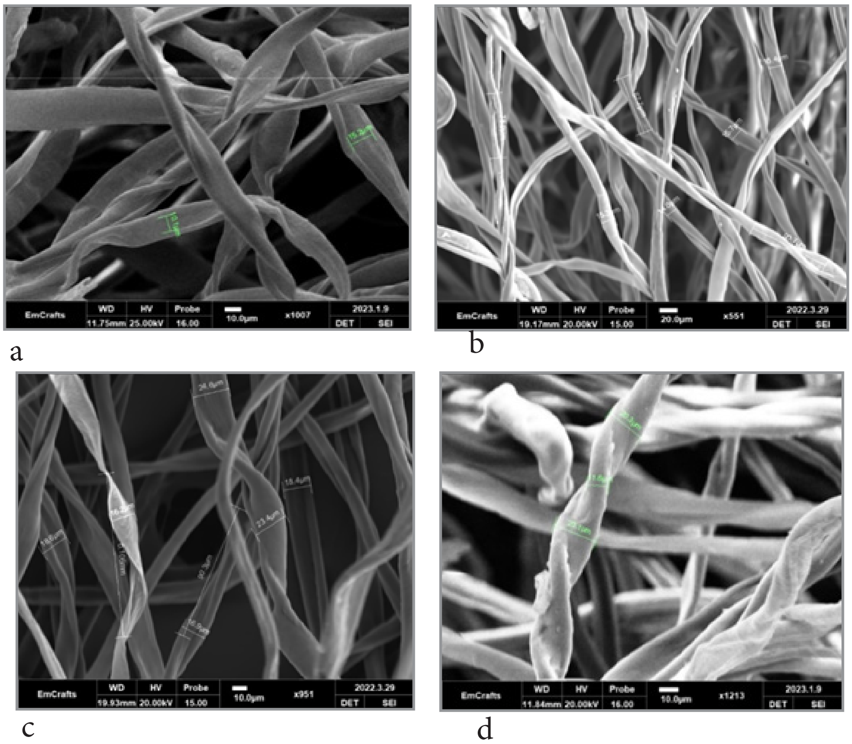

Figure 2: SEM photographs of cotton fiber samples:a - P-1; b - P-2; c - P-4; d - S-6524

Table 4: Average geometric parameters of cotton fibers of different selection varieties

No.	Width, mm	Length of the curl, mm	Thickness, mm
Porlok-1			
1	0.0464	0.07135	0.005
Porlok-2			
2	0.0179	0.0662	0.0002
Porlok-4			
3	0.0328	0.0813	0.002
S-6524			
4	0.0217	0.0835	0.0146

The analysis of the photograph of cotton fiber samples obtained using SEM also confirms the differences in the geometric param-eters of cot-ton fibers of different selection varieties (Table 4).

Based on the results of previous studies, differences in the struc-tural and volumetric properties of the studied samples of geneti-cally modi-fied varieties of cotton fiber were established.

In order to study the effect of reagents and considering the dif-ference in the structural and volumetric properties of the studied objects, cot-ton fibers were boiled (Table 5). At the initial stage, the quality of preparation for finishing of the studied cotton fi-ber samples was as-sessed according to the current technological mode and traditionally used reagents.

The selected technology corresponds to the technological mode of OSBORN TEXTILE LLC: fiber boiling was carried out ac-cording to a periodic mode with the following composition (g/l): NaOH – 2.0; Na2SiO3 – 8.0; H2O2 – 3.0; SAS – 0.5. Washing (g/l): 1st stage – 70 °C water, 10 min; 2nd stage – acid buffer (RUCO ACID EPV 18582) – 1.0 80 °C 10 min; 3rd stage anti-peroxide (RUCOLASE C) – 1.0 45 °C 20 min.

Table 5: Quality of boiled cotton fibers of different selection varieties, carried out according to the current technology

Selection varie-ties of cotton fiber	Degree of whiteness, %	
	original	bleached

S-6524	67.0	80.7
Porlok-1	73.4	83.0
Porlok-2	72.0	82.0
Porlok-4	69.0	83.0

*According to standard requirements, the degree of whiteness is not less than 82 %

When preparing cotton fibers for finishing according to the current technological mode, the same degree of whiteness is not achieved in these samples. Subsequently, the effect of the concentration of the main boiling reagents on the degree of whiteness of the samples was studied.

Table 6: Effect of the concentration of the alkaline agent on the degree of whiteness* of cotton fibers of different selection varieties

Concentration of the alkaline agent*, g/l	Selection varieties of cotton fiber			
	S-6524	P-1	P-2	P-4
1.5	71.3	76.4	75.5	78.0
2.0	78.0	82.8	81.2	82.7
2.5	79.4	83.4	82.5	84.0
3.0	81.6	83.9	83.0	85.2
3.5	83.5	84.0	83.4	85.5

*Concentration of H2O2 is 3.0 g/l.

With increasing concentration of the alkaline agent, the degree of whiteness increases in all samples of cotton fiber (Tables 6-7). The necessary concentration of alkali to achieve approximately the same indicators of the degree of whiteness for all the studied samples differ. The study of the effect of the bleaching agent on the quality of bleach-ing of a specific fiber grade was carried out with the appropriate amount of sodium hydroxide.

Changes in the concentration of the bleaching agent have different effects on the degree of whiteness of the samples (see Table 7). The results of the experiments show that in order to achieve approximately the same indicators of whiteness, it is necessary to adjust the composi-tion of the coiling and bleaching bath.

Table 7: Effect of hydrogen peroxide concentration on the degree of whiteness of cotton fibers of different selection varieties

Quality indicators	Cotton fiber variety			
	P-1	**P-2**	**P-4**	**S-6524**
Monolayer capacity Xm, mol/kg	0.115	0.101	0.107	0.105
Specific surface Ssp, m2/g	74.41	40.14	69.54	35.86
Total pore volume W0, cm3/g	0.0659	0.0543	0.0688	0.0452
Capillary radius Pk, Å	24.2	17.8	20.7	24.2

The capacity of the monolayer, which characterizes the water absorp-tion of all samples, regardless of the grade, increases from 5 to 10 times due to the removal of fatty-wax impurities and cellulose satel-lites from the surface (Table 8).

The decrease in the specific surface area and the total pore volume is associated with the narrowing of the capillaries. Apparently, in a free state at a high temperature, relaxation processes and shrinkage of the fiber occur, as a result of which the capillaries narrow. However, the sizes of the capillaries remain commensurate with the sizes of the molecules of textile auxiliary substances and dyes. Considering the size of the sulfogroups, the length of the molecules of direct, acidic and active dyes is 10-15 Å, monoazodisulfonic acid is 14.5–19.5 Å, and H2O2 is 1.45 Å, SAS is 39.3 Å, NaOH is 1.31 Å (Tables 9-10).

Table 9: Effect of NaOH concentration on the quality indicators of yarn samples

Yarn from dif-ferent selec-tion varieties	Concentration of sodium hydroxide, g/l					
	indicators of the original sample	1.5	2.0	2.5	3.0	3.5
Degree of whiteness*, %						
Porlok-1	73.0	77.0	82.4	83.6	84.8	85.5
Porlok-2	71.6	76.0	81.0	82.5	84.5	85.7

Porlok-4	69.5	75.2	81.8	84.0	85.1	86.3
S-6524	67.0	75.0	78.8	80.0	82.3	83.6
Capillarity*, mm/h						
Porlok-1	0	112	129	133	138	141
Porlok-2	0	108	116	131	148	151
Porlok-4	0	105	136	139	141	144
S-6524	0	98	100	117	131	142
Tear strength, N						
Porlok-1	249.0	252.4	257.0	259.0	261.0	256.0
Porlok-2	252.4	258.0	265.0	269.0	266.0	255.0
Porlok-4	256.0	261.0	268.0	271.0	261.0	251.0
S-6524	243.5	246.0	248.0	250.0	255.0	252.0

Table 10: Effect of H2O2 concentration on the quality indicators of yarn samples

Yarn from different selection varieties	**Concentration of hydrogen peroxide, g/l**					
	indicators of the original sample	1.5	2.0	2.5	3.0	3.5
Degree of whiteness*, %						
Porlok-1	73.0	79.0	82.6	83.0	84.8	85.5
Porlok-2	71.6	76.0	81.0	82.5	84.5	85.7
Porlok-4	69.5	75.2	79.3	80.5	82.8	86.3
S-6524	67.0	72.0	76.8	79.5	83.0	83.6
Tear strength, N						
Porlok-1	249.0	252.4	257.0	259.0	256.0	253.0
Porlok-2	252.4	258.0	265.0	270.0	271.0	269.0
Porlok-4	256.0	259.0	262.0	266.0	269.0	264.0
S-6524	243.5	248.0	249.0	251.0	254.0	252.0

Therefore, preparation for dyeing of cotton yarn of different selection varieties according to the current technological mode does not provide the same degree of whiteness. The results of the experiments show that in order to achieve the degree of whiteness corresponding to the standard requirements, it is necessary to adjust the composition of the cooking and bleaching bath.

Based on the results of the experiment, technical parameters of the process of preparation for dyeing of the selected varieties of cotton yarn were proposed and tested in production conditions.

In the conditions of "AGRO TEKS ALLIANCE" LLC and "NAMANGAN TOKIMACHI" LLC, the selected varieties "Porlock-2" and "Porlock-2" were used, experimental batches of yarn with the quality indicators given in Table 11-12, which were dyed in the Khorezm and Namangan regions, were prepared for dyeing. These yarn samples underwent the process of preparation for dyeing at the enterprise of "OSBORN TEXTILE" LLC according to the proposed technology and were accepted for implementation.

Table 11: Developed technological mode of the process of preparation for dyeing of yarn based on "Porlock-2" cotton fiber

Introduction of preparation reagents			
Operations	**Concentration of chemical materi-als, g/l**	**Tempera-ture T, °C**	**Processing time, min**
Introduction of yarn into equipment			20
Sealing			
Water heating	Steam	5 deg/min	10
Introduction of preparation reagents			
	NaOH - 2.2 Na2SiO3 - 8 H2O2 - 2.5 SAS - 0.5		10
1st stage		50	20±2
2nd stage		95	20±2

Washing			
1st stage	Water	80	15
2nd stage	Acetic acid and		
antiperoxide	50	20	
3rd stage	Cold water		10

Table 12: Developed technological mode of the process of preparation for dyeing of yarn based on "Porlock-4" cotton fiber

Operations	Concentration of chemical ma-terials, g/l	Tempera-ture T, °C	Pro-cessing time, min	Module
Introduction of yarn into equipment				20
Sealing				
Water heating	Steam	5 deg/min	10	
Introduction of preparation reagents				
1st stage	NaOH - 1.6 Na2SiO3 - 8 H2O2 - 3.0 SAS - 0.5		10	
1st stage		50	20±2	1:8
		95	20±2	1:8
Washing				
1st stage	Water	80	15	
2nd stage	Acetic acid and antiper-oxide	50	20	
3rd stage	Cold water		10	

The physical, mechanical and quality indicators of the original and boiled yarn are given in Table 13.

Table 13: Physical, mechanical and quality indicators of the original and boiled cotton yarns based on "Porlock-2" and "Porlock-4" cotton fibers

Yarn grade	Degree of whiteness*, %		Capillarity*, mm/hour		Breaking load, cN		Elongation at break, %	
	orig.	bleach	orig.	bleach	orig.	bleach	orig.	bleach
Samples boiled using production technology								
S-6524	69.0	81.7	0	138	243.5	251.0	7.9	8.2
Porlok-2	71.6	80.8	0	133	252.4	257.0	6.3	7.2
Porlok-4	70.0	80.5	0	135	256.0	258.5	7.0	7.5
Samples boiled using proposed technology								
S-6524	69.0	80.0	0	139	243.5	248.9	7.9	8.0
Porlok-2	71.6	83.5	0	140	252.4	265.0	6.3	7.6
Porlok-4	70.0	82.7	0	144	256.0	268.0	7.0	7.9

The process of boiling cotton yarn samples according to the proposed technology ensures high whiteness, capillarity con-sidering their struc-tural features. Improvement of physical and mechanical properties is associated with shrinkage and increase in linear density after boiling the yarn.

Differences in the structure of cotton yarn formed during vegeta-tive growth and subsequent mechanical treatment have a notice-able effect on the amount of the main components of the boiling bath in Table 14.

The structural and volumetric properties of yarns of different selection varieties change differently after the boiling process. Due to the re-moval of fat and wax substances, the fiber surface becomes more de-veloped, and the total volume also increases. Apparently, the decrease in the capillary radii is associated with shrinkage of the yarn after wet and heat treatments. The increase in the total pore volume and specific surface can be explained by an increase in inter-fiber spaces in the yarn.

Table 14: Surface and volume properties of boiled yarns produced from different selection varieties

Sample	Monolay-er capaci-ty Xm, g/g	Specific surface area Ssp, m2/g	Total pore volume W0, cm3/g	Capillary radius rcp, Å
Porlok-1	0.0121	42.07	0.068	26.87
Porlok-2	0.0157	37.17	0.080	29.03
Porlok-4	0.1011	65.74	0.035	22.4
S-6524	0.0131	46.05	0.085	31.26

Technological cycle of preparation for finishing provides textile mate-rials with high and uniform wettability, sorption capacity, high and stable whiteness. The above properties of the prepared cloth accelerate diffusion at the interface of two phases, thereby contributing to uni-form and intensive dyeing, printing and final finishing.

Conclusion

The obtained results allowed drawing the following conclusions:
1. The micronaire indices of the "Porlock" and S-6524 varieties are different. The new varieties of cotton fiber belong to a higher type, are characterized by better geometric properties, fineness and fiber length indices.
2. Comparative analysis of genetically modified P-1, P-2 and P-4 cot-ton fiber varieties with the S-6524 zoned fiber variety was carried out. It was established that the selection varieties of cotton fiber P-1 and P-4 have a larger specific surface area, i.e., 2 and 1.9 times, respectively, and the total pore volume for the selection varieties P-1, P-2 and P-4 are also 1.5, 1.2 and 1.6 times, respectively, greater compared to the S-6524 zoned vari-ety. Differences in the structure of fibers formed dur-ing vegeta-tive growth, as well as their subsequent mechanical pro-cessing in the process of yarn formation, have a noticeable effect on the course of chemical finishing processes.
3. The effect of the concentration of the main reagents for the prepara-tion of yarn from new selection varieties of cotton fiber was studied in order to achieve the quality indicators provided for by the standards. The process of preparing yarn from the P-2 selection variety with a denser structure for dyeing requires rel-atively high concentrations of an alkaline agent (up to 10%) and a low concentration of hydrogen peroxide (up to 17%), while the P-4 selection variety with high vol-ume properties requires a smaller amount of an alkaline agent (by 20%).
4. The expected effective method of preparing the proposed yarn prep-aration technology is achieved by adjusting the concentra-tions of the reagents used.

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