EduVision: Journal of Innovations in Pedagogy and Educational Advancements
Volume 01, Issue 09, September, 2025
brightmindpublishing.com
ISSN (E): 3061-6972

COMPREHENSIVE ASSESSMENT OF THE QUALITY OF TWO-LAYER KNITTED FABRICS WITH A NEW STRUCTURE

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Abstract
The article presents the results of a comprehensive assessment of the quality indicators of double-layer knitted fabrics from spun cotton yarn, using local raw materials effectively. In order to expand the range of knitted fabrics and study the influence of knitting the structure on their shape retention properties and other quality indicators, 7 variants of double-layer knitted fabrics were developed, differing in structure. Samples of double-layer knitted fabrics were produced on a Long Xing LXA 252 SC flatbed knitting machine.

Keywords: Knitwear, structure, wrinkle resistance, abrasion resistance, breathability, penetration.

Introduction

A Presidential Decree of the Republic of Uzbekistan was adopted on additional measures for the development of the processing chain in the textile and garment-knitting industry. According to this decree, in order to further increase the investment attractiveness and competitiveness of the textile and garment-knitting industry, expand the export potential of the sector, and create favorable conditions for wider access of domestic textile products to foreign markets, the following key target indicators for the development of the processing chain in the textile and garment-knitting industry for 2025–2027 have been established:

- increasing product exports to USD 4.0 billion in 2025, USD 5.0 billion in 2026, and USD 7.0 billion in 2027;
- reaching USD 500 million in exports of finished products to the markets of the United States and European countries;

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- raising the share of finished garment-knitting products in total exports to 70% by widely introducing advanced technologies and modern design solutions as well as attracting international brands;

attracting USD 5.0 billion in foreign investments and loans to further develop deep processing of yarn.

To create favorable financial conditions for deepening processing in the textile sector, the following support mechanisms will be introduced:

- Revenues generated from the export duties (levies) on yarn and fabrics shall be fully allocated to the Industry Support Fund (hereinafter referred to as the Fund);
- Of the revenues from yarn and fabric export duties, USD 15 million in 2025 (and from 2026 onward, not less than 80% of such revenues), together with USD 15 million allocated from resources intended for subsidizing the purchase of production equipment, shall be directed in foreign currency through commercial banks to finance equipment acquisition within projects for the production of fabrics, textiles, and finished garment-knitting products. Furthermore, when necessary, these funds may also be utilized by the Chamber of Commerce and Industry or the "Uztextile Industry" Association to participate as a founding partner in such projects.

Materials and Methods

Worldwide, scientific research is being conducted on the rational use of natural raw materials in production, expanding the scope of their application, and improving new techniques and technologies in the development of novel assortments of knitted fabrics. In the knitting industry, the trend of producing double-layer knitted fabrics is being widely implemented. The study of the technological capabilities of modern knitting machines allows for the creation and production of new types of double-layer knitted fabrics with innovative structures. In this regard, a number of researchers have carried out scientific investigations.

Sh. K. Usmonkulov applied diagrammatic and histogram analysis to comprehensively evaluate the quality indicators of double-layer knitted fabrics, one side of which was made of spun silk yarn and the other of various raw materials. The use of spun silk yarn in the production of double-layer knitted fabrics improved their hygienic properties and durability. The study developed a technology for producing double-layer knitted fabrics by employing an additional yarn using the

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press-joining method. Furthermore, the technological parameters and changes in the physical and mechanical properties of double-layer knitted fabrics with newly bonded layers were investigated.

Analysis of Research Results

In order to expand the assortment of knitted fabrics and to study the influence of knitted structure on shape-retention properties and other quality indicators, six variants of double-layer knitted fabrics with different structural designs were developed. The samples of double-layer knitted fabrics were produced on a Long Xing LXA 252 SC flatbed knitting machine. To form two independent layers of the double-layer knitted fabrics, spun cotton yarn with a linear density of 20 tex and four-thread density was used as raw material (Table 1).

The physical and mechanical properties of the produced double-layer knitted fabric samples were tested using standard methods in the “CENTEX UZ” testing laboratory under TTESI, equipped with modern instruments. The obtained results are presented in the table. Depending on the intended conditions of use and functional purpose, the characterization of knitted fabrics is carried out by analyzing their structure and physical-mechanical properties.

Indicators of the physical and mechanical properties of double-layer knitted fabrics

Table 1

Indicators		Variants						
Yarn type, linear density, tex	Front layer: cotton 20 tex × 4 Back layer: cotton 20 tex × 4	0	I	II	III	IV	V	VI
Surface density of knitted fabric, Ms, g/m²		513	506,9	611	525	604.5	557	556
Thickness of knitted fabric, T, mm		1,5	1,5	1.8	1.7	1.9	1.65	1.7
Volumetric density of knitted fabric, δ, mg/cm³		342	337.9	339,4	308,8	318,1	337,6	327,2
Air permeability, Vr, cm³/cm²·s		96,5	228,7	155,6	203,0	155,6	155,6	168,6
Abrasion resistance, thousand cycles		30000	17000	19500	18000	19000	18000	19000
Breaking force, Rr, N	Lengthwise	409,5	418,0	516,1	392,6	609,7	465,2	480,3
	Widthwise	301,5	301,2	379,2	317,4	364,2	195,2	182,1
Elongation at break, L, %	Lengthwise	96,5	158,0	108,3	97,0	177,6	120,0	70,0
	Widthwise	136,5	160,0	110,0	159,8	156,6	90,0	83,0
Residual deformation, εn, %	Lengthwise	13%	28%	15%	11%	13%	12%	11%
	Widthwise	22%	31%	19%	17%	22%	20%	16%
Elastic recovery, εo, %	Lengthwise	87%	72%	85%	89%	87%	88%	89%
	Widthwise	78%	69%	81%	83%	78%	80%	84%
Shrinkage, U, %	Lengthwise	10,1%	9%	3%	9%	1%	5%	9,4%
	Widthwise	-5,1%	-12%	1%	-6%	8%	-4,3%	1%

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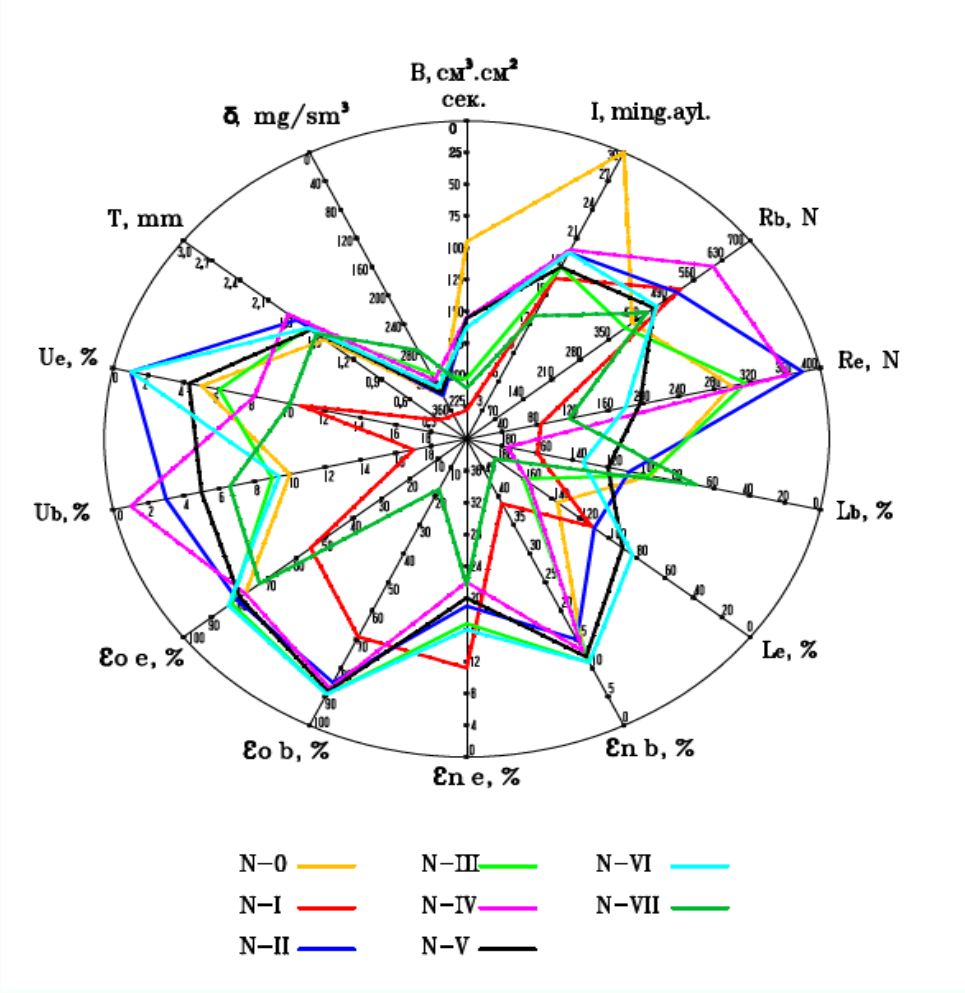
Experimental tests revealed that the quality indicators of the produced samples demonstrated advantages in different variants. As a result, it became necessary to identify the optimal variant with lower raw material consumption and superior quality characteristics. To determine the best variants of knitted fabrics, it is recommended to consider and evaluate a number of factors that define the structure and properties of the fabric. Therefore, in order to compare statistical data with the obtained experimental results, a comprehensive evaluation method of quality indicators of double-layer knitted fabrics was applied. To identify the best variants among double-layer knitted fabrics produced entirely from spun cotton yarn, a comprehensive quality assessment diagram (Figure 1) and histogram (Figure 2) were constructed.



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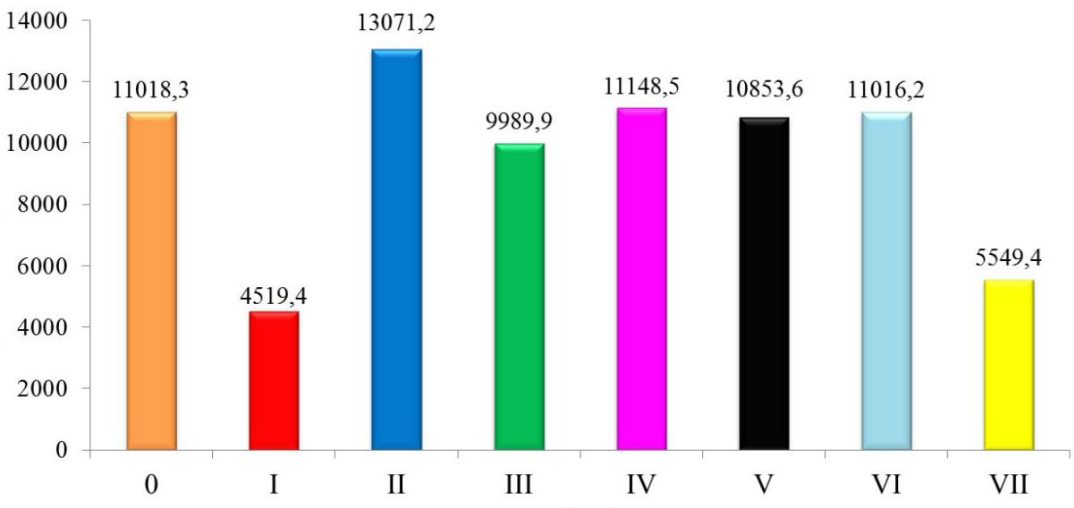

Figure 2. Comparative histogram of the comprehensive evaluation of the quality indicators of double-layer knitted fabrics.

To identify the highest quality variants, it is essential to take into account multiple factors that determine the structure and properties of double-layer knitted fabrics. Therefore, the method of constructing a comprehensive quality evaluation diagram was applied. This method makes it possible to determine the most optimal variant. On each axis of the comprehensive diagram, the numerical values of the technological parameters and physical-mechanical properties of the double-layer knitted fabrics are represented. The results of fabric quality assessment are presented in graphical form in the diagram. During the study, the most important properties required for lightweight outerwear knitted products were considered. These include air permeability, tensile strength, abrasion resistance, fabric thickness, elongation at break (which characterizes shape retention), elastic recovery, and actual relative lightness indicators. The analysis of the quality evaluation diagram and histogram of double-layer knitted fabrics revealed that the most rational variants with optimal quality indicators were variants II, IV, and VI, produced from press and patterned plain structures. It was determined that variant II (13,071.2 mm²) exceeded variant I by 2,052.9 mm², i.e., by 15.8%.

Conclusion

In the production of double-layer knitted fabrics, quality indicators were improved not by modifying the knitting machine's design, but by fully utilizing its technological capabilities to alter the fabric structure. Based on the evaluation

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results, the optimal variants with lower raw material consumption and higher quality indicators were identified. The analysis and comprehensive evaluation of the parameters and physical-mechanical properties of the newly developed double-layer knitted fabric samples confirmed that variants II, IV, and VI demonstrated superior quality characteristics.

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