Plant Archives Vol. 25, Supplement 2, 2025 pp. e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-2.213

SERICULTURE BASED BY-PRODUCTS: INNOVATIONS AND MARKET TRENDS

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(Date of Receiving : 18-05-2025; Date of Acceptance : 23-07-2025)

ABSTRACT

Sericulture, beyond silk production, offers a wide range of valuable by-products from both silkworms and mulberry plants, unlocking significant potential across multiple industries. Innovations in the extraction and application of sericin, fibroin and silkworm pupae along with bioactive compounds from mulberry leaves, fruits and twigs have opened new avenues in cosmetics, pharmaceuticals, functional foods, and agriculture. Mulberry, rich in antioxidants and antidiabetic compounds, is gaining prominence in nutraceuticals and health beverages. Recent market trends show an increasing preference for eco-friendly and sustainable materials, driving interest in biodegradable sericin-based films, protein-rich animal feed from pupae, and mulberry-infused wellness products. This shift not only supports green innovation but also enhances rural livelihoods by adding value to every component of the sericulture process.
***Keywords*:** Sericulture, by-products, value addition, innovations, market trends.

Introduction

Sericulture is an agro-based industry that mainly focuses at rearing of silkworm (*Bombyx mori* L.) with the main objective of silk production. In addition to the silk, a chain of secondary product has also been produced, having excellent economic value. Its by-products have remarkable application as in preparation of compost, in human medicine, handicrafts, cosmetics, food industry etc. High protein content in silkworm pupae make it a nutritionally rich food for humans and livestock mainly poultry, pigs and fish. Proper utilization of sericulture waste adds a value of up to 40 per cent to the silk industry. Mulberry (*Morus* spp.) despite sole food for silkworm it have many uses in pharmaceutical and food industry. Cocoon craft is one of the very remarkable utility of by-products of sericulture which can provide scope to develop human skills by generating self-employment and revenue (Sharma *et al*., 2022)

Sericulture produces a wide range of valuable by-products from both mulberry plants and silkworms, supporting sustainability and income diversification. Mulberry by-products like leaves, fruits, twigs, and roots are rich in bioactive compounds and are used in nutraceuticals, herbal medicine, cosmetics, and health drinks. Silkworm by-products arise during rearing, reeling, and grainage. Silkworm excreta is used for composting, vermicomposting, biogas, and pharmaceutical purposes. During reeling, pupae are utilized in food, medicine, animal feed, and oil extraction. Sericin from silk is applied in cosmetics, pharmaceuticals, and eco-packaging, while fibroin is used in wound care and skincare products. In grainage, silk moths become animal feed, and pierced cocoons are repurposed in crafts, promoting zero-waste and rural cottage industries

Need for innovations in secondary Sericulture

Adding value to sericulture by-products boosts profitability by transforming waste into goods like nutraceuticals and cosmetics, increasing income and economic sustainability. Using wastes such as silkworm excreta, pupae, and mulberry residues supports eco-friendly, sustainable production. Diversifying into food, pharma and cosmetic products

reduces dependence on silk alone and enhances industry resilience. Developing by-product-based products taps into green markets, improving competitiveness and supporting rural livelihoods. Efficient use of all resources promotes a circular economy by reducing waste and increasing overall productivity.

Mulberry Based By-products

Mulberry leaf

Mulberry leaves, primarily used for feeding silkworms, have significant untapped potential beyond sericulture. Often discarded as waste, leftover leaves are rich in nutrients and bioactive compounds, making them valuable for animal feed, functional foods, nutraceuticals and biofuel production. With growing emphasis on sustainability and green technologies, repurposing these leaves supports economic growth and environmental conservation by reducing waste and offering eco-friendly alternatives to conventional resources. (Yang *et al*., 2019)

Studies showed that tudan's organic mulberry leaves tea is a high-protein, zero-fat beverage with good shelf stability and favourable sensory appeal. Its mild taste, natural colour and low caffeine content led to strong consumer acceptance, with 85% willing to purchase indicating promising market potential. (Angki *et al.,* 2018)

Mulberry Paper: Mulberry paper, made from the bark of the Mulberry tree, is known by various names such as Kozo, Rice Paper, Hanji and Unryu. It features long fibers that give it a soft texture and exceptional durability. Available in a range of weights from translucent Unryu to heavyweight Kozo this paper is produced in multiple countries. Its feathered, torn edges make it ideal for creative uses like stationery, wedding invitations and scrapbooking. Mulberry papers, including archival Korean Hanji and decorative Japanese Yuzen Washi, offer unique textures and artistic value for diverse projects. ((https://www.mulberrypaperandmore.com/c-101-printable-mulberry-paper.aspx)

These 25 fresh mulberry leaves are organically grown and harvested in Southwest Florida, pesticide-free, and packed with essential nutrients. Perfect for silkworm feeding, culinary use, or health supplements, they deliver farm-fresh quality directly to your door, exclusively from MovaGarden. (https://www.desertcart.in/products/181621298-25 fresh-mulberry-leaves-good-for-silkworm-organic-mulberry-leaves-harvest-in-florida)

Kordel's White Mulberry Leaf Extract, powered by Reducose®, helps lower post-meal blood sugar by over 40%. Just one capsule before meals reduces the glycemic impact of carbs.It supports blood sugar control and aids in weight management naturally.

(https://www.kordels.co/our-products/kordels-white-mulberry-leaf-extract-250mg-30s/)

Mulberry fruit - Peel off mask

- Black mulberry *(Morus nigra)* ethanol extract demonstrated antibacterial activity against *Propionibacterium acnes* and *Staphylococcus epidermidis*, with MIC values of (2.5–5%) and (1.25–2.5%), respectively, and MBC values of (5%) and (2.5%). A peel-off gel face mask formulated using (2.5%) mulberry extract, along with varying concentrations of PVA and HPMC, was evaluated for physical stability and skin compatibility. The optimized formulation (7% PVA, 2.5% HPMC) showed good homogeneity, acceptable pH and viscosity, and no significant skin irritation, confirming its potential as a safe and effective topical cosmetic product. (Budiman *et al*., 2017)

Mulberry fruit-Probiotic black mulberry whey beverages

Mulberry fruits are widely consumed in various forms, with juices, jams and jellies being the most popular value-added products. The vibrant, sweet-tart taste of mulberries makes them an appealing option for creating refreshing fruit juices and beverages. These juices are often marketed for their high content of vitamin C, which supports immune health and antioxidants, which help in neutralizing harmful free radicals in the body. Mulberry juice is especially sought after in health-conscious markets, as it is considered a functional beverage that can help improve overall well-being.

The antioxidant properties of mulberries, specifically due to the presence of anthocyanins and flavonoids, are beneficial for preventing oxidative stress-related diseases. Additionally, mulberry fruits contain natural sugars, which can offer a healthier alternative to artificially sweetened beverages. As the demand for functional beverages increases, mulberry juice. (Rasool *et al*., 2022)

Studies showed that incorporation of black mulberry juice into whey beverages enhanced their nutritional value, antioxidant activity and probiotic viability. The (75%) mulberry formulation Sweet Whey black mulberry (SWBM3) juice showed the best balance of health benefits and sensory acceptability. These findings highlight the potential of black mulberry in developing functional probiotic beverages (Abdulalim *et al.,* 2018).

Also, mulberry fruit powder (MFP) jelly, formulated with gelling agents and sweeteners, showed high nutritional value, including 4.2 g dietary fiber and 66.16/kcal per 170/g. It exhibited significantly higher phenolic content (21.34 mg GAE/g), anthocyanins (12.76 mg/g), and antioxidant activity compared to control guava fruit jelly. Sensory evaluation revealed high consumer acceptance with optimal sweetness and sourness levels (Nom *et al*., 2020).

Bagicha Corner in Mahabaleshwar (Maharashtra) is the best restaurant to go to for fresh mulberries with ice cream or cream. I have rarely seen any restaurant serve mulberries with ice cream in Mahabaleshwar, except for Bagicha.

https://www.tripadvisor.in/ShowUserReviews-g635749-d10288699-r480893142-Bagicha_Corner-Mahabaleshwar_Satara_District_Maharashtra.html#

Mulberry root:

Applications of mulberry root extracts in recent years

Recent studies have highlighted the potential of mulberry root extracts in the development of pharmaceuticals and nutraceuticals. Their antioxidant, anti-inflammatory and antidiabetic properties make them suitable for formulating supplements and herbal remedies aimed at improving metabolic health and preventing chronic diseases. Mulberry root extracts are being explored for their potential in developing drugs for diabetes, cancer and inflammatory diseases. The bioactive compounds in mulberry roots offer multiple therapeutic targets, making them valuable in pharmaceutical research (Eo *et al*., 2014). The health-promoting properties of mulberry root phytochemicals have led to their inclusion in dietary supplements and functional foods. These products aim to enhance overall health, prevent disease and promote longevity.

Recommended for: Hair Oil, Cold Press Soap, Melt and Pour Soap, Bath Bomb, Lotion, Salt & Scrubs, Lip Balms and many more cosmetic product

Mulberry bark

On the whole, oral treatment of mulberry branch bark powder efficiently maintained the usual state of glucose metabolism and regulated the release of insulin in mice. This may be achieved by enhancing antioxidant capacity, preventing pancreatic cell death and healing liver and pancreas damage (Yin *et al*., 2017). There are several applications for mulberry bark fibre micro composite in the automotive, textile and packaging industries. Therefore, it can substitute current materials as a biopolymer formed from the bark of the Indian mulberry plant in various polymer applications according to its performance (Balachandran *et al.,* 2023).

Fig. 1 : Diverse uses of mulberry bark.

Mulberry stems have been utilized as reinforcement in polypropylene composites for usage in automobiles, furniture and green buildings (Guna *et al*., 2023). Crude polysaccharides from mulberry branches contain various sugars and may exhibit antioxidant activity despite the presence of flavonoids and phenols in the bark extract (Qiu *et al*., 2016). *Morus alba* stem fibre has an adequate cellulose content and superior physical, chemical and thermal properties. These characteristics make it a promising alternative to synthetic fibres (Prithivirajan *et al.,* 2019). The phenolic components of ethanolic extracts of mulberry twig were maclurin, rutin, soquercitrin, resveratrol and morin.

Fig. 2: By-products of mulberry bark

Ethanolic extracts of mulberry twigs (EEMT) act as natural antioxidants and tyrosinase inhibitors, offering protective benefits (Liu *et al*., 2010). The inner layer of mulberry branch bark contains cellulose pulp that can be added to paper pulp up to 30 % of the way to make paper (Babakhanova *et al*., 2020). Pectin with varying degrees of esterification may be found in the bark of mulberry branches (Liu *et al*., 2010).

Cellulose whiskers were extracted from the branch bark of *M. alba* L. These whiskers have potential applications as additives in the pharmaceutical and optical industries, as well as reinforcement components in composite materials (Li *et al*., 2009).

Sericulture based by-products:

Sericin: Sericin is a hydrophilic, adhesive globular protein that binds silk filaments to maintain cocoon structure, composed mainly of serine, aspartic acid and glycine. With its beneficial properties, it has found growing applications in cosmetics, biomedical, pharmaceutical and food industries (Sharma *et al*., 2022). Sericin has some marvelous properties like biocompatibility, biodegradability and wettability, which are use in the preparation of cosmetic products for skin, nails and hair (Padamwar & Pawar, 2003). Silk sericin has also antiaging properties comparable to vitamin C, except for oxidative stress, where silk sericin was superior as sericin can stimulate synthesis of collagen type 1 which suppress the regulation of nitrate, which may induces oxidative stress, and up regulate the expression of b-cell lymphoma 2 (bcl-2) to inhibit cell apoptosis, without altering fibroblast growth kinetics or cellular ultra-structure (Kitisin *et al*., 2013). 8 per cent sericin can induce wound healing in the patients of second-degree burns (Aram wit *et al*., 2013). Cocoons of *Bombyx mori* L. can provide natural pigments typically flavonoids and carotenoids that accumulate in sericin layers (Kurioka and Yamazaki, 2002). These pigments are known for their biological properties as antioxidants and antityrosinase. Sericin can also be used as food packaging material.

Studies showed that Sericin-based edible coating reduced weight loss and preserved firmness in tomatoes over 45 days. It delayed ripening by maintaining pH, TSS, TA, lycopene and antioxidant levels. SEM analysis showed a uniform, thin (~1.042 µm), semi-permeable layer allowing proper gas exchange. Overall, it effectively extended shelf life while maintaining tomato quality (Tarangini *et al*., 2022).

Silk Fibroin:

Silk fibroin (SF) is a strong, resilient and elastic natural fiber with tensile strength comparable to glass and synthetic fibers. It is more biocompatible and less immunogenic than materials like collagen, polylactic acid, or polyglycolic acid. SF degrades safely through proteolytic enzymes, with the degradation rate influenced by its β-sheet content, crystallinity and molecular weight lower β-sheet SF degrades faster. Enzymes like protease XIV and chymotrypsin target specific amino acids to break SF into peptides and amino acids. Due to its safety, biodegradability, and tunable properties, SF is a promising biomaterial, now being developed for advanced uses like injectable formulations, conductive materials, and bio-inks in regenerative medicine (Phillips *et al*., 2004).

Studies showed that silk fibroin hydrogels, especially when combined with FGF1, significantly accelerated wound healing and reduced scar size in rats. Early wound closure was enhanced due to elevated PDGF expression on day 7, while TGF-β1 levels remained stable. Fibroin + FGF1 showed superior healing compared to fibroin or chitosan alone, indicating strong potential for wound care applications. (He *et al*., 2019)

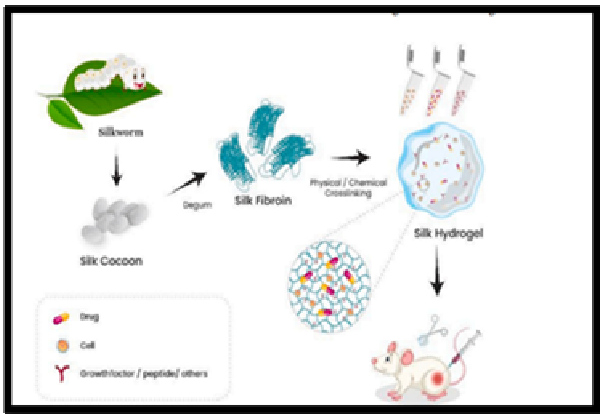


Fig. 3 : Silk fibroin hydrogel, a versatile biomaterial for delivery application.

Silkworm Pupae oil:

Fig. 4: By-products of silkworm pupae

Silkworm (*Bombyx mori* L.) pupae have 4.8 per cent and 9.0 per cent oil content in males and females (Suresh *et al*., 2012). The yield of silkworm pupae oil is approximately 20 per cent on the dry weight of pupae. The oil extracted from silkworm pupae contains more than 70 per cent unsaturated fatty acids, particularly the α-linolenic acid and oleic acid accounting for a high percentage (Rao, 1994). Oil extracted from silkworm pupae by boiling is used in the cosmetics industries for making soaps and moisturizers (Winitchai *et al*., 2011) and this soap was used for degumming of silk. The pupae oil can be used in jute industry for lubricating (presently rice bran oil is being used) and in leather processing (presently, fish oil is being used). Pupal oil also contains 1-Deoxynojirimycin (DNJ), which is a potent alpha glucosidase inhibitor used to treat diabetes (Kotake *et al*., 2002). Silkworm pupae and pupal oil are important materials as they are a rich source of essential omega-3 fatty acid and ALA (alpha linoleic acid), which are of great importance for human health (Tomotake *et al*., 2010). The valuable pupae oil is used in industrial products such as paints, varnishes, pharmaceuticals, soaps, candles, plastic and biofuel (Wang *et al*., 2013).

- **Silkworm pupae in compost**: Dried silkworm pupae contain 8 per cent of nitrogen. Since the pupa contain high amount of nitrogen and protein along with micronutrients like zinc, copper, magnesium and manganese, there is a prospective potential for the bioconversion of pupal waste to enriched compost and utilization as a nutrient source (Mahesh *et al*., 2020). Application of Silkworm pupae residual biocompost (SPRB) along with chemical fertilizers significantly increased both growth and yield parameters of mulberry (Mahesh *et al*., 2020). Karthikeyan and Sivakumar (2007) cultivated in mass the biopesticide bacterium, Bacillus thuringiensis by utilizing silkworm pupal waste where viable spore count (VSC) was taken as a criterion for evaluating the efficiency of pupal waste medium

SILK

Silk powders:

Silk resins were prepared from *Bombyx mori* and Eri silk powders using hot pressing after fine milling and sieving. Both resins appeared homogeneous, though Eri resins were lighter in colour. Mechanical properties such as hardness, elastic modulus and bending strength improved with drying time. *B. mori* resins showed superior performance, reaching optimal strength after 7 days, while Eri resins peaked at 5 days, after which over-drying reduced strength due to loss of bound water critical for cross-linking. (Tuan *et al.,* 2019)

In the silk industry, by-products include non-reelable silk waste, the pelade layer, pupa (as basin refuse) and sericin discarded during degumming. Silkworm pupae, a major reeling by-product, have applications in food and medicine. India produces around 40,000 MT of dry silkworm pupae annually (Priyadharshini *et al*., 2017). Pupa contains crude 50-60 per cent proteins, 25-35 per cent fats, 5-8 per cent free amino acids, 8-10 per cent sugars, E, B1, B2 vitamins, calcium and phosphorus. 75 per cent daily protein necessity of human individual can be obtain from 100g of dried silkworm pupae (Singh and Suryanarayana, 2003). The vitamins like pyridoxal, riboflavin, thiamine, ascorbic acid, folic acid and nicotonic acid, pantothenic acid and minerals like calcium, selenium and phosphorus make the pupae more nutritive (Koundeniya and Thangavaleu, 2005). Silkworm pupae contain edible lipids of high quality that are use as raw material in medicine (Shanker *et al*., 2006). Silkworm pupae regulate plasma lipid and lipoprotein levels in the serum of rats by activating apoproteins and lipid-metabolizing enzymes. Thus, it could be used to treat hyperlipidemia (Hu and Chen, 2011). Silkworm pupae, rich in antioxidant lecithin, are a premium animal protein source and the only insect food listed as a Novel Food Resource by China's Ministry of Health. Widely used in dietary

supplements, medicines, and animal feed in China and Korea (Kim *et al.*, 2008). Silkworm pupae are consumable as whole, oil, or powder, offering complete proteins rich in essential amino acids. Their amino acid profile aligns with WHO recommendations, making them a valuable dietary source (Kohler *et al.*, 2019). Silkworm pupae contain 70–80% unsaturated fatty acids and beneficial sterols, making them nutritionally rich. Pupal powder can be used in masala cookies, significantly boosting protein, fat, energy, calcium, and iron content (Vishaka *et al.*, 2020).

Fig. 5 : Silk based by products

By-products of grainage:

Grainages are the egg producing centers. Quality silkworm egg is the basic living resource for successful sericulture industry. The grainages yields substantial quantity of moths of both sexes and pierced cocoons as a by-product in the process of egg production of parental lines or cross breeds. Aruga (1994) reported that, silk moths could be used in the preparation of animal feed mixtures.

Use of defective cocoons in craft: Defective cocoons are creatively repurposed in cocoon crafts, generating self-employment and enhancing post-cocoon value addition by 10–25% (Vathsala, 1997). Products like garlands, jewellery, dolls, and greeting cards are commonly made. Japan has also developed silk paper and silk powder-based paint ("silk leather") for decorative uses.

Fig. 6: From waste to art: Empowering women through cocoon shell creations

Market trends:

Market trend is the asset's price direction over a given period. Market trends apply to all assets and markets such as foreign exchange, commodities, stocks and bonds, where prices and trading volumes fluctuate.

The global sericulture market was valued at USD 19.6 billion in 2022 and is expected to reach USD 31.71 Billion by 2030, growing at a CAGR of 6.2% from 2023 to 2030 . One of the key drivers - Fashion industry.(https://market.biz/report/global-sericulture-market-qy/506132/#inquiry)

❖ **Key trends shaping the mulberry by-product market include**

1. Superfood recognition, boosting health diet adoption.

2. Emphasis on sustainable cultivation practices.
3. Product innovation: mulberry-infused beverages, snacks and supplements.
4. Growing integration into traditional medicine, expanding wellness product offerings.

Present Trends

- Mulberry market trends over the last several years include using mulberries in smoothie bowls, yogurt and granola as well as developing supplements derived from them
- Organic and non-GMO mulberry products have become increasingly popular among health-minded customers

Recent Developments (2023-2032):

- Since 2023, the global mulberry market has witnessed increased investments in cultivation technologies such as precision agriculture and controlled environment farming
- As well as an upsurge in online retail platforms offering various mulberry-related products and collaboration between growers and food companies to develop innovative recipes using this fruit

Key players in mulberry market:

Bolt threads, ASML group, Navitas organics, Sevenhills Wholefood. (Mulberry market report 2024-2033 Marketresearch.Biz)

- The global mulberry leaf extract market size was valued at USD 1.8 billion in 2023 and is estimated to grow at a CAGR of over 3.5% from 2024 to 2032..
- White Mulberry Leaves Extract Market size was valued at USD 40.65 billion in 2023 and is projected to grow at 12.7% CAGR from 2024 to 2032. (https://www.gminsights.com/industry-analysis /silk-protein-market)

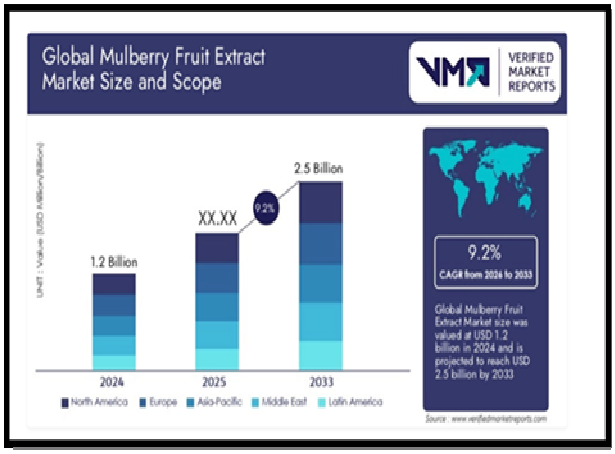


Fig. 7: Mulberry Fruit Extract Market Insights

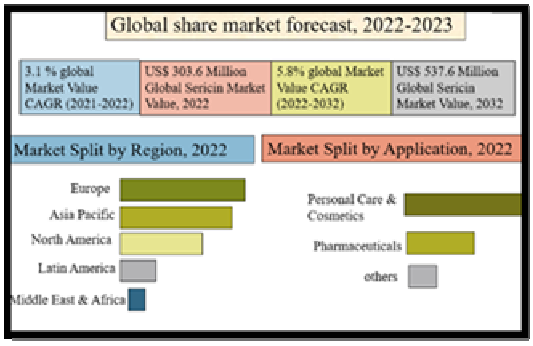
Mulberry Fruit Extract Market size was valued at USD 1.2 Billion in 2024 and is forecasted to grow at a CAGR of 9.2% from 2026 to 2033, reaching USD 2.5 Billion by 2033

Fig. 8: Top Mulberry Fruit Extract Companies (https://www.verifiedmarketreports.com/product/mulberry-fruit-extract-market/)

- **Exports**: Export of silk and silk products 2023-2024 is 292.69 $ Million

Silk sericin powder

The product is in powder form, packaged in 20 kg units, and classified as a technical grade cosmetic



Over the 2017-2021 historical period, the global sericin market registered a CAGR of 3.1%, and according to the FactMR, a market research and competitive intelligence provider, the market is projected to exhibit growth at 5.8% CAGR between 2022 and 2032

Table 1 : Inclination towards anti-ageing products to strengthen the sericin market over 2022-2023

Report attributes	**Details**
Sericin market size (2021A)	US$ 289.3 million
Estimated market value (2022E)	US$ 303.6 million
Forecasted market value (2032F)	US$ 537.6 million
Global market growth rate (2022-2032)	5.8% CAGR
Key companies profiled	• Seiren Co. • Hyundai bioland • Specialty natural products Co. Ltd

https://www.factmr.com/report/3248/sericin-market

The global sericin market is anticipated to value at US$ 303.6 million in 2022 and further expand at a CAGR of 5,8% to reach US$ 537.6 million by the end of 2032

- **Short Term (2022 to 2025):** Rapid growing personal care and cosmetics market
- **Medium term (2025 – 2028):** Europe and Asia are anticipated to witness high sericin demand on the back of increasing expenditure on cosmetic products that are leading to a growing cosmetic industry
- **Long term (2028 -2032):** Increasing use of sericin in pharmaceutical, food, and textile industries will drive the demand in the long run
- The China market for sericin is projected to reach a valuation of US$ 27.6 million in 2022
- In May 2022, Karnataka state sericulture research and development institute (KSSRDI) announced that they are planning to launch 12 sericin-based cosmetic products

Silk fibroin

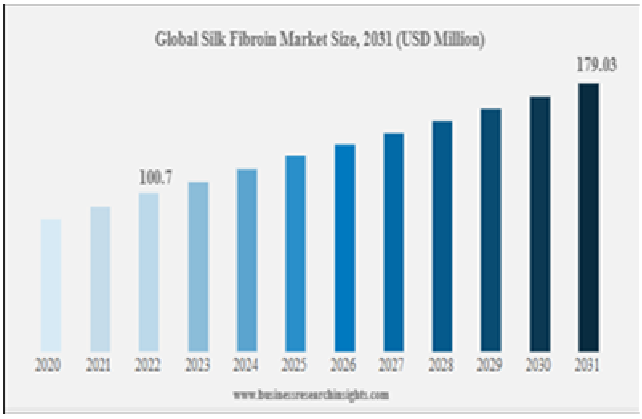
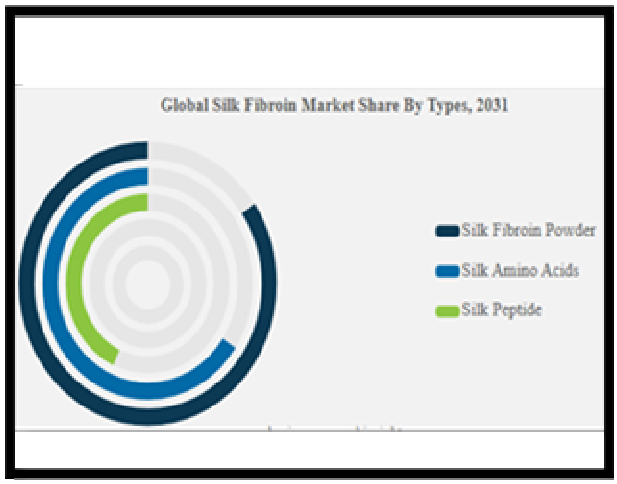


Fig. 9 : Silk fibroin market size, share, growth, and industry analysis, by type, by application and regional forecast to 2031

SILK FIBROIN MARKET REPORT OVERVIEW

Global silk fibroin market size was USD 100.7 million in 2022 and market is projected to touch USD 179.03 Million By 2031, exhibiting a CAGR of 6.6% during the forecast period

Global silk fibroin market share by type, 2031



SILK FIBROIN MARKET SEGMENTATION

By Type

Based on type the silk fibroin market can be categorized into silk fibroin powder, silk amino acids, and silk peptide.

By Application

Based on application the silk fibroin market can be categorized into cosmetic & personal care, biomedical, and supplements.

Market players

- Seidecosa (India), Caresilk (India), Huzhou silkspark biotech Co. Ltd (China)

(https://www.businessresearchinsights.com/market-reports/silk-fibroin-market-106103)

Fig. 10: Silk Protein Market Size

Silk protein's unique properties, such as its moisturizing and anti-aging benefits, are fueling demand in the cosmetics industry. Increased awareness of silk protein's ability to improve skin and hair health is prompting its inclusion in a variety of formulations, from shampoos to serums. Additionally, the textile industry's innovation in silk protein-based fabrics is expanding its market reach, appealing to environmentally conscious consumers. As the market continues to emphasize efficacy and eco-friendliness, silk protein's diverse applications are driving its demand across various sectors. Thus, the market is expected to attain a market value of over USD 1.61 billion by 2032. (https://www.gminsights. com/ industry-analysis/silk-protein-market)

Silk Protein Market Trends

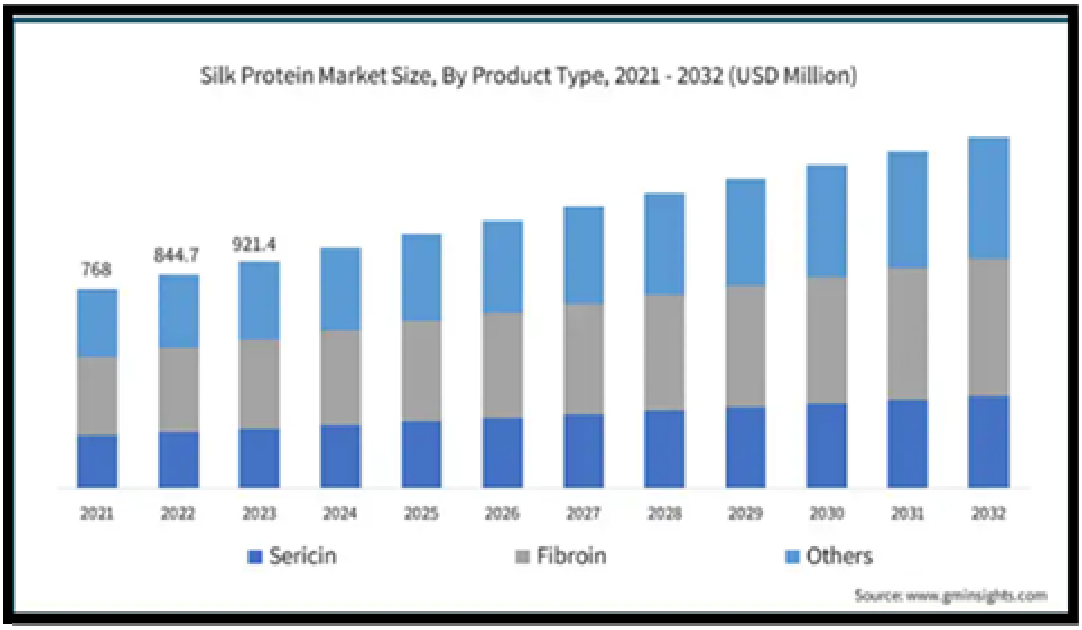


Fig. 11: Silk protein market size

The silk protein industry is witnessing several notable trends that are shaping its trajectory. One prominent trend is the surge in demand for silk protein in skincare products, driven by its moisturizing and anti-aging properties. Beauty and cosmetics companies are increasingly incorporating silk protein into their

formulations, capitalizing on its ability to enhance skin texture and promote collagen production. Another trend is the growing popularity of silk protein in hair care products, where it is valued for its ability to strengthen hair strands and improve over hair health.

Furthermore, the market is experiencing a shift towards sustainable and eco-friendly practices, with silk protein aligning well with this trend. Consumers are seeking products that are not only effective but also environmentally conscious, leading to a rise in the use of silk protein in natural and organic cosmetic lines. This emphasis on sustainability is also extending to the textile industry, where silk protein-based fabrics are gaining traction as an eco-friendly alternative to traditional materials. (https://www.gminsights.com/ industry -analysis/silk-protein-market)

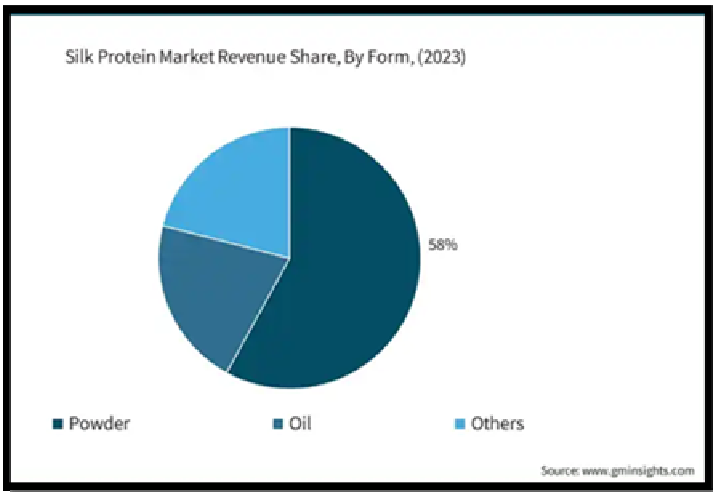


Fig. 12: Silk protein market revenue share, by from, (2023)

Based on form, the market is categorized into powder, oil and others. Powder accounted for 58% market share in 2023 and is projected to grow through 2032. Powdered silk protein offers convenience and ease of use, making it a versatile ingredient for formulation in various products. Whether it's skincare, cosmetics, or dietary supplements, powdered silk protein can be easily incorporated into formulations to enhance their properties. This form also allows for better control over dosage and application, appealing to both manufacturers and end-users seeking effective and customizable solutions.

Silk protein is increasingly popular in the beauty industry, especially in skincare, due to its moisturizing, anti-aging, and skin-smoothing properties. Skincare led the market with a share of USD 344.63 million in 2023 and is projected to reach USD 604.9 million by 2032. Its ability to enhance skin texture, boost collagen, and protect from environmental damage aligns with the growing demand for natural, sustainable self-care products, solidifying its dominance in the cosmetic market.

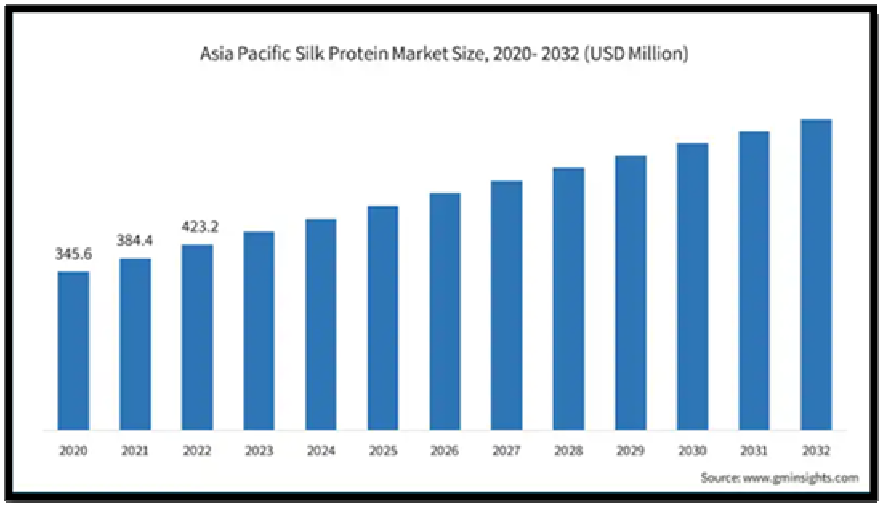


Fig. 13: Asia pacific protein market size, 2020-2032(USD million)

Asia Pacific dominated the global silk protein market in 2023. It generated a revenue of USD 462.21 million in 2023 and is expected to reach USD 816.35 million by 2032. The Asia Pacific region stands out as a dominant force in the industry due to several key factors. Culturally, silk has been deeply intertwined with Asian history and tradition for centuries, particularly in countries like China, India, and Japan. This cultural significance translates into a strong market demand for silk-based products, including silk protein. Additionally, the Asia Pacific region boasts a large and diverse textile industry, where silk is a prized material. This existing infrastructure and expertise in silk production contribute to the region's dominance in the market.

China stands out as the dominant force in the silk protein industry within the Asia-Pacific region. This is largely due to China's rich history and deep-rooted tradition in silk production, dating back thousands of years. The country boasts a robust silk industry, with a vast network of silk farms and skilled artisans. China's expertise in sericulture, the cultivation of silkworms for silk production, gives it a competitive edge in supplying high-quality silk protein to various industries, including cosmetics, textiles, and healthcare. The sheer volume of silk produced in China, coupled with its advanced processing capabilities, positions the country as a key player in meeting the growing global demand for silk protein.

The Silk protein industry includes innovators like AMSilk and Bolt Threads, known for textile and biomedical applications, and Evolved by Nature, focused on sustainable technologies.

Caribbean Natural Products and KISCO Ltd cater to the cosmetics and healthcare markets, while Chinese firms lead in silk extraction expertise. Biotech firms like Kraig Biocraft and SilkTech Biopharmaceuticals advance genetically engineered silk, highlighting the sector's diversity and growth. (https://www.gminsights.com/industry-analysis/silk-protein-market)

Silk Protein Industry News

In 2023, Evonik partnered with AMSilk to produce sustainable silk proteins for use in fashion, automotive materials and medical devices. In 2024, Givaudan launched Silk-iCare, a vegan, biomimetic silk protein developed through white biotechnology to protect and repair skin, marking a major advancement in skincare innovation.

Conclusion

The innovations and market trends within the sericulture industry showcase a promising future for sericulture by-products. Through advancements in technology, sustainable practices and innovations and market demand sericulture has evolved beyond silk production to explore a valuable by-products like silk proteins, cosmetics and medical materials. These innovations not only offer economic opportunities for sericulture farmers but also contribute to environmental sustainability and diversification of these by-products. In depth innovative research work has to be carried out along with strategic market expansion for increasing the global market demand for by-products

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