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EXPERIMENTAL STUDY OF THE PROPERTIES OF MATERIALS USED IN WOMEN'S CLOTHING

Abstract. The article presents the results of a study on the application of elastic polyurethane yarns in textile materials used for manufacturing garments for various purposes. The study examines the combination of polyurethane yarns with natural and synthetic fibers, as well as their role as functional components of the yarn. The methodology includes an analysis of scientific and technical literature, systematic and comparative analysis, and synthesis of experimental data. During the study, the structural characteristics of fabrics containing small amounts of polyurethane yarns embedded within the weave structure were investigated. It was established that incorporating polyurethane yarns increases fabric elasticity, improves garment shape retention, reduces wrinkling, and enhances wearing comfort. Garments made from such fabrics exhibit good body fit, resistance to deformation, and maintain their original shape during wear. The results have practical significance and can inform the design and production of modern garments with improved performance and consumer properties. Using polyurethane yarns in textiles allows for the development of garments that meet functional, comfort, and aesthetic requirements.

Keywords: textiles, fibers, physical and mechanical properties, polyurethane, performance properties.



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Introduction. Women's shoulder products have a multi-layered structure, consisting of main upper materials and lining. The composition of raw materials and the types of textile fibers are among the main factors determining the physical, mechanical, and hygienic properties of the materials, including strength, wear resistance, electrostatic behavior, color fastness to physical and mechanical impacts, and other technological properties of textile materials [1-3]. In the production of textiles for clothing, chemical fibers and yarns such as polyester, polyamide, cellulose, polyurethane, and polyacrylonitrile are widely used [1,2].

Polyester fabrics are used in all types of clothing. To create multiple textures:

- textured (volumetric) threads;
- shaped yarn (made of knots and loops), gives a voluminous and spectacular appearance;
- monothreads;
- yarn, crepe texture.

Currently, polyurethane yarns are used in combination with natural and synthetic fibers. Polyurethane (elastic) threads act as functional components of yarns. They are incorporated in small quantities and are typically concealed within the fabric structure. Garments made from fabrics containing polyurethane threads exhibit good fit, high wearing comfort, low crease formation, resistance to deformation, and shape retention [2]. To impart elasticity to the fabric and allow it to stretch and return to its original shape, it is sufficient to include 2-5% polyurethane threads in the composition.

Polyacrylonitrile fibers, due to their warming properties, are similar to wool fibers and are widely used in costume and coat fabrics. Interest in natural fibers, such as wool, cotton, and linen, has resurged because of their hygienic and aesthetic qualities. At the same time, blends of wool with Lycra or linen are recommended to improve elasticity and wear resistance [4].

Fabrics combining original yarn structures and shiny threads of various shapes are particularly suitable for elegant clothing. While functionality remains a primary requirement, a balance of harmony and elegance is essential, especially in women's classic garments. Contemporary fabrics include dense yet lightweight and voluminous materials, soft tweeds, bouclé, and other textured fabrics. Velvet jackets with varied effects, wool blends, knitted fabrics, and finished wool fabrics are increasingly popular.

High-tech fabrics and materials with elastic coatings, Teflon treatment, or membrane properties are increasingly applied in garment production [5]. New fibers and blends, such as Meryl/Lycra, allow a significant reduction in fabric thickness, making lightness and semi-transparency fashionable again [5].

For lining fabrics, viscose, cotton, and polyester fibers and their blends are commonly used. Typical weaves include simple, wedge ("Christmas tree"), jacquard, satin, or velvet, with the fabric often being soft, plush, or silky. In garment production, woven linings as well as adhesive and non-adhesive nonwoven interlinings are widely applied [6].

Leading foreign companies from Western Europe, the USA, and Japan continue to develop combined thermoregulating cushioning materials, designed to interface with polyester fiber fabrics at temperatures not exceeding 100°C and compatible with lightweight base materials [7]. These materials are intended to bond with fabrics having various coatings, such as silicone [8].

Leaky linings (durable press) are produced for garments that are dyed in their finished form, as well as for products made from fur, leather, or other materials that cannot withstand conventional processing conditions. During the development of primer materials, particular attention is paid to joint connections, layer adhesion, and the selection of appropriate adhesives [9].

Materials and methods. The aim of the study was to investigate the physical and mechanical properties of modern fabrics used in the production of women's clothing, as well as to assess their resistance to operational influences, particularly abrasion.

The objects of the study were six samples of cotton and blended fabrics (A1-A6) differing in raw material composition, surface density, weave structure, and dyeing method. The main characteristics of the investigated fabrics are presented in

Table 1. To evaluate the performance properties of the materials, standard methods were applied to determine fabric density, mass per unit area, and abrasion resistance. Abrasion tests were performed using Martindale and UTN-1 devices with 10,000 friction cycles, which simulate real wearing conditions of garments in accordance with international and national standards [10,11].

Research results and discussion. Research is being conducted in the direction of developing new types of the base of the lining material, creating new form-resistant, resistant to gluing. The use of various non-woven materials is increasing. In addition to a small mass lining and a thin thermo network, types of volumetric lining fabric with a proportion of thermoplastic fibers are offered, which makes it possible to obtain voluminous, well-packed, soft parts. The production of knitted lining materials is also expanding.

Heat-adhesive lightweight non-woven linings made from polyester melt are widely used. These linings are designed to ensure compatibility with polyester-based outer fabrics and enhance shape stability [12]. The final finishing of non-woven materials from polymer melts is carried out using a heated roller, on which a pattern in the form of a “cat’s foot” is applied using blunt rods. High-quality garments are achieved through multi-zone lining materials, where single-layer linings create zones of varying rigidity, altering the stiffness of the lining base [12].

In addition to glued single-layer materials, various composite linings have recently been developed, which, when added to a package, provide the required physical and mechanical properties. For example, Dhj (UK) developed a composite lining material that ensures shape stability for small garment details such as collars and darts. This composite material consists of two layers of thin-film material with an elastic filler in between [6]. Similarly, Grown Textile (USA) developed the Grown Slev material, consisting of two fabric layers with multiple rubber layers in between, primarily used for shoulder pads [13].

Analysis of new types of sewing materials shows that they are made from different fibers and possess diverse physical, mechanical, and aesthetic properties, significantly expanding the range of garments that meet the requirements of modern consumers [13]. Modern fabrics differ from classical fabrics in their properties; therefore, traditional design approaches and technologies are not always suitable for ensuring flexibility and maintaining structural stability in composite garments. It is thus crucial to develop design methods that preserve the utility of materials for the consumer while ensuring that garment elements retain the desired shape during use.

In this study, six cotton fabrics with wear effects and blended fabrics used in garment production were examined. Their main characteristics are presented in Table 1. According to the fabric designations, the primary threads are of colors A2 and A3, while fabric A4 is dyed only on the front side. The remaining fabrics were dyed after knitting [8].

Table 1

Physical and mechanical characteristics of the fabric

№	Fabric designation	Color	Composition	Density, thread/CM		Textile braids	Weight, g/m ²
				base	weft		
1	2	3	4	5	6	7	8
1	A1	Dark Brown	100% cotton	28	14	fleecy	339
2	A2	Dark Blue	65% cotton, 35% polyethersulfone	26	19	sheet fabric	227

Table 1 (continued)

1	2	3	4	5	6	7	8
3	A3	Dark blue	100% cotton	32	21	½ Sargia	298
4	A4	Grey	98% cotton, 2% elastin (weft)	56	24	½ Sargia	292
5	A5	Camel	43% cotton, 57% linen	20	13	sheet fabric	228
6	A6	Black gold	100% cotton	44	14	sheet fabric	293


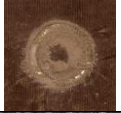






Results of experimental testing of fabric samples according to the above methods. Table 1 shows the appearance of fabric samples tested during grinding on Martindale and UTN-1 instrument.

Analysis of the data presented in Table 1 showed that fabric A1, made of 100% cotton with a pile structure, has the highest surface density (339 g/m²). This sample demonstrated the highest abrasion resistance in Martindale testing, as evidenced by the reservation of structural integrity after 10,000 friction cycles. This indicates high wear resistance and the suitability of the fabric for garments subjected to significant operational loads.

As a result of the experimental studies, it was established that the physical, mechanical, and performance properties of fabrics are largely determined by their raw material composition, weave structure, surface density, and the presence of elastic components.

Table 2

Type of material samples after grinding with Martindale instrument and UTN-1 instrument (10.000 cycles)

Fabric designation	Samples of grinding materials with Martindale(10000 cycles)	Samples of materials after friction with the Dit-2M
A1		
A2		
A3		
A4		

Fabrics A2 and A3, based on cotton and its blends with polyester fibers, showed average abrasion resistance values. At the same time, sample A2, despite having a lower surface density, demonstrated better performance compared to A3, which can be explained by the presence of chemical fibers in the composition, enhancing the strength and structural stability of the material.

Of particular interest are the results for fabric A4 containing 2% elastane. This sample is characterized by increased weft density and a twill weave, which, in

combination with the elastic component, ensures good shape retention, resistance to deformation, and satisfactory abrasion resistance. This confirms the expediency of using polyurethane yarns in fabrics for women's clothing, where comfort and shape preservation are of particular importance.

The lowest abrasion resistance indicators were recorded for fabric A5 (a cotton-linen blend). Despite its natural composition and satisfactory hygienic properties, this sample showed low resistance to abrasion due to its lower surface density and the structural characteristics of linen fibers. This limits its use in garments subjected to intensive wear.

Thus, the experimental results confirm that fabric abrasion resistance is formed under the influence of a complex set of factors and is not determined solely by increased fabric density, an optimal combination of raw material composition, weave structure, and the introduction of elastic fibers makes it possible to obtain fabrics with improved performance characteristics that meet the requirements of modern women's clothing [14].

The conducted studies demonstrated that the performance properties of fabrics for women's outer garments are formed under the influence of a combination of factors, among which raw material composition, weave structure, surface density, and the presence of elastic fibers are key. The obtained experimental data confirm the absence of a direct linear relationship between fabric surface density and abrasion resistance, which is consistent with contemporary concepts of textile material behavior during use.

Fabric A1, possessing the highest surface density, indeed demonstrated maximum wear resistance; however, samples with lower density but optimized composition and structure (A2, A4) showed comparable or more stable results. This indicates that the introduction of chemical and elastic fibers contributes to load redistribution within the fabric structure and reduces localized deformations under friction.

The results obtained for fabric A4 containing 2% elastane are of particular significance. Despite the relatively small proportion of polyurethane yarns, this sample is characterized by enhanced shape stability and the ability to maintain geometric parameters after mechanical stresses. This confirms the effectiveness of using polyurethane yarns in the amount of 2-5% to improve fabric performance properties without compromising their appearance and tactile characteristics.

The low abrasion resistance of fabric A5 (cotton-linen blend) indicates the need for cautious use of materials dominated by natural fibers in garments intended for intensive wear. Despite their high hygienic and aesthetic qualities, such fabrics require additional structural reinforcement, the use of interlining materials, or combination with more durable fibers.

The obtained results confirm the relevance of using modern high-tech materials, including composite interlinings and multi-zone lining materials, which allow targeted regulation of stiffness and stability in specific garment areas. The use of such materials ensures shape retention of women's clothing during wear and expands the possibilities of design and structural engineering.

Thus, the discussion of the results leads to the conclusion that a comprehensive approach to material selection for women's outer garments is required, based not only on fashion trends but also on an in-depth analysis of the physical, mechanical, and performance characteristics of fabrics.

Conclusion. In an experimental study, the friction resistance was evaluated for several fabrics, with the highest value observed in the thickest A1 fabric. Naturally, thicker fabrics tend to exhibit greater friction resistance; however, there

is no strict linear relationship between thickness and friction resistance. The lowest resistance was observed in the blended cotton/linen A5 fabric, despite A2 being the thinnest sample. The lower friction resistance of A5 may be attributed to its relatively low density.

The study established that the physical, mechanical, and performance properties of fabrics for women's outerwear are influenced by a combination of factors, including raw material composition, weave structure, surface density, and the presence of elastic components [14,15]. Experimental results confirm that abrasion resistance is not solely determined by fabric density but depends on the complex interaction of structural and compositional characteristics.

It was demonstrated that the inclusion of polyurethane (elastic) yarns at 2–5% of the fabric composition effectively enhances shape retention, elasticity, and wearing comfort, while maintaining satisfactory wear resistance. Even a small proportion of elastic yarn reduces residual deformations and helps preserve the geometric dimensions of garments during use.

The study also found that fabrics made from natural fibers, despite their excellent hygienic and aesthetic properties, may exhibit lower resistance to mechanical stress. This necessitates the use of additional structural and technological solutions, such as interlinings, composite materials, and the blending of natural fibers with chemical or elastic yarns.

The practical significance of this research lies in its application to the selection of textile materials and the development of structural and technological solutions for women's clothing design. A comprehensive approach to fabric analysis allows for improved garment quality and the expansion of competitive product ranges in the modern apparel industry [15,16].

In conclusion, an integrated approach to material selection and property evaluation enables the enhancement of quality in women's outer garments and broadens the range of competitive products. The findings of this study can be applied in material selection and in designing structural and technological solutions aimed at achieving a balance of functionality, comfort, and aesthetic appeal in women's clothing.

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ӘЙЕЛ КИІМІНДЕ ҚОЛДАНЫЛАТЫН МАТЕРИАЛДАРДЫҢ ҚАСИЕТТЕРІН ЭКСПЕРИМЕНТТІК ЗЕРТТЕУ

Аңдатпа. Мақалада әртүрлі мақсаттағы киім өндірісінде қолданылатын тоқыма материалдарының құрамында полиуретанды (серпімді) жіптерді қолдануды зерттеу нәтижелері келтірілген. Полиуретанды жіптердің табиғи және химиялық талшықтармен үйлесу ерекшеліктері, сондай-ақ олардың иірілген жіптің функционалды компоненттері ретіндегі рөлі қарастырылады. Зерттеудің әдіснамалық негізі ғылыми-техникалық әдебиеттерді талдау, жүйелік және салыстырмалы талдау және эксперименттік деректерді байланыстыру болды. Зерттеу барысында материалдың құрамына аз мөлшерде енгізілген және оның өрімінде жасырылған полиуретанды жіптері бар тіндердің құрылымдық

ерекшеліктері зерттелді. Полиуретанды жіптерді қолдану маталардың икемділігін арттыруға, бұйымдардың пішінге төзімділігін жақсартуға, мыжылуды азайтуға және пайдалану кезінде жоғары жайлылықты қамтамасыз етуге ықпал ететіні анықталды. Мұндай материалдардан жасалған киім тұлғаға жақсы қонымдылығымен, деформацияға төзімділігімен және пайдалану процесінде бастапқы пішінін сақтай алатындығымен ерекшеленеді. Зерттеу нәтижелері практикалық маңыздылыққа ие және пайдалану, сонымен қатар тұтыну қасиеттері жоғары заманауи киімдерді жобалау мен өндіруде қолданыла алады. Тоқыма материалдарында полиуретанды жіптерді қолдану функционалдылық, ыңғайлылық және эстетика талаптарына сәйкес келетін өнімдердің ассортиментін кеңейтуге мүмкіндік береді.

Тірек сөздер: текстиль, талшық, физика-механикалық қасиеттері, полиуретан, пайдалану қасиеттері.

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ЭКСПЕРИМЕНТАЛЬНОЕ ИССЛЕДОВАНИЕ СВОЙСТВ МАТЕРИАЛОВ ИСПОЛЬЗУЕМЫХ В ЖЕНСКОЙ ОДЕЖДЕ

Аннотация. В статье представлены результаты исследования применения полиуретановых (эластичных) нитей в составе текстильных материалов, используемых при изготовлении одежды различного назначения. Рассматриваются особенности сочетания полиуретановых нитей с натуральными и химическими волокнами, а так же их роль как функциональных составляющих пряжи. Методологической основой исследования послужили анализ научно-технической литературы, системный и сравнительный анализ, и обобщение экспериментальных данных. В процессе исследования изучены структурные особенности тканей с содержанием полиуретановых нитей, вводимых в состав материала в небольшом количестве и скрытых в его переплетении. Установлено, что использование полиуретановых нитей способствует повышению эластичности тканей, улучшению формоустойчивости изделий, снижению сминаемости и обеспечению высокой степени комфортности при эксплуатации. Отмечено, что одежда из таких материалов отличается хорошей посадкой на фигуре, устойчивостью к деформации и способностью сохранять первоначальную форму в процессе использования. Результаты исследования имеют практическую значимость и могут быть использованы при проектировании и производстве современной одежды с повышенными эксплуатационными и потребительскими свойствами. Применение полиуретановых нитей в текстильных материалах позволяет расширить ассортимент изделий, отвечающих требованиям функциональности, удобства и эстетичности.

Ключевые слова: текстиль, волокна, физико-механические свойства, полиуретан, эксплуатационные свойства.