



AGRI MAGAZINE

(International E-Magazine for Agricultural Articles)

Volume: 02, Issue: 09 (September, 2025)

Available online at <http://www.agrimagazine.in>

© Agri Magazine, ISSN: 3048-8656

Soya Fibre: A Sustainable Approach for Textile Industry

*Sneha Gargi and Dr. Rupal Babel

Department of Apparel and Textile Science, CCAS, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

*Corresponding Author's email: gargisneha5@gmail.com

Soya fibre, derived from soybean protein, is emerging as a sustainable and innovative alternative in the textile industry. Produced from the by-product of soybean oil extraction, this eco-friendly fibre transforms agricultural waste into valuable textile material. Soya fibre combines softness, breathability, and moisture management with natural antibacterial and UV-protective properties, making it ideal for skin-friendly applications like intimate apparel, baby clothing, and activewear. Its biodegradability further enhances its environmental appeal, positioning it as a responsible choice in sustainable fashion. Despite challenges such as lower tensile strength and higher production costs compared to conventional fibres, ongoing research and development are expanding its commercial potential. With growing global emphasis on environmentally conscious materials, soya fibre represents a promising solution for future textile manufacturing, contributing to reduced environmental impact and supporting circular economy practices.

Keywords: Eco-friendly fibre, Sustainable fashion

Introduction

The global textile industry is undergoing a significant transformation as sustainability and environmental responsibility become key priorities for manufacturers and consumers alike. At the end of the twentieth century, there was a growing attention on eco-friendly natural-based sustainable biodegradable fibers due to ecological concerns, which leads to the awakening of promising soybean protein fiber.

Soya fibre, commonly referred to as soy protein fibre (SPF), is emerging as a promising sustainable alternative in the textile sector. Derived from the residue of soybean oil extraction, soya fibre embodies the concept of waste-to-wealth, transforming agricultural by-products into a valuable raw material. The first attempts to produce textile fibres from soybean protein were carried out during the mid-twentieth century. Recent technical performance enhancement of soybean protein fiber via genetic-engineering techniques extends the commercial scope of this fibre. Therefore, in the 2000s, new soybean protein fiber, made from soybean protein and polyvinyl alcohol, was developed and a new soybean fibres' production process commercially promoted, standardized and launched to the textile markets. Soybean protein fiber is under the classification of Azlon group and it is also known as "vegetable cashmere," "artificial cashmere," and "soy silk" due to its cashmere feel. The natural color of soybean protein fibres is pale yellow or cream.

Production Process of Soybean Fibre

1) Raw Material Preparation:

- **Source:** Defatted soybean cake, which is a by-product after oil extraction from soybeans, is used as the raw material.
- **Cleaning & Grinding:** The soybean cake is cleaned to remove impurities and then finely ground to facilitate protein extraction.

2) Protein Extraction:

- The ground soybean material undergoes a **protein extraction** process using an alkaline solution.
- Soy proteins (mainly soy protein isolate) are dissolved, separating them from non-protein components.

3) Filtration and Purification:

- The extracted protein solution is filtered to remove insoluble residues.
- The solution is then purified to remove excess alkali and other impurities.

4) Wet Spinning Process:

- The purified soy protein solution is pushed through spinnerets (tiny holes) in a process similar to synthetic fibre spinning.
- As the solution is extruded into a coagulation bath containing acidic or saline solutions, it solidifies into long continuous filaments.
- This **wet spinning** method helps form fibres with the desired physical structure.

5) Fibre Stabilization:

- The formed filaments are chemically treated (often with aldehydes or cross-linking agents) to stabilize the protein structure.
- This step improves **fibre strength, water resistance, and durability**.

6) Washing and Drying:

- The stabilized fibres are thoroughly washed to remove residual chemicals and by-products from the spinning process.
- The fibres are then dried under controlled conditions.

7) Drawing and Cutting:

- The dried fibres are stretched (drawn) to align the molecular chains, which enhances the **tensile strength** and elasticity.
- The continuous filaments are then **cut into staple fibres** or kept as filaments, depending on the intended end-use.

8) Finishing:

- Optional treatments, such as softening agents, antimicrobial finishes, or UV protective coatings, can be applied.
- The finished fibres are baled and prepared for spinning into yarns or blending with other fibres.



Source: <https://sewport.com/fabrics-directory/soy-fabric>

Properties of Soya Fibre

1) Physical Properties:

- **Softness:** Soya fibre is extremely soft, often called "vegetable cashmere."
- **Lustre:** Natural silk-like shine and elegant appearance.
- **Lightweight:** Soya fibres produce lightweight fabrics suitable for comfort wear.
- **Moisture Absorption:** Good moisture-wicking properties help keep the skin dry and comfortable.
- **Thermal Retention:** Offers moderate thermal insulation, suitable for both warm and cool conditions.
- **Elasticity:** Moderate elasticity; fibres can stretch slightly without permanent deformation.
- **Drape:** Excellent drape due to its smooth surface and fine fibre structure.

2) Chemical Properties:

- **Protein-Based Structure:** Composed mainly of soy protein isolates, containing amino acids.
- **Biodegradability:** Completely biodegradable, decomposes naturally without releasing harmful substances.
- **UV Resistance:** Offers natural ultraviolet protection, useful for outdoor clothing.
- **Antibacterial Properties:** Possesses inherent antibacterial and anti-odour qualities due to the protein content.
- **Dye Affinity:** Good dyeing properties, especially with acid and reactive dyes, allowing vibrant and long-lasting colours.

3) Mechanical Properties:

- **Tensile Strength:** Lower than synthetic fibres like polyester; often blended for strength enhancement.
- **Pilling Resistance:** Low tendency to pill, contributing to fabric longevity.
- **Wrinkle Resistance:** Moderate; wrinkles less than cotton but more than synthetic fibres.
- **Blending Capability:** Blends well with cotton, wool, silk, and synthetic fibres for enhanced strength and texture.

4) Functional Properties:

- **Skin-Friendly:** Hypoallergenic, suitable for sensitive skin.
- **Breathability:** Allows air circulation, enhancing comfort in warm conditions.
- **Eco-Friendly Production:** Uses agricultural waste (defatted soybean cake) as raw material.
- **Sustainability:** Reduces reliance on petroleum-based fibres and animal-based textiles.
- **Comfort:** Combines moisture control, softness, and antibacterial properties for superior wear comfort.

Applications

Soya fibre is characterized by a range of desirable physical and functional properties that make it suitable for various textile applications. In addition to its tactile appeal, soya fibre demonstrates excellent breathability and moisture absorption, allowing fabrics to regulate body temperature effectively. Another notable feature of soya fibre is its natural antibacterial and hypoallergenic properties, attributed to amino acids present in soy proteins, making it ideal for sensitive skin and hygiene-focused textiles.

- **Apparel:** Activewear, undergarments, T-shirts, baby clothing, and luxury garments.
- **Home Textiles:** Bed linen, curtains, upholstery.
- **Medical Textiles:** Due to its hypoallergenic properties.
- **Blended Fabrics:** Often blended with cotton, wool, or synthetic fibres to enhance durability and texture.

Soya Fibre and Sustainability

One of the key environmental benefits of soya fibre is its biodegradability. soya fibre decomposes naturally within months under composting conditions, leaving no harmful residues. This property significantly reduces the fibre's environmental footprint at the end of its lifecycle. Furthermore, soya fibre provides inherent UV protection, offering added functional benefits to clothing, especially outdoor wear. Thermally, it maintains good insulation properties, which can be enhanced when blended with other fibres.

Challenges

Despite its many advantages, soya fibre has yet to achieve widespread commercial adoption, primarily due to certain limitations. The cost of production remains relatively higher compared to conventional natural fibres such as cotton or synthetic alternatives like polyester. This is partly due to the specialized processing required to extract and spin soy proteins into usable filaments. Additionally, although the fibre offers good moisture management and softness, its tensile strength is lower than that of many synthetic fibres, which can restrict its

use in heavy-duty or high-performance applications. Manufacturers are working to overcome these challenges by improving processing technologies and developing fibre blends that enhance the strength and durability of soya-based fabrics without compromising their sustainability credentials.

Conclusion

Soya fibre exemplifies a sustainable innovation for the textile industry, blending ecological responsibility with functional performance. Its transformation from soybean agricultural waste to luxurious, skin-friendly fabric represents a forward-thinking approach to material sourcing. While commercial scalability and production efficiency remain areas for development, the environmental benefits, consumer appeal, and versatile applications of soya fibre establish it as a valuable contender in the future of sustainable textiles. As global focus intensifies on reducing the environmental impact of the textile industry, soya fibre's potential as an eco-friendly, biodegradable, and functional material should be further explored and promoted for responsible and innovative textile solutions.

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