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Serichemistry: Unlocking the chemical potential of sericulture

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Abstract
Serichemistry is an emerging interdisciplinary field that explores the chemical constituents derived from sericulture primarily silk proteins and by-products such as fibroin, sericin, and silkworm pupae oil. This paper aims to comprehensively study the bio-molecular makeup of these compounds, their extraction, and diverse industrial and biomedical applications. The environmental sustainability, biocompatibility, and functionality of serichemicals offer promising alternatives to synthetic materials in fields ranging from cosmetics and pharmaceuticals to textiles and agriculture. Through an extensive literature review, the paper outlines the advances, current methodologies, and future scope of serichemistry, contributing to value addition in sericulture.

Keywords: Silk proteins, fibroin and sericin applications, silkworm pupae oil utilization

1. Introduction

Sericulture traditionally refers to the rearing of silkworms for silk production. Over time, this practice has evolved into a rich source of biomaterials, prompting the development of serichemistry, which focuses on the chemical components and applications of sericultural outputs. The primary substances of interest in this domain are fibroin (the structural protein of silk), sericin (the gummy protein surrounding fibroin), and silkworm pupae oil (a nutrient-rich lipid extracted from silkworm waste).

This interdisciplinary field combines biochemistry, analytical chemistry, polymer science, and material engineering. Serichemicals are increasingly valued for their biodegradability, biocompatibility, and functional versatility, making them attractive in green chemistry and sustainable industrial development (Mondal *et al.*, 2007; Kundu *et al.*, 2012) [7, 6].

2. Chemical Composition of Sericultural Products

2.1 Fibroin

Silk fibroin is a fibrous protein primarily composed of glycine, alanine, and serine arranged in β-sheet structures. These sheets provide tensile strength and elasticity (Zhou *et al.*, 2001) [16].

- **Molecular weight:** ~390 kDa
- **Structure:** Anti-parallel β-sheet
- **Properties:** Biocompatible, slow degradation, hydrophobic

2.2 Sericin

Sericin is a water-soluble globular protein with emulsifying, antioxidant, and antimicrobial properties. It constitutes ~25-30% of raw silk weight (Sasaki *et al.*, 2000) [11].

- **Amino acids:** Serine (~30%), aspartic acid, and glycine
- **Molecular weight:** 10-310 kDa (varies with extraction method)

2.3 Silkworm Pupae Oil

Silkworm pupae oil contains 70-85% unsaturated fatty acids, notably linoleic and oleic acid. It is also rich in proteins, vitamins, and sterols (Sarker *et al.*, 2019) [12].

3. Extraction and Analytical Techniques
3.1 Extraction Methods

Component	Extraction Method	Notes
Fibroin	Degumming + solvent dissolution (LiBr, $CaCl_2$)	Requires dialysis
Sericin	Hot water, alkali (Na_2CO_3), or enzyme hydrolysis	Retains bioactivity
Pupa Oil	Cold pressing, Soxhlet with hexane/ethanol	Cold press preserves nutrients

3.2 Analytical Tools
- **FTIR (Fourier-transform infrared spectroscopy):** Identifies functional groups.
- **NMR (Nuclear magnetic resonance):** Structural elucidation of proteins.
- **XRD (X-ray diffraction):** Crystalline structure of fibroin.
- **GC-MS (Gas Chromatography-Mass Spectrometry):** Fatty acid profile.
- **UV-Vis Spectrophotometry:** Antioxidant assays (DPPH, ABTS).

4. Industrial and Biomedical Applications
4.1 Biomedical Engineering
- **Tissue engineering scaffolds** (Kundu *et al.*, 2013) [5]
- **Drug delivery systems** using fibroin nanoparticles (Seib, 2018) [13]
- **Sericin wound dressings** with antimicrobial properties (Zhou *et al.*, 2001) [16]

4.2 Cosmetics
- **Moisturizers and serums**: Sericin improves hydration and elasticity (Kato *et al.*, 2001) [4].
- **Hair care**: Conditioners and shampoos incorporate sericin for smoothing effect.

4.3 Textiles and Smart Fabrics
- **Antibacterial fabrics** treated with sericin or fibroin composites (Das *et al.*, 2009) [2]
- **UV-resistant silk fibers** for high-performance clothing (Patra *et al.*, 2014) [8]

4.4 Agriculture
- **Bio-fertilizers** from pupae residue and sericin hydrolysate (Ravikumar *et al.*, 2020) [9]

4.5 Food and Nutrition
- **Silkworm pupae powder** used as protein supplements (Reddy *et al.*, 2021) [10]

4.6 Bioenergy
- **Biodiesel** from silkworm pupa oil (Singh *et al.*, 2021) [14]

5. Environmental Significance
Serichemistry promotes a circular economy by converting silk waste into valuable products, reducing environmental load from sericulture waste. Sericin extraction avoids pollution caused by traditional degumming (Gupta *et al.*, 2015) [3]. Pupa residue, often discarded, is now a resource for bioenergy and organic fertilizers.

6. Future Directions
- Development of hybrid silk-protein composites for medical devices.
- Use of genetically engineered silkworms to produce high-performance biomaterials (Xu *et al.*, 2018) [15].
- Nano-sericin and fibroin hydrogels in cancer therapy and regenerative medicine.
- Valorization of wild silk species like *Antheraea mylitta* in serichemistry research (Chattopadhyay *et al.*, 2022) [1].

7. Conclusion
Serichemistry has transformed sericulture from a traditional industry into a scientific frontier. The chemical richness of silk proteins and their by-products enables applications across multiple high-value sectors. Ongoing research, combined with sustainable processing and biotechnological advancements, positions serichemistry as a cornerstone of future biomaterial innovation and environmental sustainability.

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