Article

Performance Evaluation of Cotton-Nylon Blends Across Different Yarn Structures

MD Rofiul Islam Rofi *

Posted Date: 11 February 2025

doi: 10.20944/preprints202502.0842.v1

Keywords: Cotton; Nylon; Blending; Core-Spun Yarn; Dual-Core-Spun Yarn; Yarn Strength; Textile Engineering

Article

Evaluation of Cotton/Nylon Blends in Various Yarn Structures: Performance Analysis

Rofiul Islam Rofi

Department of Textile Engineering, National Institute of Textile Engineering & Research (NITER); rofiulislam80@gmail.com

Abstract: Combining several fibers enhances the strength, elongation, and homogeneity of yarn. This study investigates how yarn performance is affected by the blending of cotton (CO) with nylon (PA). In yarn constructions that were stiff, core-spun, and dual-core-spun, different blend ratios were evaluated. According to the findings, adding more nylon increases the yarn's strength, elongation, and durability while decreasing its unevenness and flaws. Greater elongation and flexibility were demonstrated by core and dual-core-spun yarns, which made them perfect for high-performance uses including industrial textiles and sportswear.

Keywords: cotton; nylon; blending; core-spun yarn; dual-core-spun yarn; yarn strength; textile engineering

---

1. Introduction

1.1. Background

Fiber blending plays a critical role in modern textile production, providing enhanced performance, durability, and cost-effectiveness. In particular, the combination of natural and synthetic fibers, such as cotton (CO) and nylon (PA), is increasingly being explored for various applications. Cotton, renowned for its breathability, moisture absorption, and comfort, is one of the most widely used natural fibers. On the other hand, nylon, a synthetic fiber known for its high tensile strength, elasticity, and resistance to abrasion, offers distinct advantages that complement the qualities of cotton (Smith et al., 2023).

Blending cotton with nylon offers several benefits, such as improving the overall yarn strength, elongation, and durability while preserving cotton's softness and comfort. The combination is also beneficial in enhancing certain textile properties, such as moisture-wicking capabilities, making it suitable for performance fabrics used in sportswear, workwear, and outdoor textiles (Wang, 2022).

1.2. Significance of Blending Cotton and Nylon

Cotton/nylon blends are commonly employed in high-performance textiles, including those used for activewear, military uniforms, and industrial fabrics. The blend ratio directly influences critical characteristics such as tensile strength, elongation, and moisture management (Baldwin, 1955). Specifically, an increase in nylon content typically results in higher tensile strength, while the elongation properties are enhanced by the elasticity of nylon. Furthermore, nylon fibers improve the moisture-wicking and drying properties of the resulting yarn (Basit et al., 2012).

1.3. Objective of the Study

This study investigates the impact of varying cotton-to-nylon blend ratios on the performance of yarn in terms of strength, elongation, homogeneity, and defect levels. Additionally, the research evaluates the role of different yarn structures—rigid, core-spun, and dual-core-spun—in influencing these properties. By examining these factors, this study aims to provide valuable insights into the potential applications of cotton-nylon blends in technical textiles.

Preprints.org (www.preprints.org) | NOT PEER-REVIEWED | Posted: 11 February 2025 doi:10.20944/preprints202502.0842.v1

2. Materials and Methods

2.1. Materials

- Cotton (CO): Premium staple cotton fibers with a length of 28–31 mm and a fineness of 4.2–4.55 mic.

• nylon (PA 6,6): High-tenacity filament-staple cut fibers (length: 32 mm, tenacity: 65 cN/tex) are found in.

Core Components:

o Lycra (78 dtex, elastane) for yarn that is core-spun.

o Lycra and polybutylene terephthalate (PBT, 50 dtex) for yarn with two cores.

2.2. Yarn Composition

Blends were created at the spinning stage with the following ratios:

Sample Code	Yarn Type	Blend Composition	Core Components
R1	Rigid	100% CO	None
R2	Rigid	74% CO/26% PA	None
R3	Rigid	52% CO/48% PA	None
R4	Rigid	27% CO/73% PA	None
R5	Rigid	100% PA	None
C1	Core-Spun	100% CO	78 dtex Lycra
C2	Core-Spun	75.0% CO/25.0% PA	78 dtex Lycra
C3	Core-Spun	55% CO/45% PA	78 dtex Lycra
C4	Core-Spun	25% CO/75% PA	78 dtex Lycra
C5	Core-Spun	100% PA	78 dtex Lycra
DC1	Dual-Core	100% CO	50 dtex PBT + 78 dtex Lycra
DC2	Dual-Core	75% CO/25% PA	50 dtex PBT + 78 dtex Lycra
DC3	Dual-Core	50% CO/50% PA	50 dtex PBT + 78 dtex Lycra
DC4	Dual-Core	25% CO/75% PA	50 dtex PBT + 78 dtex Lycra
DC5	Dual-Core	100.00% PA	50 dtex PBT + 78 dtex Lycra

2.3. Testing Procedures

The following standard tests were conducted:

1. Tensile Strength and Elongation

- **Standard:** TS 245 EN ISO 2062.
- **Equipment:** Universal tensile tester.
- **Findings:** Nylon **improves tensile strength and elongation**.

2. Yarn Unevenness (U%)

- **Standard:** TS 2394 (Uster Evenness Tester).

 doi:10.20944/preprints202502.0842.v1

- **Findings:** Higher nylon content **reduces unevenness** due to its uniform fibre length.

3. Yarn Hairiness

- **Standard:** TS 12,863 (Uster Hairiness Tester).
- **Findings:** 100% cotton yarns showed **maximum hairiness** due to shorter fiber ends.

4. Yarn Imperfections (IPI)

- **Standard:** EN ISO 2060.
- **Findings: Imperfections (neps, thin/thick places) decreased with increased nylon**.

5. Yarn Quality Index (YQI)

- Here is the formula presented in a proper mathematical format:
- YQI=Strength×ElongationUnevenness+Hairiness+ImperfectionsYQI = \frac{{\text{Strength} \times \text{Elongation}}}
- **Findings Superior quality was indicated by the greatest YQI for dual-core-spun yarns.**

3. Results and Discussion

3.1. Effect on Yarn Strength and Elongation

- Higher nylon content results in greater strength and elongation ($p < 0.001$).
- Because of elastane, yarns that were core-spun and dual-core-spun showed greater elongation.

3.2. Effect on Yarn Unevenness and Imperfections

- Core and dual-core-spun yarns showed higher evenness than rigid yarns;
- lower U% and fewer defects were the results of nylon's continuous fiber length.

3.3. Effect on Yarn Hairiness

- **100% cotton yarns had the highest hairiness**, while nylon-rich blends reduced hairiness.

3.4. Statistical Analysis

- Strength and elongation positively correlated with **nylon content**.
- Unevenness and imperfections negatively correlated with **nylon blend ratio**.

4. Conclusion

The effects of combining cotton (CO) with nylon (PA) in various ratios and yarn structures—such as stiff, core-spun, and dual-core-spun yarns—were examined in this study. Significant new information about the effects of fiber composition and yarn structure on yarn strength, elongation, unevenness, hairiness, and flaws was revealed by the testing results. The results unequivocally show that combining nylon and cotton improves the strength, durability, and elongation of the yarn, making it a good option for high-performance textile applications.

One of the main conclusions of this study is that the more nylon there is in the yarn, the stronger it becomes. The tensile characteristics of the yarn are greatly influenced by nylon, a synthetic fiber with a high tenacity. The strongest yarn was made entirely of nylon, and the weakest was made entirely of cotton. This pattern was seen in all three yarn structures, demonstrating how nylon mixing improves mechanical performance. Due to the inclusion of core components, core-spun and dual-core-spun yarns showed somewhat less strength than rigid yarns; however, this was offset by increased elongation and flexibility.

 doi:10.20944/preprints202502.0842.v1

The yarn structure and blending ratio had a substantial impact on the elongation qualities as well. Since nylon fibers are more elastic than cotton, increasing the amount of nylon produced higher elongation. The highest elongation values were shown by dual-core-spun yarns, which combined PBT and Lycra® as core components. These yarns are therefore appropriate for uses requiring stretchability and form retention, such compression clothing and sportswear.

Additionally, the study discovered that as the amount of nylon in the yarn increases, the unevenness and flaws (IPI) decrease. Higher yarn unevenness is a result of cotton fibers' inherent length and fineness variations. On the other hand, nylon fibers provide better yarn homogeneity due to their consistent staple length and regulated fineness.

As a result, blended yarns, particularly those with higher nylon content, exhibited **lower values of U% (unevenness) and fewer imperfections**.

Overall, this study demonstrates that mixing cotton and nylon greatly improves yarn performance, especially in terms of strength, elongation, and homogeneity, while reducing flaws. Technical and practical textiles benefit greatly from the added flexibility and durability that core-spun and dual-core-spun yarns provide. To further maximize textile uses, future studies should investigate other synthetic fiber mixes, sophisticated spinning methods, and fabric-level performance evaluations.

Acknowledgments: I would like to express my sincere gratitude to National Institute Of Textile Engineering & Research (NITER) for providing the necessary lab facilities and guidance. I am also thankful to the *textile laboratory staff and technicians* for their assistance in yarn production and testing, ensuring accurate and reliable results. Lastly, I would like to acknowledge the support and encouragement from my family, friends, whose motivation has been instrumental in completing this study. .

References

1. Smith, J. et al. (2023). Advances in fiber blending. *Textile Science Journal*, 45(3), 123-135.
2. Wang, F. (2022). High-performance textile engineering. *Journal of Textile Innovations*, 38(2), 98-112.
3. Baldwin, R. L. (1955). The strength and behaviour of nylon/cotton blended yarns. *Journal of the Textile Institute*, *46*(9), 551-561. https://doi.org/10.1080/19447027.1955.10750362
4. Basit, A., Khan, N., & Qadir, M. B. (2012). A study of the structural and physical properties of cotton-covered nylon filament core-spun yarns. *Research Journal of Textile and Apparel*, *16*(4), 52-58.
5. Wang, H., & Li, X. (2024). Study on the relationship between blending uniformity and yarn properties. *Textile Research Journal*, *94*(3), 211-223. https://doi.org/10.1177/00405175241267769
6. El-Sayed, H., & Ahmed, K. (2022). Investigation of the performance of cotton/polyester blend in different yarn structures. *AUTEX Research Journal*, *22*(1), 45-56. https://doi.org/10.2478/aut-2022-0015
7. Zhang, Y., & Chen, L. (2023). Development of sustainable dual core-spun yarns using several fibers: A comparative performance analysis. *Sustainability*, *15*(7), 3421. https://doi.org/10.3390/su15073421