

USE OF BLENDED FIBER YARNS IN THE WEFT OF SHIRTING FABRICS AND THEIR COMPREHENSIVE ASSESSMENT

Fayzullayev Shavkat Raimovich

Associate Professor, Tashkent Institute of Textile and Light Industry,

E-mail: shavkat.fayzullayev72@gmail.com

Tel: +998909971767

Bobojanov Xusanxon Toxirovich

Associate Professor Namangan State Technical University,

E-mail: husanbobojanov@gmail.com

Tel: +998935977666

Kojametov Batir Tokhtarbay ugli,

Independent Researcher, Tashkent Institute of Textile and Light Industry,

E-mail: k_batir@karsu.uz

Tel: +998906506777

Kasimov Sanjar Shavkatovich

Specialist of the Marketing Department of "Osborn Textile" LLC

Tel: +998 93 500 06 48

Abstract

This article highlights the importance of using various blended fiber yarns in the production of shirting fabrics. Various methods for assessing the quality indicators of shirting fabrics are presented. A comprehensive assessment method was used to determine the impact on the quality indicators of shirting fabrics woven from blended fiber yarns. For the comprehensive assessment, experimental fabric samples were woven in 5 variants based on plain weave with a weft density of 10 cm being 225, using yarn samples spun from a cotton/polyester 70/30 fiber blend and 100% cotton yarn in the weft. Several indicators of the fabric samples were determined, such as air permeability, hygroscopicity, electrostaticity, color fastness, breaking strength, change in dimensions after wet processing, and fabric composition, and the fabric samples were comprehensively assessed. Analysis of the comprehensive assessment diagram and histogram of the fabric quality indicators showed that the quality indicators of the shirting fabric in variant IV are the best, being superior to the surfaces of other shirting fabrics; this fabric was produced with a weft density of 225 and a linear density of 20 tex, made from a blended fiber yarn with a 70/30 ratio.

Keywords. Blended fiber, shirting fabric, comprehensive assessment, cotton/polyester, quality indicators.



Introduction

The production of high-quality shirting fabrics holds one of the leading positions in the global application of energy- and resource-saving technologies and equipment. In developed countries worldwide, significant attention is paid to improving the quality, physico-mechanical and hygienic properties, and enhancing the durability of shirting fabrics in textile production. This necessitates the practical implementation of producing shirt products using various fiber blends [1]. In this regard, the use of different fiber blends is of great importance for improving the consumer properties of fabrics and enhancing the competitiveness of textile products on the world market.

In our Republic, comprehensive measures are being implemented and certain results are being achieved regarding organizing the production of a wide range of high-quality garment products from new assortments of shirting fabrics, expanding the use of local natural raw materials, and increasing the export potential of producers of various blended products. The new development strategy of Uzbekistan for 2022-2026 has set important tasks, including "...accelerated development of the national economy and ensuring high growth rates, ...reducing losses in industrial sectors and increasing the efficiency of resource utilization..." [2].

In the development of the textile industry, research works are being carried out aimed at improving modern, automated, high-productivity machinery and technologies for producing high-quality shirting fabrics, and creating new types of shirt products and changing their assortment based on market demand and supply. In this regard, special attention is being paid to using yarns of various fiber compositions applied in the fabric manufacturing process to improve the properties and strength of new assortments of shirting fabrics, reducing yarn breakage during the weaving process, further enhancing the consumer properties of textile products, and creating new assortments of shirting fabrics with high durability [3].

One of the main tasks facing our Republic's textile industry is to produce new assortments of high-quality blended products, specifically fabrics with good consumer properties, using raw materials of various blended compositions. In accomplishing this task, the use of blended fiber yarns in shirting fabrics and the investigation of quality indicators to improve the fabric's consumer properties, obtaining new assortments of shirting fabrics with different compositions, and enhancing fabric quality based on selecting optimally blended yarns with composition ratios suitable for different seasons are of significant importance [4].

Theoretical Research

An analysis of literary sources indicates that many scientific works are directed towards studying the structure and properties of fabrics, their manufacturing technologies, and improving fabrics of various blend compositions. In our Republic, utilizing existing raw material resources to find ways to reduce the amount of cotton fiber in the weaving process of shirting fabrics according to the season is one of the most crucial fundamental tasks facing the textile industry. The blending of various high-performance, new, inexpensive, and effective chemical fibers with cotton fiber to obtain new fabric compositions is of significant importance. At the same time, it must be noted that despite the noticeable development of woven fabric production, there remain many problems that need to be solved. In particular, comprehensive



research on producing inexpensive fabrics of various structures using different blended fibers suitable for the season to improve the physico-mechanical and hygienic properties of shirting fabrics has not been sufficiently conducted at the textile enterprises of our Republic. Therefore, conducting scientific research related to creating new assortments of shirting fabrics is of great importance [5].

For shirting fabrics, a comprehensive assessment of the properties, weaving parameters, and indicators of fabrics woven from yarns with different blend ratio compositions is considered appropriate.

There are several methods for assessing the quality of shirting fabrics, including experimental, organoleptic, expert, sociological, computational, differential, complex, and mixed methods [6].

The advantage of a comprehensive assessment of the physico-mechanical properties of shirting fabrics is that when determining the surface area based on the obtained test results, it is possible to clearly see that the fabric with the larger surface area is better. Therefore, this method is currently widely used.

Depending on the nature of the product's quality indicators, complex assessment is divided into actual and approximate complex assessment.

Actual complex assessment has defined physical objectives, which often express the spinnability of the fiber and the service life of the product.

Actual complex assessment is always better than approximate assessment. For example, the amount of defects and waste in the cotton fiber content is called an actual complex property [7].

The advantage of complex assessment is that a conclusion is made based on a single numerical final evaluation. However, this evaluation is not without its drawbacks, as we do not obtain complete information about the individual properties.

To correctly select raw materials, manage the technological process, and know how to use the material rationally during its service life, it is necessary to consider that the initial properties of a given material can have a positive effect on the quality of the manufactured product and a negative effect on the progress of the technological process. The finer the fiber, the higher the specific strength of the yarn produced from it, the lower its irregularity, and the smoother its appearance. It must not be forgotten that a complex assessment of a particular quality can be derived from various calculations of individual quality indicators [8].

The average complex assessment may remain unchanged based on the level of several quality indicators, where some may be at a lower level and others at a higher level. Thus, the complex assessment can be supplemented without changing the individual quality indicators of the material.

There are various methods for the comprehensive assessment of the quality indicators of shirting fabrics. For example, if a differential dimensionless evaluation is given for m^* materials based on n^* indicators, and they have different importance coefficients, they are evaluated with an importance coefficient.

In the scientific research work, we use the graphical method of complex assessment to recommend the most optimal variants based on the indicators of geometric and physico-

mechanical properties. The advantage of this method is the ability to objectively identify the most optimal variants of the generalized quality indicators of properties according to the requirements set for the materials simultaneously [9].

Experimental research

Today, the demand for products made from blends of natural and chemical fibers is increasing daily. In world fashion, fabrics involving cotton and polyester fibers are achieving great success [10-15]. Increasing the processing volume of our primary resource—local textile fibers—and finding ways to create new fabric assortments are considered crucial [16-19].

For the purpose of a comprehensive assessment of the fabric's quality indicators, fabric samples were produced in 5 variants based on the technological parameters of the fabric listed in Table 1. The production took place on a modern TOYOTA AIRJET 810 loom from Japan's TOYOTA company, installed in the laboratory of the "Textile Fabric Technology" department of the Tashkent Institute of Textile and Light Industry. The fabrics were woven in a plain weave (rapport $R_T=R_A=2$, $S=1$) with uniform density, using yarn samples spun from a cotton/polyester 70/30 fiber blend and 100% cotton yarn.

Table 1 Technological parameters of fabric

№	Indicators name	Samples				
		1	2	3	4	5
1	Warp yarn, Cotton	100 %	100 %	100 %	100 %	100 %
2	Weft yarn, Cotton/ Polyester	70/30	70/30	70/30	80/20	100 %
3	Yarn linear density, Ne - warp Ne - weft	38/2	38/2	38/2	38/2	38/2
		29,5/1	29,5/1	29,5/1	29,5/1	29,5/1
4	Yarn density by 10 cm - by warp - by weft	240	240	240	240	240
		225	225	225	225	225
5	Weave type	Plain Weave	Plain Weave	Plain Weave	Plain Weave	Plain Weave

The fabric samples were tested in the laboratory of the Uzbek-Turk Center in accordance with GOST 29298-2005. Several indicators were tested, such as surface density, breaking strength, change in fabric dimensions after wet processing, air permeability, hygroscopicity, electrostaticity, color fastness, and fabric composition.

A fabric quality complex assessment diagram and histogram were used to identify the best variant among the woven samples.

By studying the quality indicators of the fabric, one can determine the quality of the garment sewn from it. For this purpose, a comprehensive assessment of the fabric quality is considered necessary.

As the analyzed indicators, those which determine the suitability of the fabric for the selected product assortment were considered.

On the loom, 5 shirting fabric samples were produced, with a weft density of 200 per 10 cm as listed in Table 1, using weft yarns made from a 70/30 fiber blend and 100% cotton yarn.

The prepared fabric samples were tested in the laboratory of the Uzbek-Turk Center according to the normative values of GOST 29298-2005, intended for checking shirting fabric indicators. Several parameters of the woven fabric samples were tested, including change in dimensions after wet processing, skewness of yarns in the fabric (fabric bias), breaking strength, air permeability, hygroscopicity, and electrostaticity (Table 2).

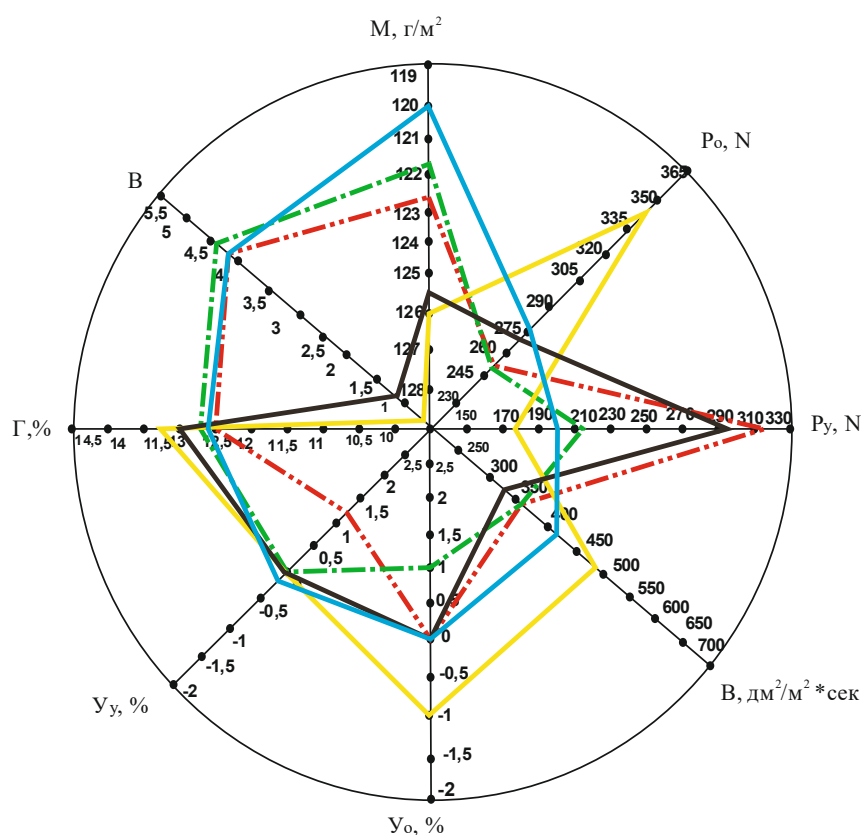
Table 2 Analysis of the physico-mechanical properties of the manufactured fabric samples

№	Name of Indicators		GOST 29298-2005 Indicators	Samples					Correspondence of Indicators
				I	II	III	IV	V	
1	Fabric Composition, %	Cotton	Part 3.2	87,6	87,8	87,7	90,5	100	Corresponds
		Polyester		12,4	12,2	12,3	9,5	0	
2	Surface density, g/m2: not less than		Part 4.2.11-Table 4 from 100 to 200	125,4	122,7	121,9	120,0	126,0	---
3	Strength, N, not less than - by warp - by weft		Part 4.2.11-Table 4 216 147						Samples 1-4 comply, Sample No. 5 does not comply
				273,7 294,2	249,2 315,2	248,2 212,9	275,6 200,1	344,3 174,6	
4	Fabric shrinkage, %, no more than - by warp - by weft		Part 4.2.7 Table 4 - 5,0 ± 2,0	0 0	0 +1,2	+1,0 0	0 -0,2	+1,0 0	Samples 1, 2, 4 comply, Samples 3-5 do not comply
5	Color fastness, rating, not less than: - for washing - Perspiration - Steam Pressing/- Decatizing - For Dry Rubbing		Part 4.2.3 Table 1 4/4 4/4 4 3	4/4	4/4	4/4	4/4	0	Corresponds
				4/4	4/4	4/4	4/4	0	
				4	4	4	4	0	
				4	4	4	4	0	
6	Air permeability, dm3/m2 s not less than		Part 4.2.12 Table 5 100	335,0	353,0	353,0	418,0	482,0	Corresponds
7	Hygroscopicity, %, not less than		Part 4.2.12 Table 5 12	13,0	12,5	12,6	12,4	13,3	Samples 1-4 comply, Sample No. 5 does not comply
8	Electrostaticity, Ω, no more than		Part 4.2.12 Table 5 1012	1,1 x 107	4,2 x 108	4,4 x 106	4,2 x 109	0	Corresponds
9	Fabric skew, %, no more than ...:		GOST 29298-2005 p.4.2.10 5	4,0	2,0	1,7	2,2	1,8	Corresponds
10	Number of yarns by 10 cm: - by warp - by weft		GOST 29298-2005 p.4.2.15	238 228	242 224	246 220	242 224	246 226	---

For the assessment, indicators along the axes from the center (m) for the properties are established in appropriate scales, or decreasing values are marked, and polygons are drawn using radius vectors.

In the distribution of the axes, the intended purpose of the material, its physico-mechanical properties, and the compliance of its durability indicators with established standards must be

taken into account. For example, radius vectors for surface density, warp and weft density are marked from the center, while those for strength, air permeability, and elongation at break indicators are marked towards the center (Figure 1).



I		II		III	
IV		V			

Figure 1. Comprehensive quality assessment diagram of the samples.

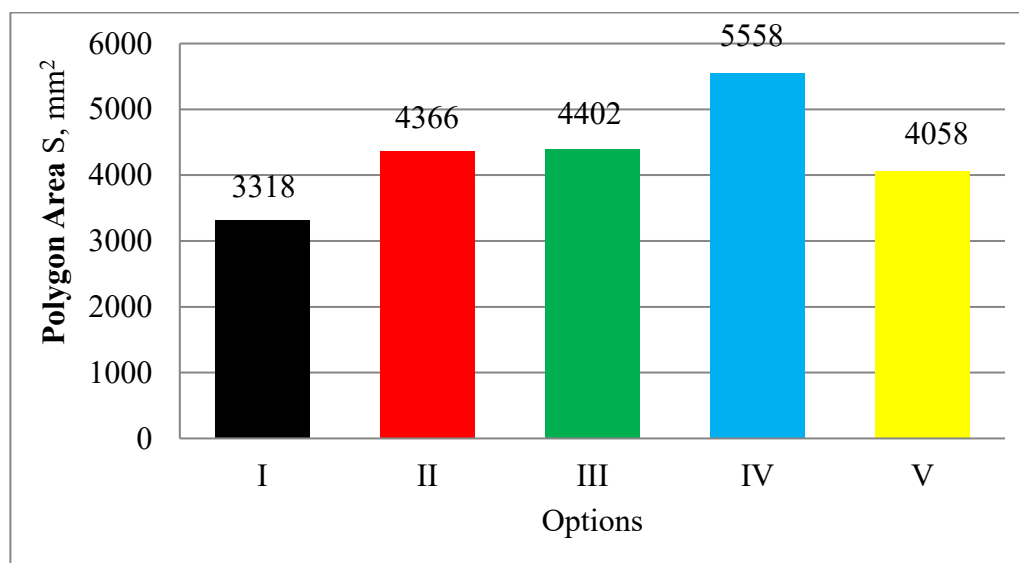


Figure 2. Comparative histogram of the samples' quality indicators.

The formed polygons are divided into triangles, and based on their areas and property indicators, the sums of the triangle areas for the variants are calculated.

After a comprehensive assessment of the test results obtained from determining the physico-mechanical properties of shirting fabrics with different raw material compositions, their surface areas were determined, and the results are presented in the form of a histogram in Figure 2.

Result Analysis

From the comparative histogram of the quality indicators of shirting fabrics, it is evident that for fabric samples woven from yarns spun from a 70/30 cotton/polyester fiber blend: the surface area based on physico-mechanical properties of the shirting fabric obtained according to option I was 3318 mm²; option II was 4366 mm²; option III was 4402 mm²; option IV was 5558 mm²; and for option V, based on yarn spun from 100% cotton fiber, the surface area was 4058 mm². This indicates that the surface area based on quality indicators for the shirting fabric in variant IV is larger compared to the surfaces of the other shirting fabrics.

In conclusion, the analysis of the assessment diagram and histogram of the quality indicators for the 5 fabric samples woven in plain weave from yarns spun from a 70/30 cotton/polyester fiber blend for shirting fabrics showed that the most rational variant, which combines the most acceptable quality indicators, is variant IV. In this variant, the fabric has a weft density of 200 and is made from a blended yarn with a linear density of 20 tex and a blend ratio of 70/30.

According to the experimental results, with a weft density of 200, changes in the fiber composition of the fabric—specifically, the decreasing proportion of cotton fiber in the composition—resulted in an observed increase in breaking strength in both warp and weft directions, a decrease in air permeability, and an increase in the hygroscopicity indicator. This is certainly dependent on the blend ratios of the mixed fibers used in fabric production and depends on the fabric weave and density.

The experimental results showed that changing the fiber composition of the yarns used in the fabric correspondingly changes the properties of the fiber. This, in turn, indicates that the use of different blend ratios in the fiber composition requires careful consideration based on the intended purposes of the fabrics being produced.

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