

A STUDIO-BASED EXPLORATION OF MATERIAL INNOVATION IN HANDLOOM WEAVING

Edward Apau¹, Morrison Appiagyei Boadi², Reindolf Amponsah Monnie³,
Bright Kofi Koseme⁴

^{1 2} Sunyani Technical University, Sunyani, Ghana

^{3 4} Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

* Email correspondence: edwardapass@gmail.com

ABSTRACT

Frequent warp yarn breakages continue to reduce the efficiency of handloom weaving, especially when using traditional spun yarns like cotton and polyester. This study explores the possibility of using nylon threads as unconventional yarns for hand weaving to overcome this issue. A studio-based, practice-led experimental design was employed, using nylon threads, commonly found in non-textile applications, as both warp and weft materials to evaluate their performance under real weaving conditions. The results show that nylon's high tensile strength and abrasion resistance allowed it to function effectively as warp yarns, preventing breakages during weaving and creating tight, durable fabrics suitable for non-clothing uses such as upholstery and interior textiles. However, its slippery texture affected weft performance, necessitating modifications such as the use of open reeds and adjusted dent densities. The study demonstrates that nylon threads can be successfully adapted for handloom production as tough warp materials, providing an innovative alternative that reduces production inefficiencies. By reinterpreting a non-traditional material through studio-based experimentation, the research contributes to sustainable textile design and underlines the importance of material innovation in advancing modern handloom practices.

Keywords: Warp yarn breakages; Studio-based research; Handloom technology; Material innovation; Nylon threads

1. Introduction

Handloom weaving remains a vital yet technically demanding method of fabric production that interlaces two sets of yarns, warp and weft, under controlled tension to create woven structures (Igarashi & Mitani, 2013). The process's efficiency and fabric quality largely depend on the tensile properties of yarns, particularly their ability to withstand repeated stresses during weaving. As Gerster (2011) notes, improper tension control often results in uneven texture or thread breakages, which compromise both productivity and product quality. Traditionally, natural fibres such as cotton, wool, and silk, as well as synthetic fibres like

polyester, have served as standard weaving yarns (Parasakthibala & Monisha, 2022). However, their relatively low tensile strength and abrasion resistance under handloom conditions remain a persistent limitation (Üte, 2024).

In handloom weaving, warp threads are continuously held under high tension while the weft is manually inserted, placing greater mechanical strain on the warp (Makhmudova, 2022). This dynamic often leads to frequent yarn breakages, which disrupt production and require significant manual intervention. Badawi (2022) attributes such failures to excessive tension, friction, and cyclic stress, while Azevedo et al. (2022) highlight that warp threads, being longitudinally fixed, experience incremental tension with each weft insertion. These breakages not only prolong weaving time but also lower fabric uniformity and reduce loom efficiency.

Although industrial weaving technologies employ automated systems, such as warp-stop and weft-stop mechanisms, to minimise downtime (Choogin et al., 2013), handloom weaving continues to rely on manual detection and repair. Afriyie et al. (2021) developed a two-way visual and auditory alert system to assist weavers in locating broken yarns, yet such innovations address the symptoms rather than the material causes of yarn breakage. The persistent reliance on conventional spun yarns such as cotton and polyester, despite their limited resistance to friction and tension, remains a significant material bottleneck for handloom production.

Addressing this challenge requires exploring alternative yarn materials capable of withstanding higher tension while maintaining structural integrity and aesthetic quality. Nylon threads, commonly used in non-textile applications such as shoe repair and cordage (Zhao, 2021), offer high tensile strength, excellent abrasion resistance, and hydrophobicity (Borodin et al., 2022). These characteristics suggest their potential as durable warp yarns that can reduce breakage rates and improve weaving continuity. Yet, scholarly inquiry into nylon's adaptation for handloom weaving remains minimal, leaving a notable gap in material innovation research within textile design.

The author has conducted exploration of the adaptability of materials, durability, and aesthetic potential in weaving ((Apau, 2025), this study addresses that gap by experimentally evaluating nylon threads as unconventional yarns for

handloom weaving. Using a studio-based research approach, the study investigates their feasibility as both warp and weft yarns through practical trials and comparative observation. Specifically, it examines nylon's mechanical behaviour during warping and weaving, its limitations, and the structural qualities of fabrics produced. By recontextualising nylon threads from a non-textile to a handloom material, this research contributes to ongoing efforts in sustainable textile innovation, demonstrating how creative material adaptation can reduce production inefficiencies and enhance the durability of handwoven fabrics.

2. Methodology

This study adopted a studio-based qualitative design to investigate the feasibility of nylon threads as unconventional yarns in handloom weaving. Studio-based research enables direct material experimentation under controlled craft conditions, integrating practice and reflection as forms of inquiry (Puadi et al., 2020; Salolainen et al., 2018). Within this framework, iterative weaving trials were conducted to observe, document, and evaluate the physical and tactile behaviour of nylon threads compared with those of conventional cotton and polyester yarns.

The design combined exploratory experimentation with comparative assessment, allowing qualitative judgments to be supported by recorded observations of performance indicators such as tension response, abrasion, and breakage frequency.

2.1 Materials

This exploratory study employed an industrial nylon thread (size 9), commonly sold for shoe repair and cordage, and sourced from the local yarn market in Kumasi, Ghana, popularly known as *nkoadwosuo*. These threads were selected due to their reported high tensile strength, abrasion resistance, and hydrophobic nature (Borodin et al., 2022; Zhao, 2021). Cotton and polyester spun yarns, representing the most common fibres in handloom weaving (Parasakthibala & Monisha, 2022), were also obtained from the same market.

The nylon thread was visibly thicker and smoother than the other yarns and exhibited a noticeably slippery handle. Manufacturer data on twist and tensile strength were not available. A standard broadloom was used together with essential

weaving accessories, including a warping mill, raddle, heddling hook, reed, reed hook, bobbin winder, and shuttle. Figure 1 presents the nylon threads that served as the primary material for this study.



Figure 1. Nylon threads used as the principal experimental material

Additionally, Figure 2 exhibits the broadloom and weaving accessories used in this studio-based explorative study.



Figure 2. Broadloom and selected weaving accessories: a) reed, b) raddle, c) reed hook, d) heddling hook, e) shuttles, f) drag box, g) bobbin winder, h) warping mill, i) broadloom (Source: Author's Shot, 2025)

2.2 Experimental Procedures

All weaving activities took place in a controlled studio environment under typical indoor Ghanaian conditions. The procedures employed in the study are described step-by-step:

- a) Warp preparation. Nylon threads were warped on the warper following the conventional sequence of warping, chaining, and beaming.

- b) Loom set-up. After being wound on the warp beam, the nylon yarns were threaded through the heddles and reed dents and tied to the apron stick using consistent manual tension. For weft application, nylon threads were wound onto bobbins and tested for their suitability in weft picking.
- c) Weaving protocol. The fabric was woven by the same operational motions of shedding, picking, and a beat-up rhythm.

Nylon threads were tested in two configurations:

- a) Warp trials: Warp tension was adjusted to simulate standard weaving conditions (moderate to high tension). Each trial consisted of 2-metre warp lengths with 10–15 cm weaving samples produced to monitor end breaks, slippage, and abrasion.
- b) Weft trials: Nylon threads were wound onto bobbins and inserted manually to evaluate picking smoothness, pliability, and interaction with the warp.

For comparison, identical procedures were repeated using cotton and polyester yarns under the same loom settings. Figure 3 shows selected stages of the warp preparatory processes.

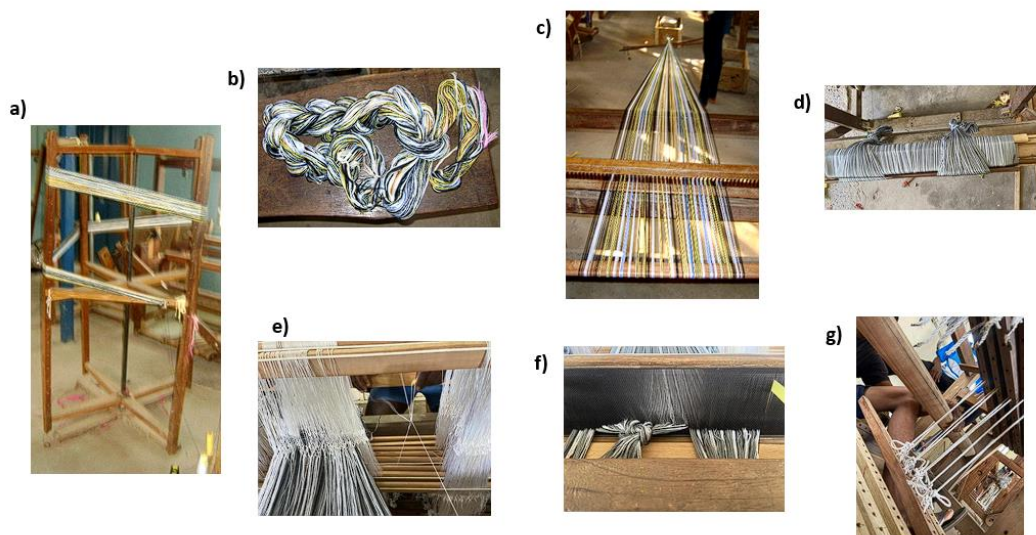


Figure 3. Warp preparation stages: a) warping, b) chaining, c) raddling, d) beaming, e) heddling, f) threading, g) tie-up (Source: Author's Shot, 2025)

2.3 Observation and Documentation

Data were collected through systematic observation sheets recording: (1) Incidences of yarn breakage per sample, (2) Points of friction on loom parts, (3)

Ease of handling during winding, denting, and beating-up, and (4) Visual and tactile responses of woven fabric surfaces.

Photographic documentation supplemented written notes for verification and later analysis. Observations were made across three replicate trials per yarn type to enhance reliability. The performance of each yarn was rated qualitatively as High, Moderate, or Low under the following criteria: (1) Tension stability, (2) Resistance to abrasion, (3) Ease of manipulation, and (4) Breakage incidence.

2.4 Data Analysis

Findings were analysed using comparative qualitative evaluation. Nylon thread performance was contrasted against cotton and polyester in tabulated summaries (presented in the Results section). Interpretations drew on both observable mechanical behaviour and the weaver's experiential feedback, aligning with the tacit-knowledge framework central to studio-based research.

3. Result and Discussion

3.1. Results

The feasibility of nylon threads as unconventional yarns for handloom weaving was evaluated under practical studio conditions. The findings reveal nylon's high tensile resilience and superior warp performance, contrasted by limitations in weft application due to surface slipperiness. The summarised performance outcomes are presented in Table 1.

3.1.1 Performance as Warp Yarns

Nylon threads demonstrated strong resistance to tensile and frictional stresses during warping, beaming, and weaving. No yarn breakages were recorded across the three experimental trials, except at knot points originating from industrial packaging. This indicates a high level of structural durability under warp tension.

However, the slippery texture of the nylon posed challenges when tying to the apron stick of the cloth beam. Achieving a firm grip required increased tension and careful manual handling to prevent slippage. Despite this, once secured, the warp yarns maintained consistent tension throughout weaving and facilitated uniform fabric formation.

3.1.2 Performance as Weft Yarns

When applied as weft, nylon threads performed less satisfactorily. Their low surface friction caused frequent sloughing off from the bobbin during picking, resulting in weaving interruptions. This limitation was resolved by substituting cotton or polyester spun yarns as wefts, which provided smoother insertion and stable interlacement with nylon warps. This adjustment highlights nylon's suitability predominantly as a warp material rather than a balanced warp–weft system.

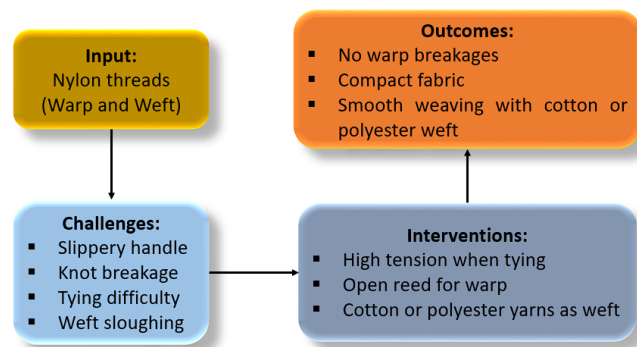


Figure 4. Summary of challenges, interventions, and outcomes in nylon thread weaving (Source: Author's Construct, 2025)

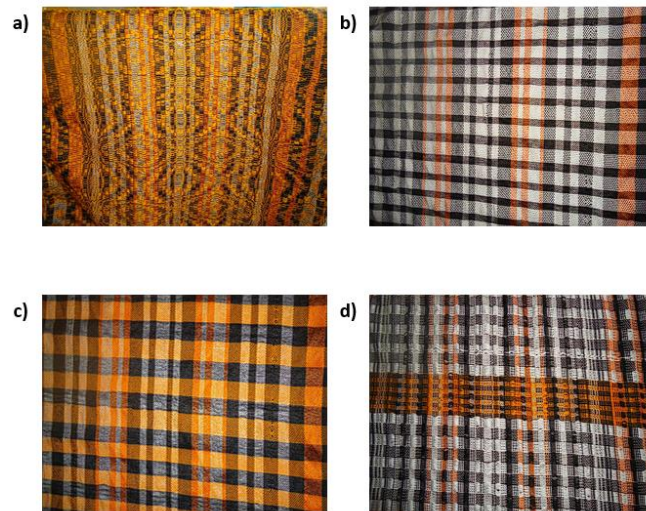


Figure 5. Woven fabric samples showing compact, dense structures obtained with nylon warps. [a) Complex twill, b) Plain weave, c) Plain weave, d) Modified plain weave] (Source: Author's Shot, 2025)

3.1.3 Weaving Adjustments and Structural Effects

The greater diameter and stiffness of nylon threads required an open reed number for smooth passage during denting. Despite these modifications, the

material produced fabrics of exceptional compactness and structural integrity. Nylon’s high abrasion resistance enabled a stronger beat-up motion without thread breakage, enhancing fabric density and stability.

Figure 4 summarises the key challenges, interventions, and outcomes identified during the experimental process, while Figure 5 presents woven samples illustrating the compact, dense structures achieved through effective beat-up.

3.1.4 Comparative Performance Evaluation

The comparative analysis across nylon, cotton, and polyester yarns confirmed nylon’s superior warp durability, moderate handling characteristics, and poor weft performance. Table 1 presents a consolidated summary based on the evaluation criteria of tension stability, abrasion resistance, ease of manipulation, and breakage incidence.

Table 1. Performance of nylon threads in handloom weaving

| Application | Observations | Outcome |
|-----------------------|---|---|
| Warp yarns | Withstood tension and strain during preparation; no breakages except at package knots | Successful - durable under warp stresses |
| Weft yarns | Sloughing off due to the slippery handle; disrupted weft picking | Unsuccessful - required substitution with cotton or polyester |
| Reeding / Threading | Thicker than conventional yarns; required open reed | Feasible - smooth passage achieved with a wider reed |
| Tying to apron stick | Slippery texture made tying difficult; needed high tension | Feasible but laborious - requires technique adjustment |
| Fabric structure | Produced compact, dense fabric with a strong beat-up | Positive - suitable for non-apparel applications |
| Application potential | High durability and density | Appropriate for upholstery and technical textiles |

Overall, the experiments demonstrate that nylon threads exhibit excellent warp performance and resilience to tension-related failures, supporting their feasibility as alternative warp materials in handloom weaving. The resulting fabrics

possess high density and mechanical strength, indicating potential for non-apparel and technical textile applications such as upholstery or table coverings. The challenges encountered, particularly nylon's slipperiness and limited weft compatibility, can be mitigated through process adaptation or blended material use.

3.2. Discussion

The results demonstrate that nylon threads possess the tensile strength and durability necessary to function effectively as warp yarns in handloom weaving. The absence of breakages, apart from those caused by pre-existing knots, confirms their ability to withstand high tension and repeated stress. This finding substantiates the claims of Borodin et al. (2022), who reported nylon's superior mechanical resilience, and directly addresses the challenges identified by Badawi (2022) and Azevedo et al. (2022) regarding warp breakages under extreme tension. The evidence thus contributes new empirical support for the use of unconventional synthetic threads in traditional weaving contexts.



Figure 6. Application of nylon-thread woven fabric as a tablecloth, illustrating its durability and suitability for non-apparel textiles (Source: Author's Shot, 2025)

The compact and firm structure of the resulting fabric also indicates nylon's compatibility with forceful beat-up motions, aligning with Üte's (2024) observation that yarns with balanced elongation and strength enhance fabric uniformity. These mechanical advantages position nylon as an attractive warp material for non-apparel applications such as upholstery, table linens, and technical textiles, where

durability, abrasion resistance, and dust repellence are essential performance qualities. The adaptation of the woven sample into a tablecloth (Figure 6) further demonstrates nylon's functional versatility and aesthetic potential in interior textile design.

In contrast, nylon's performance as a weft yarn was constrained by its low surface friction and slippery texture, which caused frequent sloughing off during weft insertion. This confirms that yarn texture and handle significantly influence shed stability and weft consistency. The need to substitute cotton or polyester wefts to restore smooth weaving supports Üte's (2024) assertion that fibre-surface interaction directly affects loom efficiency.

Additionally, nylon's greater thickness required technical adjustments, including the use of an open reed number to facilitate reeding. While such modifications enhance adaptability in handloom processes, they also reveal that unconventional yarns may necessitate customised loom configurations or auxiliary tensioning mechanisms to achieve optimal results. These practical interventions highlight both the material and procedural innovations required when integrating non-traditional yarns into established craft systems.

The findings underscore nylon's value as a complementary material rather than a complete replacement for conventional spun yarns. Its mechanical resilience effectively addresses a long-standing problem, warp breakages, while its handling challenges encourage new directions in yarn finishing, loom engineering, and hybrid yarn design.

By situating nylon within a handloom context, this study extends textile design scholarship beyond conventional fibre hierarchies, reinforcing the argument that studio-based research can generate actionable insights for material innovation. These results affirm that practice-led experimentation is a valid mode of inquiry in textile engineering, capable of translating tacit, haptic knowledge into measurable technical improvement.

It can be deduced that nylon threads offer substantial potential as durable warp materials capable of reducing yarn breakages and expanding the creative possibilities of handloom weaving. However, their successful integration requires further work in surface modification, loom calibration, and combined material

strategies. Future research should investigate nylon blends, coated filaments, or hybrid warps to balance strength with handling efficiency. Through such continued exploration, unconventional yarns like nylon can contribute meaningfully to the sustainability and modernisation of traditional weaving practices.

4. Conclusion

This study examined the feasibility of nylon threads as unconventional yarns for handloom weaving through a studio-based experimental approach. The findings demonstrate that nylon threads, owing to their high tensile strength and abrasion resistance, perform effectively as warp yarns, enduring the stresses of weaving without the frequent breakages typical of conventional spun yarns. The resulting fabrics exhibited compactness, firmness, and high structural integrity, confirming nylon's suitability for durable, non-apparel textile applications such as upholstery and interior furnishing fabrics.

However, nylon's slippery surface and thicker diameter limited its use as weft yarns and required technical adjustments, including the adoption of open reed numbers to facilitate smooth passage during reeding. These practical constraints highlight that, while nylon can enhance warp durability, it also demands adaptations in loom setup and weaving practice to optimise performance.

Overall, this research contributes to the growing discourse on material innovation in handloom weaving, demonstrating how alternative yarns can improve efficiency and expand the creative and functional scope of handwoven fabrics. The study affirms the value of studio-based experimentation as a valid mode of textile inquiry that integrates technical evaluation with design exploration. Future investigations could focus on surface treatments, yarn blending, or hybrid warp–weft systems to enhance nylon's handling properties and extend its applicability in sustainable textile production.

Building on the present findings, future research should aim to overcome the practical limitations encountered in the use of nylon threads while extending their potential in handloom weaving. Priority should be given to developing surface modification and finishing techniques that reduce slipperiness and improve yarn handling, thereby enabling effective use of nylon as both warp and weft material.

Further exploration of hybrid yarn systems, combining nylon with traditional spun fibres such as cotton or polyester, could balance tensile strength with flexibility and improve weaving efficiency. Parallel innovations in loom technology, including adaptive reed designs and advanced tension control mechanisms, may also enhance the integration of unconventional yarns into handloom processes.

Beyond nylon, comparative investigations involving recycled polyester, bio-based filaments, or other high-tenacity fibres would broaden understanding of material behaviour under similar weaving conditions. Finally, application-specific studies assessing performance in interior and technical textiles, alongside environmental evaluations within circular textile frameworks, would advance knowledge on how unconventional yarns can contribute to sustainable material innovation and the modernisation of handloom practices.

5. References

- Apau, E. (2025). An Auto-Ethnography Reflection on Weaving: A Philosophical Account of Lived Experiences. *ARTISTIC : International Journal of Creation and Innovation*, 6(2), 161-178, DOI:10.33153/artistic.v6i2.7687.
- Afriyie, A. O., Howard, E. K., Asinyo, B. K., Badoe, W., Seidu, R. K., & Apau, E. (2021). Electronic warp-break detection mechanism for manual looms. *Research Journal of Textile and Apparel*, 25(4), 361–379, DOI: 10.1108/RJTA-06-2020-0067.
- Azevedo, J. L. A., Ribeiro, R. P. P., Matos, L. M., Sousa, R., Silva, J. P., Pilastrri, A. L., & Cortez, P. (2022). Predicting Yarn Breaks in Textile Fabrics: A Machine Learning Approach. *Procedia Computer Science*, 207, 2301–2310, DOI: 10.1016/j.procs.2022.09.289.
- Badawi, S. (2022). An Analytical Study of Warp Yarns Tension during the Weaving Process. *International Design Journal*, 12(5), 179–186. DOI: 10.21608/idj.2022.260581.
- Borodin, P., Osipov, E., & Pilipchuk, D. (2022). Performance characteristics of threads made of various synthetic materials in fishing gear and aquaculture facilities. *Fisheries*, 2022(6), 79–81, DOI: 10.37663/0131-6184-2022-6-79-81.
- Choogin, V. V., Bandara, P., & Chepelyuk, E. V. (2013). *Safety devices on weaving machines* (pp. 135–144). DOI: 10.1533/9780857097859.135.
- Gerster, M. (2011). *Scrim device comprises two longitudinal edges, several crocheted warp threads parallel to longitudinal edges, several upright*

threads parallel to crochet threads and several weft threads between crochet threads and upright threads. Retrieved from: <https://www.freepatentsonline.com/DE102010015339.html>.

Igarashi, Y., & Mitani, J. (2013). Interactive card weaving design and construction. In *ACM SIGGRAPH 2013 Posters* (pp. 1-1).

Makhmudova, N. (2022). Experimental method for determining the deformation of warp threads on looms. *Eastern-European Journal of Enterprise Technologies, 1*(1), 115.

Parasakthibala, G., & Monisha, A. S. (2022). A Review on Natural Fibers; Its Properties and Application Over Synthetic Fibers. *International Journal For Science Technology And Engineering, 10*(8), 1894–1897, DOI: 10.22214/ijraset.2022.46530.

Puadi, M. F., Bin Khairani, M. Z., & Bin Othman, A. N. (2020). Studio investigation: An approach in studio-based research. *Psychology and Education, 57*(8), 1006-1011, DOI: 10.17762/TURCOMAT.V12I3.794.

Salolainen, M., Leppisaari, A. M., & Niinimäki, K. (2018). Transforming fashion expression through textile thinking. *The Artist and Journal of Home Culture, 8*(1), 3, DOI: 10.3390/ARTS8010003.

Üte, T. B. (2024). A comprehensive study on the component properties of hybrid weft yarns and their effects on denim fabric performance. *Tekstil Ve Konfeksiyon*, DOI: 10.32710/tekstilvekonfeksiyon,1469869.

Zhao, H. (2021). *Characterization and modelling of moisture influence on the behaviour of rubberized fabric thread* [Doctoral dissertation]. Technische Universität Clausthal.

Figure References

Figure 1. Nylon threads (n.d). Available at: <https://www.dreamstime.com/nylon-sewing-threads-needle-isolated-white-background-d-illustration-image219525984> (Accessed: October 20, 2025).

Figure 2. a) Reed, b) Raddle, c) Reed hook, d) Heddling hook, e) Shuttles, f) Drag box, g) Bobbin winder, h) Warping mill, i) Broadloom (2025). Textile Weaving Studio, Department of Industrial Art, Kwame Nkrumah University of Science and Technology. Authors' studio shot.

Figure 3. a) Warp milling, b) Warp chain, c) Raddling, d) Beaming, e) Heddling, f) Threading, g) Tie-up (2025). Textile Weaving Studio, Department of Industrial Art, Kwame Nkrumah University of Science and Technology. Authors' studio shot.

Figure 4. Challenges, interventions and outcomes of nylon threads in handloom weaving (2025). Authors' Construct.

Figure 5. Fabric samples woven with nylon threads, showing a compact and dense structure achieved through effective beat-up motion. [a) Weave 1: Complex twill, b) Weave 2: Plain weave, c) Weave 3: Plain weave, d) Weave 4: Modified Plain weave] (2025). Authors' studio shot.

Figure 6. Application of nylon thread-woven fabric as a tablecloth, demonstrating its suitability for durable, non-apparel textile products (2025). Authors' studio shot.

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