Functionality in Women's Shirting Fabric Design: The Role of Fiber Blends and Weave Structure on Performance

Hilal Şendur[1], Özlem Tektaş Çelikkanat[1], Nursema Pala Avcı[2], Emine Dilara Koçak[2]

[1]İpekyol Giyim Sanayi Pazarlama ve Ticaret A.Ş., İstanbul, Türkiye

[2]Marmara University, Textile Engineering Department, İstanbul, Türkiye

DOI: https://doi.org/10.51244/IJRSI.2026.1306000446

Received: 07 June 2026; Accepted: 12 June 2026; Published: 17 July 2026

ABSTRACT

This study aims to investigate the effects of material and structural parameters on the performance of women's shirting fabrics through a holistic approach. Within this scope, woven fabrics were produced in plain, twill, and satin constructions using 100% cotton and various cotton/polyester blended weft yarns. The mechanical (strength, elongation), physical (drape, air permeability, pilling), and comfort (moisture transfer, thermal conductivity, and thermal resistance) properties of the produced fabrics were analyzed according to international standard test methods.

The results demonstrated that fabric construction and fiber composition are decisive factors in performance. While plain-weave fabrics offered higher strength and structural stability, satin and twill fabrics exhibited superior drape, air permeability, and moisture transfer performance. An increase in polyester content was found to enhance tensile strength, elongation, and wrinkle resistance, while diminishing moisture transfer and thermal resistance. Fabrics with a high cotton content provided better insulation due to their higher thermal resistance. Furthermore, color fastness tests indicated that overall performance improved with increasing polyester ratio. In conclusion, it was determined that twill and plain constructions containing 50–75% polyester offer the most balanced performance in terms of mechanical durability, comfort, and ease of maintenance.

This research integrates multiple performance criteria within a unified framework. The originality lies in identifying optimal polyester blend ratios across different weave types, offering a balanced performance perspective that directly supports material selection and fabric design in textile engineering applications.

Keywords: Cotton/Polyester Blend Shirting Fabric, Mechanical Properties, Thermo-Physiological Comfort

INTRODUCTION

In the contemporary era, women's apparel design is no longer governed solely by aesthetic criteria; it is shaped by multi-dimensional parameters such as user requirements, lifestyle, and time management. The increasing pace of modern urban life has significantly bolstered the demand for textile products that offer ease of maintenance, minimize the need for ironing, and provide high levels of comfort. Consequently, the relationship between garment design and the performance characteristics of the yarns and fabrics constituting the textile surface has gained paramount importance [1].

The performance characteristics of woven fabrics are dictated by fiber composition, yarn structure, yarn twist, and weave pattern parameters. These structural variables exert a direct influence on the mechanical behavior and utilitarian performance of the fabric [2]. Specifically, parameters such as the wrinkle recovery angle, drape behavior, air permeability, and moisture management are of critical importance for both user comfort and overall garment performance [3].

Studies focusing on the wrinkling behavior and mechanical performance of fabrics indicate that yarn structure and fiber properties are primary determinants of these characteristics. It is well-established that yarn structures with high elastic recovery enhance wrinkle resistance, thereby resulting in higher-performance textile surfaces [2]. Furthermore, fiber parameters (fiber length, fineness, and strength) significantly impact the surface properties and comfort behavior of the fabric [4].

The influence of the woven structure on fabric performance, encompassing the weave type and yarn fineness, serves as a decisive factor in the thermal and moisture transfer properties, as well as the tactile sensation of coolness. Additionally, it is reported that the type of weft yarn and the weave construction play a vital role in the mechanical strength and comfort properties of the fabric [5].

In recent years, functional textiles and user-oriented design approaches have necessitated the integration of textile engineering and fashion design. Fabrics must be evaluated not merely as aesthetic surfaces but as performance-oriented engineering components. Integrating fiber properties and textile parameters into the material selection process is critical for the development of functional and sustainable products [3].

Research on thermo-physiological comfort properties specifically demonstrates that chemical and functional treatments applied to the fabric surface significantly affect comfort performance. Studies conducted on shirting fabrics have reported that treatments imparting water repellency and crease resistance directly influence the heat and moisture transfer characteristics of the material [6].

In this study, the integration of textile technology and garment design was aimed at within the framework of a material-oriented design approach. Accordingly, the mechanical, physical, and comfort properties of fabrics produced with different weave structures using cotton and cotton/polyester blended weft yarns were experimentally investigated. Based on the obtained data, the relationship between fabric performance and garment design parameters was analyzed, establishing a scientific approach for the development of functional and comfort-oriented women's apparel.

Experimental Studies

Materials

The properties of the yarns used in the study are presented in Table 1, and the specifications of the fabrics produced are given in Table 2.

Table 1: Properties of the yarns used

Yarn Composition	**Cotton fiber length (mm)**	**Cotton fineness (micron aire)**	**Polyster Fiber Length (mm)**	**Yarn Count (Ne)**	**Twist (T/m)**	**Tenacity (cN/tex)**	**Elongation at break (%)**
%100 Cotton	29	3.9	–	40/1	820	17.5	4.5
%70 Cotton/ %30 PES	29	3.9	38	40/1	820	19.5	5.5
%50 Cotton / %50 PES	29	3.9	38	40/1	820	21.5	6.0
%25 Cotton / %75 PES	29	3.9	38	40/1	820	24.0	8.0

Table 2: Fabric Properties

Code	**Weave Pattern**	**Yarn Blend (Weft)**	**Fabric Weight (g/m²)**	**Warp Density (ends/cm)**	**Weft Density (ends/cm)**	**Fabric Thickness (mm)**
B1	Plain	%100 Cotton	130	33	30	0.24

B2	Plain	%50 CO / %50 PES	125	36	30	0.22
B3	Plain	%25 CO / %75 PES	120	38	32	0.20
D1	Twill	%100 Cotton	125	32	30	0.26
D2	Twill	%50 CO / %50 PES	120	34	32	0.24
D3	Twill	%25 CO / %75 PES	125	36	34	0.22
S1	Satin	%100 Cotton	120	31	28	0.26
S2	Satin	%50 CO / %50 PES	125	32	30	0.26
S3	Satin	%25 CO / %75 PES	120	36	32	0.24

Method

In this study, woven fabrics in plain, twill, and satin structures were utilized, using Ne 40/1 weft yarns composed of 100% cotton, 70% cotton/30% polyester, 50% cotton/50% polyester, and 25% cotton/75% polyester blends. The fabrics were provided by Ipekyol Giyim San. Paz. ve Tic. A.Ş. For all samples, 100% cotton Ne 40/1 was used as the warp yarn, and production parameters were kept constant. The fabric constructions were coded as B1, B2, B3 for plain weave; D1, D2, D3 for twill; and S1, S2, S3 for satin.

The mechanical properties of the fabrics, including tensile strength and elongation, were tested according to ISO 13934-1, wrinkle recovery according to ISO 2313, and pilling resistance according to ISO 12945-2 (Martindale). Air permeability measurements were conducted in accordance with ISO 9237, and drape properties were evaluated in accordance with ISO 9073-7.

Within the scope of thermal and moisture comfort properties, heat transfer and thermal resistance were analyzed according to ISO 11092, moisture absorption according to AATCC 79, and moisture management performance according to AATCC 195.

The fastness performance of the fabrics was evaluated through color fastness to washing according to ISO 105-C06, and light fastness measurements were conducted under a xenon arc lamp according to ISO 105-B02. Rubbing fastness was assessed under both dry and wet conditions following the ISO 105-X12 standard. Pilling resistance was also evaluated using the Martindale method (ISO 12945-2). Results were graded on a scale of 1–5. All samples were conditioned in accordance with ISO 139 prior to testing. Each test was performed with at least five repetitions, and the results were recorded as average values.

RESULTS AND DISCUSSION

Tensile Properties of Shirting Fabrics

The strength data indicate that fabric construction and fiber blend ratios are decisive factors in mechanical performance. Plain-weave fabrics exhibited higher tensile strength due to their high interlacing density, whereas in satin constructions, long weft floats increased fiber slippage, thereby reducing strength. An increase in polyester content led to a rise in strength values in both warp and weft directions. The higher warp strength observed across all fabrics is attributed to the higher density and tension under which warp yarns are held during weaving. Regarding shirting fabrics, plain and twill constructions containing 50–75% PES were found to be more suitable in terms of durability and utilitarian performance [7]. The tensile properties of the shirting fabrics were evaluated in both weft and warp directions (Figure 1).

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VI June 2026

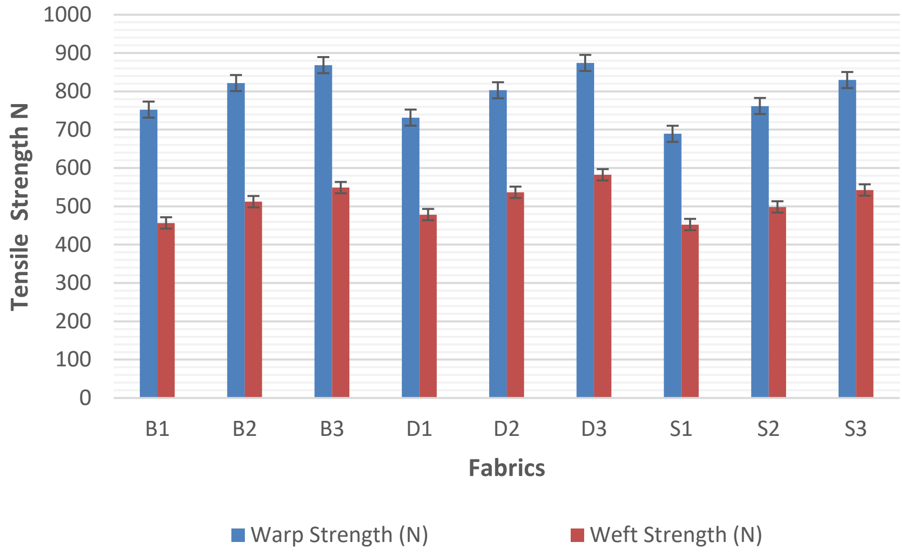


Figure 1. Tensile strength properties of fabrics

In Figure 2, elongation values vary depending on fabric construction and fiber blend ratio. Satin fabrics exhibited the highest elongation values due to long weft floats, while plain-weave fabrics showed lower elongation due to the higher number of interlacing points. Increasing the polyester ratio enhanced elongation in both directions, which is associated with the high elastic behavior of polyester fibers. The fact that warp elongation was higher than weft elongation stems from yarn placement and tension differentials. For shirting applications, twill and satin fabrics containing 50–75% PES offer better mobility [8].

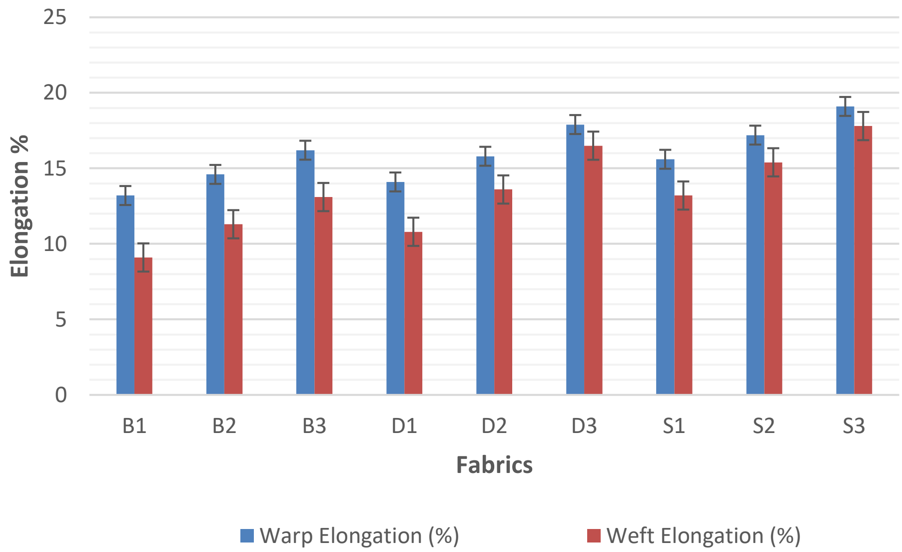


Figure 2. Elongation properties of fabrics

Wrinkle Recovery and Drape Properties

The wrinkle recovery angle results (Figure 3) are directly related to the microstructural degrees of freedom and the elastic recovery capacity of the fibers. The higher angle values obtained in satin constructions are due to the long floats, which allow internal stresses after folding to be released more easily. In plain structures, the tight interlacing points limit fiber repositioning, resulting in lower recovery angles. Regarding the blend ratio, it is observed that as the polyester content increases, the elastic recovery capacity of the structure increases, which is directly reflected in the wrinkle recovery angle. The high values obtained, especially in samples B3, D3, and S3, demonstrate how fiber-based elastic behavior manifests at the macro scale. From a shirting perspective, twill and satin constructions with medium-to-high polyester content offer advantages in ease of maintenance and shape stability, as they more effectively recover from deformations during use [9].

INTERNATIONAL JOURNAL OF RESEARCH AND SCIENTIFIC INNOVATION (IJRSI)
ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VI June 2026

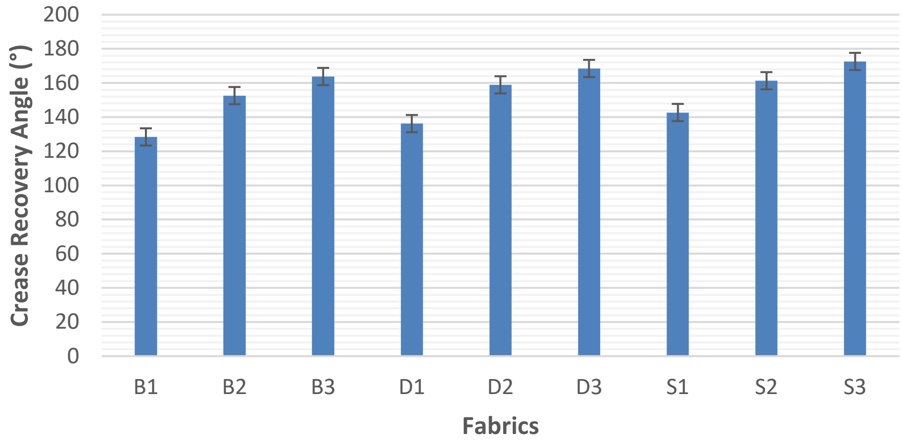


Figure 3. Wrinkle recovery angle (°) properties of fabrics

The drape coefficient results in Figure 4 show that fabric construction and fiber blend ratio are determinants of bending rigidity. Plain-weave fabrics, with a more rigid structure due to a high interlacing density, exhibited the highest drape coefficients. In satin and twill fabrics, increasing float lengths reduced bending resistance, resulting in lower drape coefficients and superior drapability. The decrease in drape coefficient with increasing polyester ratios is associated with the lower internal friction of the fibers and their higher elastic deformation capacity. For shirting fabrics, satin and twill structures with lower drape coefficients offer better form adaptation and mobility [10].

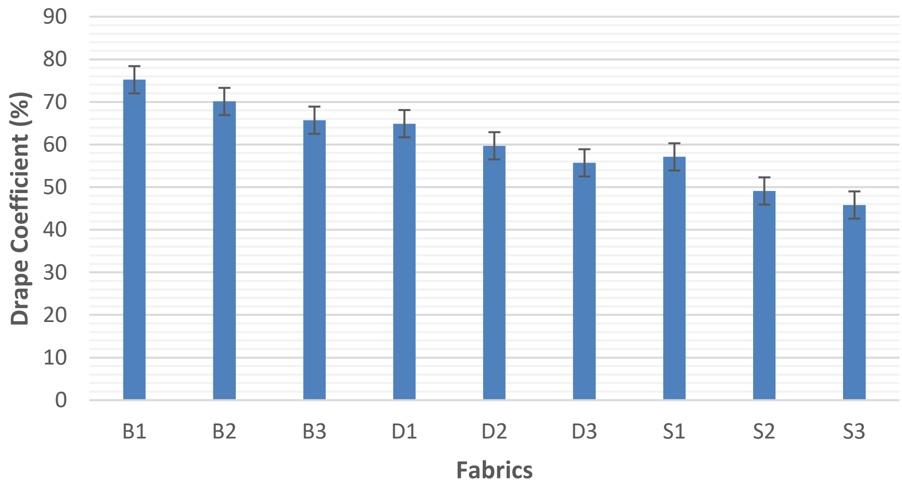


Figure 4. Drape coefficient (%) properties of fabrics

Permeability and Comfort Properties

Air permeability results (Figure 5) clearly demonstrate the impact of fabric construction and fiber blend ratio on porosity and flow resistance. The data followed the ranking of **satin> twill > plain**. Satin fabrics were determined to have the highest air permeability; the longer weft floats and lower interlacing density in these constructions lead to a more open pore structure. Conversely, the tighter interlacing in plain-weave fabrics narrows the pores, restricting air flow.

In terms of blend ratio, air permeability decreased as the polyester ratio increased. This is attributed to the smoother surface structure and the tendency toward tighter packing of polyester fibers, which reduce fabric porosity. The highest air permeability was recorded in sample S1 (337.6 mm/s), while the lowest was in B3 (214.6 mm/s). From a shirting standpoint, satin and twill fabrics with high air permeability provide better thermal comfort and breathability [11].

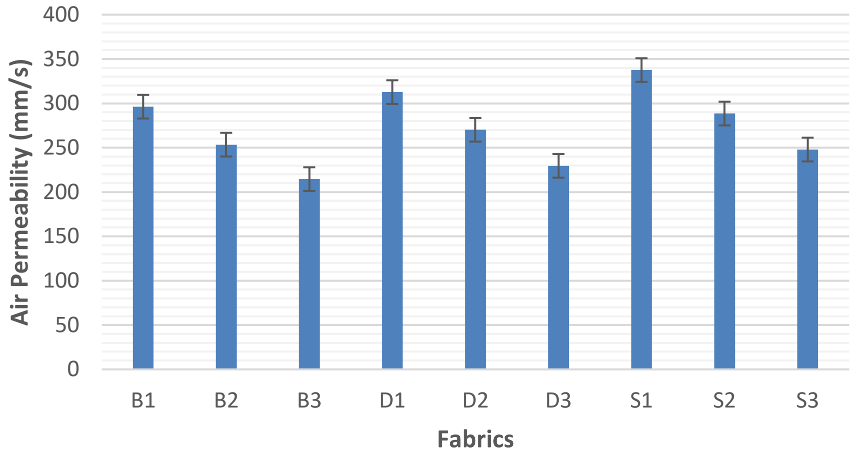
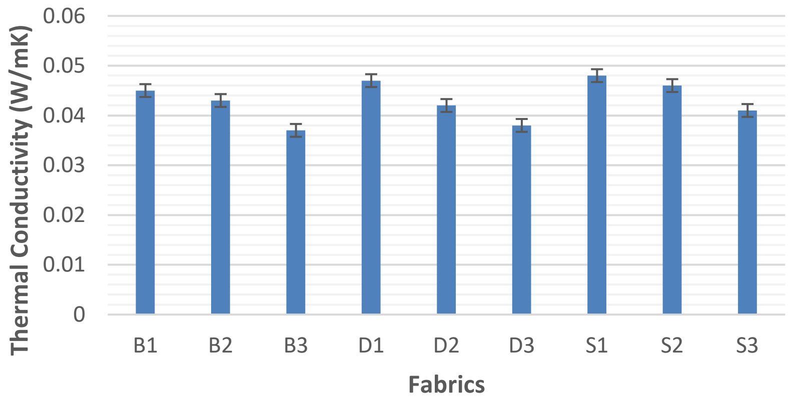


Figure 5. Air permeability properties of fabrics

The thermal properties of cotton/polyester blended woven fabrics are primarily determined by fiber composition and structural porosity (See Figure 6, Figure 7). In fabrics with high cotton content, thermal resistance increases due to higher air entrapment between fibers. Conversely, an increase in polyester content facilitates heat transfer due to a more compact structure and lower moisture regain. Regarding construction, open-structured twill and satin fabrics showed lower thermal resistance and faster heat transfer, while plain fabrics exhibited higher insulation behavior. Therefore, structures providing lower thermal resistance and balanced conductivity are more suitable for shirting, as they facilitate the rapid transfer of body heat to the environment [12].



Figures 6: Thermal conductivity of fabrics.

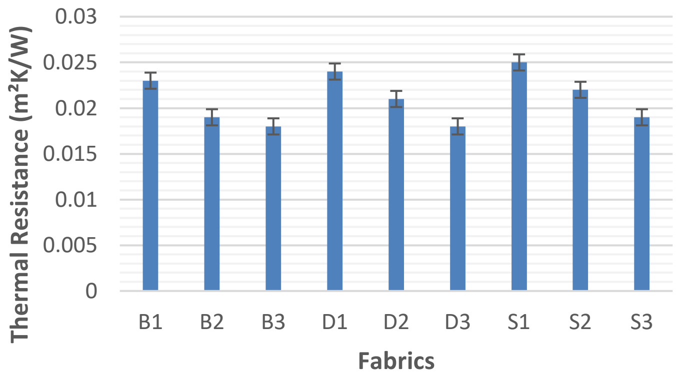


Figure 7: Thermal resistances of fabrics

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VI June 2026

The moisture transfer rate (Figure 8) is related to fabric porosity and fiber hydrophilicity. Due to their more open structure, twill and satin fabrics achieved higher moisture transfer values through increased capillary transport and vapor diffusion. In plain fabrics, high interlacing density limits moisture passage. Regarding fiber composition, the hydrophilic nature of cotton fibers enhanced moisture transfer, whereas the hydrophobic character of polyester fibers reduced it. Consequently, fabrics with higher cotton content exhibited superior moisture transfer performance [13].

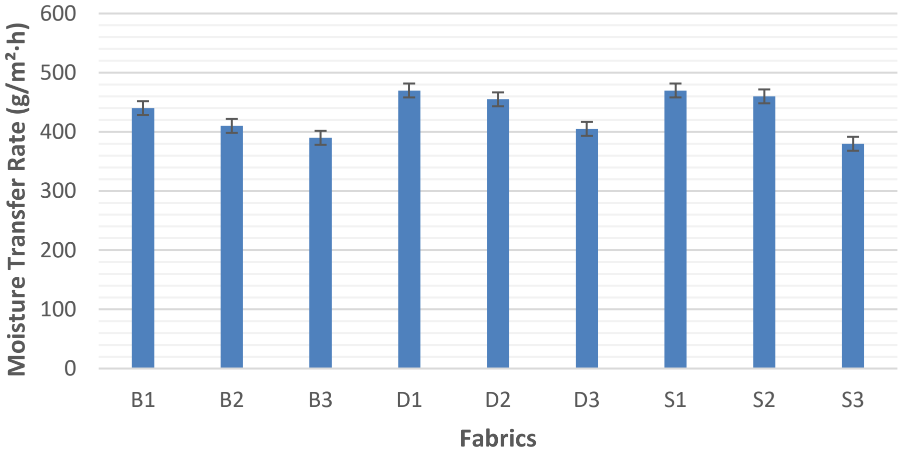


Figure 8: Moisture transfer properties of fabrics

Fastness Properties

The fastness results in Table 3 indicate that fiber composition and fabric construction are decisive for performance. The improvement in washing and light fastness with increasing polyester ratios is due to the more stable structure of polyester fibers toward dyes. The fact that dry rubbing fastness values were higher than wet values is related to dye migration from the surface. While plain and twill fabrics showed more balanced fastness performance, satin fabrics exhibited relatively lower pilling and rubbing fastness due to the prevalence of surface floats. For shirting fabrics, plain and twill structures containing 50–75% PES yielded more suitable results in terms of fastness performance.

Table 3: Fastness properties of fabrics

Code	Washing Fastness	Light Fastness	Rubbing Fastness Dry	Rubbing Fastness Wet	Pilling Resistance
B1	4	4–5	4	3–4	3
B2	4–5	5	4–5	4	4
B3	4–5	5–6	5	4–5	4–5
D1	4	4	4	3–4	3
D2	4–5	5	4–5	4	4
D3	4–5	5–6	5	4–5	4–5
S1	4	4	3–4	3	2–3
S2	4–5	5	4	3–4	3–4
S3	4–5	5–6	4–5	4	4

CONCLUSIONS

Based on the evaluation of the mechanical, performance, and comfort properties investigated in this study, the following conclusions have been drawn:

- The warp direction exhibited higher tensile strength and elongation compared to the weft direction, due to the higher tension and density levels applied during the weaving process.
- In terms of fabric construction, plain-weave fabrics provided superior tensile strength, while satin constructions offered the highest drapability.
- An increase in the polyester ratio improved tensile strength, elongation, and wrinkle recovery resistance, but decreased moisture management and thermal resistance.
- Twill and satin fabrics delivered superior comfort performance in terms of drape, air permeability, and moisture transfer.
- Fabrics with a high cotton content provided better thermal insulation, while an increase in polyester content accelerated heat transfer through the structure.
- Higher polyester content led to improved color fastness; however, pilling resistance remained lower in satin fabrics due to surface floats.

In conclusion, taking all parameters into account, twill and plain constructions containing 50–75% polyester were identified as the most suitable structures for shirting fabrics, offering an optimal balance of mechanical durability, comfort, and ease of maintenance.

REFERENCES

1. Qian, J., Li, Y., Xiang, Z., Cai, H., & Zhang, P. (2022). Effect of weave structure and yarn fineness on the coolness and thermal-wet comfort properties of woven fabric. Textile Research Journal, 92(19–20), 3782–3796. https://doi.org/10.1177/00405175221095891
2. Wang, K., Fu, C., Wang, R., Tao, G., & Xia, Z. (2021). High-resilience cotton base yarn for anti-wrinkle and durable heat-insulation fabric. Composites Part B: Engineering, 212, 108663. https://doi.org/10.1016/j.compositesb.2021.108663
3. Mazzitelli, M., Papile, F., & Del Curto, B. (2024). Materials selection and fashion design: strengthening reflections on fibre's nature in fibres and textiles selection. Discover Sustainability, 5(1), 180. https://doi.org/10.1007/s43621-024-00294-3
4. Atalie, D., & Rotich, G. K. (2020). Impact of cotton parameters on sensorial comfort of woven fabrics. Research Journal of Textile and Apparel, 24(3), 281–302. https://doi.org/10.1108/RJTA-01-2020-0004
5. Akter, N., Repon, M. R., Pranta, A. D., Islam, S., Khan, A. A., & Malik, A. (2024). Effect of cotton-polyester composite yarn on the physico-mechanical and comfort properties of woven fabric. SPE Polymers, 5(4), 557-567. https://doi.org/10.1002/pls2.10141Digital Object Identifier (DOI)
6. Dalbaşı, E. S., Çoban, S., & Özçelik Kayseri, G. (2022). Thermo-physiological comfort properties of various shirt fabrics treated with conventional and nano sized water-oil repellent and wrinkle resistant agents. The Journal of The Textile Institute, 113(6), 1104–1113. https://doi.org/10.1080/00405000.2021.1915586
7. Fiseha, K., Das, D., & Palaniswamy, N. K. (2019). Effect of blend ratio of deep-grooved polyester/cotton fibers on mechanical and comfort properties of woven fabrics. Fibers and Polymers, 20, 2215–2221. https://doi.org/10.1007/s12221-019-9124-4
8. Akhtar, K. S., Ahmad, S., Afzal, A., Anam, W., Ali, Z., & Hussain, T. (2019). Influence of yarn manufacturing techniques on physical–mechanical properties of polyester/cotton blended yarns and their woven fabrics. Journal of The Textile Institute. https://doi.org/10.1080/00405000.2019.1650545

9. Abrishami, S. H., Mousazadegan, F., & Ezazshahabi, N. (2018). Evaluating the crease recovery performance of woven fabrics considering bending behaviour in various directions. Journal of The Textile Institute. https://doi.org/10.1080/00405000.2018.1511229
10. Hu, J., & Chan, Y. F. (1998). Effect of fabric mechanical properties on drape. Textile Research Journal, 68(1), 57–64. https://doi.org/10.1177/004051759806800107
11. Ogulata, R. T., & Mavruz, S. (2010). Investigation of porosity and air permeability of woven fabrics. Fibres & Textiles in Eastern Europe, 18(5), 71–75.
12. Özdemir, H. (2017). Thermal comfort properties of clothing fabrics woven with polyester/cotton blend yarns. AUTEX Research Journal, 17(2), 135–141. https://doi.org/10.1515/aut-2016-0012
13. Ma, W., Zhang, L., Cheng, L., Psikuta, A., & Liu, Y. (2024). Investigation of the moisture transfer ability and thermal comfort properties of single-layer cotton/polyester interwoven fabrics. Textile Research Journal, 94(1–2), 166–179. https://doi.org/10.1177/004051752312014