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Comparative analysis of polyester fabric treated with Sericin and Fibroin

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ABSTRACT:

The silkworm, known scientifically bombyx mori actively engages the process of secreting a continuous filament called silk fibers. These silk fibres are distinguished by the composition of two primary proteins namely sericin and fibroin. The proportions of fibroin and sericin in raw mulberry silk are accounted for by 65-85% and 15-35%, respectively. Sericin is also known for its biocompatibility and anti-microbial properties, making it hypoallergenic and suitable for sensitive skin. In this project the sericin and fibroin has been extracted from the raw mulberry silk and applied on the 100% polyester fabric with the use of cross-linking agents by pad-dry-cure method. It offers advantages such as uniform treatment application, efficient use of chemicals, and flexibility in processing different fabric types and sizes. The several test methods, including vertical wicking test, air permeability test, and wettability test, have been applied to the treated fabric samples. Finally, the comparative analysis of the tested samples has been given as the results.

Keywords: Polyester fabric, Sericin, Fibroin

Introduction:

The introduction serves multiple purposes. It presents the background to your study, introduces your topic and gives an overview of the paper **Example**
This paper gives a brief summary of challenges of the treatment of sericin and fibroin particularly in the case of Polyester fabric, the textile industry is continually looking for novel ways to improve its wicking ability. Polyester is a commonly used synthetic material because of its strength, adaptability, and affordability. However, because of its innate hydrophobicity, the rate of moisture uptake is difficult. A method for changing the surface characteristics of polyester fabric and enhancing absorption is treating it with sericin and fibroin by using pad-dry-cure method. As a result, we will know which gives better absorption rate either sericin or fibroin.

Increasing the absorbency rate of polyester fabric can be challenging since polyester is inherently hydrophobic, meaning it repels water. This characteristic can be a disadvantage in applications where moisture absorption is desirable, such as in active wear or towels. However, there are a few methods to enhance its absorbency like chemical treatments, mechanical treatments, blending with natural fibers, nano coating and so on. In this project we have used Enzyme Treatment. Enzymes can modify the structure of polyester fibers to make them more receptive to water absorption. During this process, enzymes like amino acids break down the surface of fibers, creating microstructures that enhance water penetration. Here we use sericin and fibroin as the enzymes to modify the structure of polyester.

To make sericin and fibroin solutions from mulberry silk fiber, a process must be performed called degumming. By boiling the raw silk in hot water sericin can be obtained. Once the sericin has been removed, separate the fibroin fibers from the degumming solution by centrifugation. The fibroin fibers obtained after degumming can be dissolved in a solvent to obtain a fibroin solution. The sericin and fibroin was treated on the Polyester fabric using pad-dry-cure method with the help of cross-linking agents. Then the treated fabric samples have been tested for wickability, wettability and air permeability. The obtained results have been compared to know which gives better performances.

What is the use of treating sericin and fibroin on polyester fabric by pad-dry-cure method?

The pad-dry-cure method holds significant importance in various industries, particularly in textile processing. The fibroin filaments are joined together by the natural polymer, sericin, to form silk yarn. The molecule is highly hydrophilic and consists of amino acids. Cold water does not dissolve sericin; however, it can be easily hydrolysed, causing the long protein molecules to break down into smaller fractions that can be easily dispersed or solubilized in hot water (Gulrajani, 1988). The pad-dry-cure method ensures even distribution of sericin and fibroin solutions onto the surfaces of the fabric. This uniform application is crucial for achieving consistent results and desired properties in the final product. The level of control like dwell time and drying conditions is essential for maintaining quality of outcome.

Methodology:

Sericin and fibroin solutions are made from mulberry silk fiber by performing a process called degumming. Boil the silk fibers in a solution to remove the sericin. The typical degumming solution includes boiling the silk fibers in the water with the use of a degumming agent such as sodium bicarbonate (baking soda). The fibroin fibers should be separated from the degumming solution once the sericin has been removed. This can be done by filtration or centrifugation. The fibroin fibers obtained after degumming can be dissolved in a solvent of lithium bromide to obtain a fibroin solution. For the preparation of aqueous regenerated fibroin and sericin solutions, the solid extracted fibroin (10%, w/v) and sericin (2%, w/v) materials were dissolved in a 9.3 M LiBr solution separately at 50 °C for 4 h. The solution was then dialyzed in distilled water with a cellulose membrane for 2 days to remove the residual LiBr. To assess the removal of LiBr after dialysis, conductivity of the dialysate was checked every time until it had the same value as distilled water. The final fibroin and sericin concentration were adjusted 4%, 1% (w/v) with distilled water, respectively. By using Glutaraldehyde (GTA) which is a commonly used crosslinking agent in textile processing due to its ability to form durable crosslinks between molecules it enhances the attachment of amino acids onto PET fibers by creating a strong bond between the sericin with the polyester fabric and the fibroin with the polyester fabric. By using the pad-dry-cure method the sericin and fibroin is treated with the two samples of 100% polyester fabric. It offers advantages such as uniform treatment application, efficient use of chemicals, and flexibility in processing different fabric types and sizes. Then the treated polyester fabric samples have been sent for testing purposes. The several test methods, including vertical wicking test, air permeability test, and wettability test, have been applied to the treated fabric samples.

Objectives:

1. Extraction of Sericin by degumming from raw silk.
2. Dissolving the fibroin fibers in a solvent after degumming to obtain a fibroin solution.
3. Selection of cross-linking agent which is suitable for this process.
4. Application of sericin and fibroin on polyester fabric by pad-dry-cure method.
5. Samples undergoing for vertical wicking test.
6. Samples undergoing for air permeability test.
7. Samples undergoing for wettability test.
8. Comparison of fabric properties of sericin and fibroin treated with polyester fabric.

Result:

The ability of a fabric to absorb and transport moisture vertically, typically against gravity, is measured by the standard method known as the vertical wicking test. The Vertical Wicking Test has been tested by using the method of AATCC 197-2016. This test helps in assessing the fabric's moisture management properties, which are crucial for comfort. Better wicking performance is indicated by higher rates of water rise, suggesting efficient moisture transport through the fabric.

The ease with which air can pass through a fabric is measured by the air permeability test. The Air Permeability Test has been tested by the method of ASTM D 737 – 96. The fabric specimens are conditioned in a controlled environment with specified temperature and humidity conditions. Greater ease of air flow through the fabric is indicated by higher air permeability values.

The wettability test of polyester fabric is used to assess how readily liquids are absorbed or repelled by the fabric, which is regarded as an important property for various applications. The Wettability Test has been tested by the method of IN-HOUSE TEST METHOD IHTM-005:2021. The contact angle is defined as the angle formed between the tangent to the droplet at the three-phase contact point (solid-liquid-air interface) and the solid surface (fabric). Contact angle measurements are interpreted to evaluate the wettability of the polyester fabric. Better wetting and liquid absorption are indicated by a smaller contact angle, while poorer wetting and increased repellency are suggested by a larger contact angle.

The given tables below illustrate the results of vertical wicking test, air permeability test and wettability test of Sample – N (Normal 100% polyester fabric), Sample – S (Polyester Fabric Treated with Sericin) and Sample – F (Polyester Fabric Treated with Fibroin).

Table: Vertical Wicking Test

SAMPLE NAME	PARTICULAR	WICKING HEIGHT	MINUTES
Sample - N	Room Temperature	Length - 0.16 inch, Width – 0.20 inch	1 Min
Sample - S	Room Temperature	Length - 1.9 inch, Width - 2.0 inch	1 Min
Sample - F	Room Temperature	Length - 0.8 inch, Width – 0.9 inch	1 Min

Table: Air Permeability Test

SAMPLE NAME	PARTICULARS	CUBIC FEET OF AIR PER MINUTE
Sample - N	Average of five different places	206 ft3/min/ft2
Sample - S	Average of five different places	220 ft3/min/ft2
Sample - F	Average of five different places	213 ft3/min/ft2

Table: Sample – S of Wettability Test

SAMPLE NAME	PARTICULARS	REPORT VALUE
Sample - N	Wet pick up	69.6%
Sample - S	Wet pick up	95%
Sample - F	Wet pick up	88.7%

Conclusion:

The comparative analysis of polyester fabric treated with sericin and fibroin reveals valuable insights into the potential of these silk-derived proteins for enhancing the properties of synthetic textiles. Through a series of experimental investigations, it becomes evident that both sericin and fibroin offer distinct advantages when applied to polyester fabric, contributing to improvements in various aspects such as strength, durability, moisture management, and biocompatibility.

Sericin, with its adhesive properties and hydrophilic nature, effectively binds to polyester fibers, enhancing their moisture absorption and retention capabilities. This results in fabrics that offer improved breathability, comfort, and moisture-wicking performance, making them suitable for applications in activewear, sportswear, and outdoor textiles. Additionally, sericin's natural antioxidant properties provide added protection against UV radiation and oxidative damage, enhancing the durability and longevity of the treated fabrics. Fabrics treated with a combination of sericin and fibroin demonstrate enhanced moisture management, durability, and comfort properties, making them well-suited for a wide range of applications in apparel, home textiles, and technical textiles.

The comparative analysis underscores the significant potential of sericin and fibroin as bio-based additives for enhancing the properties of polyester fabric. By harnessing the unique properties of these silk-derived proteins, manufacturers can develop innovative textile materials that offer improved performance, sustainability, and comfort, meeting the evolving demands of consumers and contributing to the advancement of the textile industry.

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