Analysis of physical and morphological parameters of silk fibers in the aesthetic properties of silk fabrics

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Abstract. This article outlines the issues of providing the medium-sized industrial sector with natural fiber products, analyzing the aesthetic properties of fabrics in the production of fabrics that meet the aesthetic and hygienic requirements of consumers for a wide range of modern clothing, and determining the use of silk fabrics according to physical and mechanical characteristics. In the production of consumer goods in accordance with the needs of the population, the specific characteristics of gauze, including the connections between the air permeability of gauze and its filling with fiber, hygienic and hygroscopic, air and vapor permeability, the type of fabric, fiber composition, aesthetic properties, quality indicators are also analyzed. Aesthetic properties of gauzes are physical and morphological indicators, that is, color and given pattern of gauzes, hardness and layer formation; glossiness, depending on the structure of the surface level and evaluated parameters - it is determined that it depends on the requirements such as application, meeting the customs of the time and fashion trends. As a result of the research, in order to expand the scope of consumption of gas products, proposals were made to improve the production assortment, after studying the needs of consumers of different categories and nationalities.

1 Introduction

The rapid development of economic sectors in Uzbekistan, the combination of fashion trends with modernity, attractiveness and nationalism increases the demand for the production of silk fabrics, silk fiber clothes and accessories. Silk fiber, which is a natural, is one of the fabrics that interest the people of the sewing industry with its important hygienic and unique aesthetic properties.

At present, the tasks of improving the quality of products, increasing the volume of production and expanding the range of silk fabrics and products made from natural silk are relevant. Silk has the highest strength, physical and mechanical, hygienic properties among natural fibers. However, the world's textile raw materials account for only 0.5-0.2%. While the cultivation of cocoons in Japan in the middle of the last century dominated the production of raw silk, China and India began to develop rapidly from the 80s. Until 2015, the Republic

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of Uzbekistan ranked 3rd-4th in the world, growing 35,000 tons of cocoons annually and producing about 2,500 tons of raw silk.

Below we have analyzed a number of physical and mechanical properties of silk fiber fabrics.

The thickness of such fabrics (for example, poplin, reps) will correspond to three thread diameters: one for the warp and two for the weft, or two for the warp and one for the weft. The intermediate phases of the structure (from the second to the eighth) are obtained by successively increasing the bending of the warp threads and straightening the weft by 1/8 of the height of the warp or weft wave.

The main tasks facing light industry enterprises specializing in the production of silk products are to increase the export potential, increase the range and quality of products in the domestic and foreign markets, import substitution using local raw materials, and the production of silk products with high physical, mechanical and hygienic properties.

Studies have been carried out to study the change in the physical and mechanical properties of silk with a change in linear density and the type of main yarn in the canvas. During the study, the physical and mechanical properties of different variants of silk samples were analyzed.

Literature review. It was found that a change in the linear density of the base yarn in the structure of silk leads to an increase in tensile strength along the length and width, and abrasion resistance [1].

The average equilibrium is the fifth phase of the fabric structure, characterized by the same curvature of the warp and weft threads. Such a fabric has the smallest thickness, determined by the thickness of the warp and weft threads (for example, linen, chintz), and has approximately equal properties in the direction of the warp and weft threads.

Thus, the thickness of single-layer fabrics can be equal to two to three diameters of the threads from which the fabric is made. Following figure reveals Fabric properties.

We decided to study the possibility of modifying a natural (protein) fiber with solutions of polyquaternary ammonium salts, with a uniform distribution of polymer macromolecules and their salts. The samples used were raw silk boiled for 20 minutes at the boiling point of a solution containing 0.08% Na2CO3 and 0.04% soap at a bath modulus of 1:50, repeatedly washed with distilled water and dried to constant weight [2]. To improve the technological and operational properties of natural silk, it was studied under production conditions that graft copolymerization was carried out at a temperature of 323-33K and various concentrations of the initiator and monomer. Potassium persulfate (PC) -3.10-3÷1.5.10-1% by weight of polydimethylaminoethyl methacrylate with monoiodoacetic acid was used as an initiator. The maximum yield of the copolymer (11–12%) was obtained in the presence of 1.2×10–2% PC, at a temperature of 333 K, and a reaction time of 1 h [3]. The amount of polymer on the fiber depends on the initial concentration of the monomeric salt in the solution.

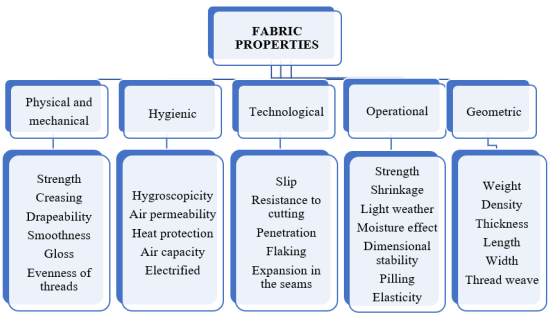

Fig. 1. Fabric properties.

Some finishing processes can increase or decrease the thickness of the fabric. Such as, when rolling and napping the fabric thickens significantly, and vice versa when pressing.

Silk is the finest natural protein fiber (similar to human hair), which has unique properties to absorb moisture and regulate body temperature depending on the season and ambient temperature. Silk is the only natural material that maintains an ideal microclimate for the human body, depending on the ambient temperature.

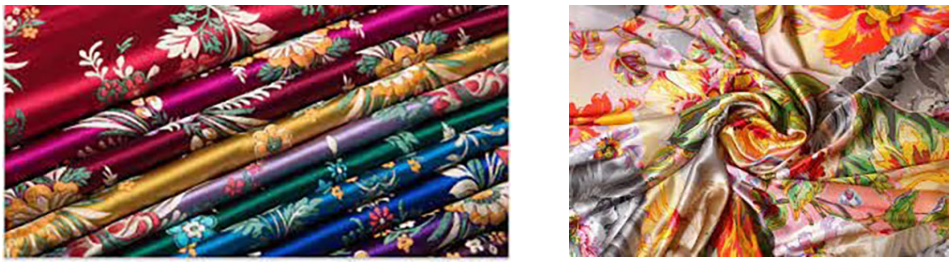

Fig. 2. Types of silk.

2 Research methodology

Repeated studies have proven that bedding and clothing made of silk can provide the prevention of diseases such as arthritis and rheumatism, cardiovascular and skin diseases, colds and flu.

Data on the thickness of fabrics for various purposes are given in Table 1.

Table 1. Thickness of fabrics for various purposes.

Fabrics (for dresses and underwear)	**Thickness, mm**
Silk	
crepe de chine, crepe chiffon, nylon muslin	0.1 – 0.24
crepe maroquin, fidechin, satin	0.25 – 0.32
Linen and semi-linen	0.3 – 0.4

Sewing enterprises supply fabrics of those widths that are provided by the standard. It is planned to produce fabrics of the greatest possible width, which will improve the layout of patterns on the canvas when cutting fabrics and reduce the amount of inter-pattern waste.

The great importance for the economical use of the fabric is its uniformity in width within the piece. The uneven width of the fabric in the piece causes an increase in waste when cutting. The uniform width of the fabric in the piece indicates the correct arrangement of the warp and weft threads. The unevenness in the width of the fabrics in the batch causes difficulties in work:

- firstly, the batch must be sorted by width;
- secondly, very small batches of fabrics are often obtained;
- thirdly, it makes it necessary to change the layout of the patterns in accordance with the width of the fabric.

The width of the fabric is an indicator on which the number of linear meters necessary for cutting a particular product depends.

It is more convenient to cut fabrics for clothing of various types at a certain, so-called rational, width of the fabric, at which a minimum amount of waste is obtained. Table 2 shows the width of fabrics for various purposes in accordance with GOST 9202 76, 9203 - 76, 9204 - 70, 9205 - 75 (for silk, linen, woolen and cotton fabrics.

Table 2. Width of silk and semi-silk fabrics for various uses.

Class	Subclass	Use	Rational width of fabrics with edges, cm
Clothing	Suit-dress	Dresses, dress suits, robes, blouses	90, 95, 100, 105, 110, 120, 140, 150, 160
	Dress shirt	Shirts	90, 95, 100, 110, 140
Linen	Underwear	Corset	95, 100, 110, 120, 130, 140, 150, 160
	Dress worn in bed	Pajamas	115, 125, 140, 150, 160, 180

3 Analysis and results

In the clothing industry, when calculating the consumption rates of fabrics for a product and to determine the value group of fabrics, the conventional fabric widths accepted in the industry are used: 61, 71, 100 and 133 cm, depending on the type of fabric [4].

Determine the surface density of the fabric if the sample has a length of 150 mm, a width of 50 mm and a mass of 1.5 g.

$$M = \frac{1.5 \cdot 1000 \cdot 1000}{150 \cdot 50} = 200 \ \frac{g}{m^2}$$

Due to the hygroscopicity of the fibers, the surface density of the fabric can vary significantly depending on the environmental conditions, therefore, the compliance of the surface density of the fabric with the norms of the standard can only be verified by determining the conditional surface density M_k, i.e. the surface density at normal humidity, calculated by the formula

$$M_k = M \cdot \frac{100+W_k}{100+W_f},$$

where: W_k - conditioned moisture of fabric, %; W_f - actual moisture of fabric, %.

The surface density of the fabric can be determined by calculation if the thickness of the warp threads T_o and weft T_u and the density of the warp threads P_o and weft P_u are known using the formula

$$M_k = 0.01 \cdot T_0 \cdot P_0 + T_u \cdot P_u \ .$$

Its purpose depends on the surface density of the fabric: fabrics with a low surface density are used for underwear and dresses, with a higher one - for suits, and with the highest - for coats, and for women's and children's clothing, fabrics are lighter than for men [5].

The surface density of tissues is very diverse. In table. 3 showen the approximate surface density of tissues, taking into account their purpose.

Table 3. Surface density of silk fabrics for various purposes, g/m².

Made from natural silk	40 - 80	25 - 160	100 - 240	100 - 160
From artificial threads	80 - 150	80 - 280	140 - 280	200 - 280
Made from synthetic yarns	-	20 - 120	120 - 200	-
Staple	-	100 - 240	140 - 340	-

The surface density of the fabric also affects the processes of sewing production: it is more difficult to lay down heavy fabrics for cutting than light ones; heavy fabrics are ground with thicker threads, wet-heat treatment of products made from them is more laborious, and assembly and relocation operations are more tedious.

Bulk weight (density) of fabrics - the mass of 1 cm³ of fabric, g. It depends on the bulk weight of the fibers and the porosity of the fabric. The volumetric mass of the fabric δ, g/cm³, is calculated by the formula δ = M/(1000 h), where M is the surface density of the fabric, g/m², h is the thickness of the fabric, mm [6, 7].

Water permeability refers to the permeability of the fabric itself. Water vapor passes through the holes into the fabric, also due to the hygroscopicity of the materials. Gauze absorbs moisture from the air under clothing and evaporates the environment.

The water permeability coefficient is taken as the character of water permeability, it shows the amount of water from 1 cm² of fabric at a given water pressure in 1 min and is calculated by the following formula.

$$C_P = \frac{V}{S \cdot t}, \ \frac{dm^3}{sm^2 \cdot s}$$

where: V - is the amount of water that has passed through the sample for a certain time, dm³;

S - is the sample surface, cm²;

t - time, seconds.

The hygroscopicity and vapor permeability indicators of gauzes depend, not only on the fiber content of the gauze, but also on its structure. The denser the gauze is woven, the higher its hygroscopicity and vapor permeability index.

The hygroscopicity of the gauze depends not only on the fiber content, but also on the structure of the gauze.

Indicators that have a more positive effect on the hygroscopicity of material are the thickness and density of the fabric. But the thickness and high density of the fabric has a negative effect on the air permeability of it. The denser the yarn and the yarn are, the lower the air permeability of the yarn. The relationship between fabric's permeability and density, which affects it, can be expressed by the following regression equation:

$$W = -71.43 + \frac{215277.77}{R_0 + R_u} \quad (R=0.8).$$

The air permeability of the gauze also depends on its filling with fibers. The higher the filling capacity of the gauze with fibers, the lower its air permeability, because the fibers fill the pores in the gauze and prevent air from passing through. The relationship between the permeability and its fiber filling capacity can be expressed by the following equation.

$$W = 141.08 + \frac{6363.63}{nt} \ (R = 0.8).$$

The aesthetic properties of silk fabrics are considered one of the most important properties for consumers, today the indicators of the aesthetic properties are not taken into account in the comprehensive evaluation of silk fabrics. The aesthetic properties of gauzes are physical-morphological (color and given pattern of gauze, rhythmic repetition of patterns, hardness and layer formation; glossiness, structure of the surface level) and evaluable (use, compliance with tradition, response to today's material, existing in gauze news) depends on indicators. In the assessment of the complex aesthetic indicators of the fabrics, 37.5% of the fabrics were rated "excellent" (E_m = 0.76–1), 62.5% of the fabrics were rated as "good" (E_m = 0.51–0.75).

The physical and mechanical properties of tissues are associated both with the influence of the external environment on them (light, moisture, etc.), and with various mechanical influences (tension, compression, bending, friction). The ability of fabrics to withstand these loads - determines its mechanical properties (degree of strength, elongation, wear resistance, creasing, stiffness, drape).

The hygienic properties of fabrics determine the degree of comfort of products made from them, are associated with the creation of a microclimate around the human body during operation (thermal protection, water resistance, hygroscopicity, dust capacity, etc.).

In the process of its development, mankind has created or adapted many materials for protection from the environment, for numerous household needs, and also simply for decorating themselves. And one of these materials deserves special attention.

Such a fiber or thread is also called natural silk, thereby distinguishing it from chemical fibers or threads, sometimes also called silk. Natural silk is a biopolymer. The cocoon filament is a reinforced protein composition of two fibroin silks connected by sericin. Sericin contains more oxygen than fibroin. It is distinguished by less resistance to the effects of physical and chemical reagents. Along with the noted proteins, the cocoon filament also contains minor amounts of mineral (1-1.7%), fat-wax substances (0.5-3.2%) and traces of pigments.

And so, natural silk is soft, thin, easy to dye and has a pleasant moderate sheen, high wear resistance, does not peel, tolerates hand washing well, and has good thermal insulation. Sericin is a valuable protein substance, its content in raw silk is 25-27%. Currently, sericin is not used at all, since it is water-soluble and, together with decoction solutions, is discharged into wastewater.

4 Conclusion

From the results of the research, it can be concluded that the most important hygienic properties of gauze are not only the fiber content used in gauze, but also the structure of gauze: density, with fibers depends on the filling, the thickness of the gauze, the type of knitting used, the softness and smoothness of the threads. Therefore, manufacturing companies should consider not only the fiber content of the fabric, but also its structure when designing and producing new fabrics.

So, it became known that there is a close correlation between the physico-morphological and evaluated indicators of the aesthetic properties of silk fabrics. Consumers, while evaluating the aesthetic properties of gauze, first of all, should pay attention to the color-pattern, glossiness, given decorations of fabric, the purpose of use of fabric, traditions and today's fashion. That's why manufacturing enterprises should take into account the hygienic properties of fabric products that affect the health of consumers and the aesthetic properties that are the biggest importance for consumers, before producing fabrics.

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