

# DEVELOPMENT OF NANO SERICIN PARTICLES FOR IMPROVING TEXTILE PERFORMANCE

## Abstract

The abstract discusses the potential uses and benefits of sericin, a protein produced by the silkworm *Bombyx mori*. It highlights how degumming, a process used in the textile industry to remove sericin from the cocoon, has led to the waste of a valuable biomaterial. The abstract goes on to explain the properties of sericin, including its antimicrobial, UV resistance, and moisture absorption qualities, and how it can be extracted using various techniques. The abstract concludes by discussing the use of sericin in the production of nanoparticles and as a capping agent for silver nanoparticles, which has resulted in its recognition as a biomaterial with significant potential for various applications.

**Keywords:** Sericin, Textile industry, cocoon.

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## I. INTRODUCTION

Sericin is a protein that is generated by the silkworm, *Bombyx mori*, and is an important component of silk fibres. The process of degumming is used to treat the cocoon and remove most of the sericin to leave the silk fibres soft and glossy. Recent research has shown that sericin has several beneficial properties, including antimicrobial and UV resistance, moisture absorption, and ease of dissolution in hot water. Sericin can be extracted from degumming wastewater and transformed into nanoparticles for a variety of uses, such as an antimicrobial agent and a finishing agent for natural and synthetic fibres in the textile industry. The production of sericin powders involves a number of processes, including desolation, coacervation, emulsification, and electrospray drying.<sup>[1]</sup>

A different type of silk protein called sericin has 18 amino acids and is distinguished by having 32% serine. Sericin comprises 45.8% of all hydroxy amino acids that are known to exist. There are three types of sericin: sericin A, sericin B, and sericin C. Sericin A is the outermost layer, followed by Sericin B and Sericin C, which are the deepest layers. The method of extraction affects how sericin behaves in terms of its biochemical and biophysical properties. Several techniques can be used to extract sericin, such as hot water, acidic solutions, citric acid solution, and degumming, with the latter being the most frequently used in industries. The degumming method employing soap and alkali is particularly effective in entirely removing sericin from fibroin. However, using the soap and alkali approach is not important because it is difficult to separate soap and alkali from sericin.

Previously, silk sericin was considered a waste product of the apparel industry, but recent studies have discovered some of its crucial biological characteristics. Sericin has significant and well-known antibacterial, anti-inflammatory, and regenerative properties, making it a biomaterial with the potential for widespread application in many other disciplines. Sericin is easily recovered from silkworm cocoons and has been successfully employed as a capping agent during the manufacture of nanoparticles.<sup>[2]</sup> The nanoparticles are somewhat stabilised and efficiently kept from coagulating by sericin in an aqueous media. Additionally, when applied to silk fabric, the sericin-capped silver nanoparticles provide antibacterial qualities. Sericin creates unstable nanoparticles in an aqueous solution, requiring the use of crosslinking agents or the blending of other stabiliser polymers.

Around the world, a variety of natural biomaterials, such as proteins, polysaccharides, lipids, and resins, separately or in combination, are frequently used as edible coating materials. However, they can be expensive and not economically viable. Using low-cost, sustainable resources is crucial to make them safe and cost-effective. For this reason, the use of readily available sericin as an edible coating material is gaining interest. Sericin coatings can provide a protective barrier against moisture, oxygen, and other external factors, increasing the shelf life of food products. Furthermore, sericin coatings have excellent biocompatibility and biodegradability, making them a sustainable and environmentally friendly alternative to synthetic coatings.

## II. MATERIALS AND METHODS

- 1. Materials:** The materials required for the cross-linking of sericin in various ways include several reagents and polymers. For the cross-linking using aldehydes, the required materials include DMU, glycerol, PEG-DE 600, glutaraldehyde, and genipin, along with

gelatin, PVP, and guar gum as the polymers. The recommended amount of DMU is 0.4 g/g sericin. For sericin-acrylamide cross-linking, the required materials include acrylamide, potassium persulfate, and methylene bisacrylamide, along with glutaraldehyde for the final polymerization step.<sup>[3]</sup> Cross-linking of sericin with several polymers, including gelatin, guar gum, and polyvinylpyrrolidone, requires sericin solution and the respective polymer solutions in varying amounts, along with glutaraldehyde for the final polymerization step. These materials are used to perform drug release tests on tablet dosage forms containing various cross-linked sericin for potential biomedical applications.

## 2. Methods

- **Selection of Silkworm:** This sub-topic includes the selection of silkworms for sericin extraction based on the quality and quantity of the sericin produced, the cost, and the availability of silkworms. Factors affecting the sericin content and quality of cocoons, such as feeding conditions, environmental factors, and genetics, are also considered.
- **Sericin Extraction from Silk:** This sub-topic includes the method of sericin extraction from mulberry cocoon samples, which involves boiling the cocoons using HTHP beakers for about 1 hour, collecting the sericin solution, filtering it, and storing it in a refrigerator.
- **Centrifuge:** This sub-topic explains the common method used to separate sericin from silk fibers, which involves cutting the boiled cocoons into small pieces and subjecting them to centrifugation.
- **Pre-filtration and Ultra Filtration:** This sub-topic explains the methods of purifying sericin after extraction using pre-filtration and ultrafiltration. Pre-filtration involves passing the sericin solution through a filter to remove any large particles or debris, while ultrafiltration separates and purifies sericin based on its molecular weight.
- **Spray Drying:** This sub-topic explains the method of producing sericin powder from sericin solution using spray drying, which is a highly efficient and effective method for producing a dry, powder form of sericin.
- **Selection of Fabric Polyester:** This sub-topic includes the selection of polyester as the fabric for sericin coating based on its physical and chemical characteristics, such as being hydrophobic, water-resistant, strong, resilient, cost-effective, and resistant to wrinkles, stretching, and shrinking.<sup>[4]</sup>
- **Application of Sericin on Polyester:** This sub-topic explains the method of applying sericin on polyester fabric by pre-treating the fabric with NaOH, padding it with the sericin solution, coupled with glutaraldehyde, magnesium chloride, and acetic acid, hanging it for drying and cure, cleaning, drying, and conditioning it for performance testing.
- **Pre-Treatment of Polyester with NaOH:** The polyester fabric was treated with 15% NaOH at 60°C for 30 minutes to achieve a weight loss of 5%. This treatment was intended to provide sufficient hydroxyl and carboxyl end groups for subsequent treatment.
- **Padding Treatment with Sericin:** The pre-treated polyester fabric was padded with a sericin solution (20 g/l) coupled with glutaraldehyde (1% v/v), magnesium chloride (1% w/v), and acetic acid (0.1% v/v). The cushioned fabric was hung for drying and curing.

- **Performance Testing:** The treated samples were cleaned and dried before being subjected to various performance tests. The antistatic property of the cloth was determined using a Static Honest meter in accordance with Japanese Standard JIS L 1094: 1997. The moisture content of the completed samples was determined using Sartorius Moisture Analyzer.
- **Wetting Time:** The time it took for the fabric to absorb an 18 L water droplet was measured using a stopwatch. The average wetting time was estimated after taking measurements on four distinct sections of the fabric.
- **Wicking Time:** The time it took for water to rise (20 mm) between three datum lines on a rectangular polyester sample (100 mm x 20 mm) was recorded as vertical wicking time.
- **Dyeing:** The untreated and sericin-treated polyester samples were dyed with acid dyes in the same way that silk is dyed with acid dyes. The dye solutions were prepared with acetic acid and sodium sulfate to prevent rushing of the dyes to the surface. The material was then entered into the dye bath, dyed at 80°C for 1 hour, and removed, rinsed, and dried.
- **Washing of dyed samples:** The colored samples were tested for washing fastness with 2 gpl non-ionic detergents at 60°C for 20 minutes (as per ISO 3 Standard).
- **Measurement of color parameters:** The color value (K/S values) and other color parameters such as L\*, a\*, b\*, C\* and h° were measured in Premier Color Scan Spectrophotometer.<sup>[5]</sup>
- **Redyeing Studies with Acid Dyes:** The stability of sericin on the polyester can be confirmed by dyeing the sericin-treated samples before and after washing together with acid dyes and comparing the shade with a computer color matching system. The color value (K/S values) and other color parameters such as L\*, a\*, b\*, C\* and h° can be compared subjectively.<sup>[6]</sup>

### III.RESULT AND DISCUSSION

1. **Fabric Thickness:** The fabric thickness of treated and untreated fabric is determined using 5 inch diameter sample. The Fabric Thickness is measured in mm(millimetre) of the sample before and after the process. The fabric thickness test is given in the table 1. It is clear from the above Table 1 the thickness values before and after the treatment or process are the same for each sample, it is likely that the treatment did not have a significant effect on the thickness of the samples.
2. **Fabric Weight:** The Fabric weight of treated and untreated sample is determined using the 5 inch diameter sample. The sample result is given in the table 2.From the table 2 it is reported that the sample PT001 had a fabric weight of 131.4gsm before the treatment, and a weight of 132.6 gsm after the treatment. The same can be observed for the other samples in the table and resulted in an increase in weight.
3. **Abrasion:** The abrasion is measured as the percentage of weight loss of the sample before and after the process. The table 3 shows that all five samples have experienced some degree of abrasion, The abrasion of fabrics is measured that some samples showed an increase in abrasion after the treatment, so the results suggest that these samples may have good abrasion resistance.

#### 4. Colour Fastness Test

- **Rubbing (Dry & Wet):** The sample test result is given in the table 4. Most samples had good to excellent colour fastness, with sample PT001 having a colour fastness of 3 for wet treatment and 4/5 for dry treatment.
- **Washing:** The colour fastness results of different samples to washing treatment, withal samples scoring 4/5 or higher, indicating good to excellent colour fastness. The result is given in the table 5.
- **Perspiration (Acid & Alkaline):** The test results is shown in the table 6 and it suggest that the samples exhibit moderate to good colour fastness, good to excellent perspiration in acid resistance, and good to excellent in alkaline resistance.

**Table 1: Fabric Thickness**

S.NO	SAMPLE	THICKNESS (in mm)	
		Before	After
1	PT001	0.2	0.2
2	PT002	0.3	0.3
3	PT003	0.2	0.2
4	PT004	0.3	0.3
5	PT005	0.3	0.3

**Table 2: Fabric Weight**

S.NO	SAMPLE	FABRIC WEIGHT (in gsm)	
		Before	After
1	PT001	131.4	132.6
2	PT002	133.4	134.8
3	PT003	123.2	124.3
4	PT004	128.6	130.1
5	PT005	130.4	132.5

**Table 3: Abrasion**

S.NO	SAMPLE	ABRASION (WEIGHT LOSS %)	
		Before	After
1	PT001	0.48	0.49
2	PT002	0.53	0.53
3	PT003	0.50	0.48
4	PT004	0.43	0.43
5	PT005	0.46	0.46

**Table 4: Colour Fastness**

S.NO	TESTING SAMPLES	COLOUR FASTNESS	
		RUBBING	
		WET	DRY
1	PT001	3	4/5
2	PT002	¾	4/5
3	PT003	4/5	4/5
4	PT004	¾	4/5
5	PT005	¾	4/5

**Table 5: Washing**

S.NO	TESTING SAMPLES	COLOUR FASTNESS
		WASHING
1	PT001	4/5
2	PT002	4/5
3	PT003	4/5
4	PT004	4/5
5	PT005	4/5

**Table 6: Colour Fastness to Perspiration (Acid and Alkaline)**

S.NO	TESTING SAMPLES	COLOUR FASTNESS	
		PERSPIRATION	
		ACID	ALKALINE
1	PT001	¾	4
2	PT002	¾	4/5
3	PT003	¾	4
4	PT004	¾	4/5
5	PT005	¾	4/5

#### IV. CONCLUSION

In conclusion, the study demonstrates the potential of sericin coating on polyester fabric to improve its properties and expand its range of applications. Polyester samples were treated with sericin solution and were studied for its improvement in its wetting and wicking behaviour. This study findings could be useful for the textile industry to develop new materials with improved moisture control, colourfastness, and durability. The study measured the fabric thickness, weight, and abrasion of different samples before and after treatment. The methods used in the study, such as the diffusion method for sericin application and the wetting and wicking time measurement, could also be used for further research and development in this area.

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