Review Article

A Review on Medicinal Value of Silkworm product and By-products

ABSTRACT

Sericulture is an agro based industry that includes production of raw silk by breeding, rearing of silkworm and cultivation of their host plants. The manufacture of various types of silk was the only emphasis of the traditional sericulture industry, and leftovers were typically disposed away as trash. Byproducts and products from sericulture can be used medicinally in addition to generating silk. The silkworm is a valuable tool in laboratory research and has been utilised as a model organism in life sciences, environmental monitoring, antimicrobial drug screening, and other applications. Protein extract from silkworm eggs is used to improve memory and assist control weight. The silkworm's larvae are also beneficial medicinally; they include blood glucose-lowering agents and silkworm gut fibre, among other things. Similarly, silkworm pupae, a significant by-product of the silk reeling business, have great nutritional content and potential medical applications including hepatoprotection, anticancer, and anti-aging. They can be utilised as an alternative to conventional dietary supplements. As a result, functional sericulture under a new paradigm has replaced sericulture to produce solely silk fabric, greatly increasing farmer revenue while also relieving patient suffering.

Keywords: Silkworm, Products, Byproducts, Life science and Therapeutical

1. INTRODUCTION

Sericulture agro industry is worth for generating foreign currency and uplifting socioeconomic status of farmers in India [9]. Sericulture mainl involves the silkworms are reared mainly for the production of the different kind of silk from different type of silkworms. There are four commercially exploited silkworms namely: Mulberry (*Bombyx mori*),Muga *(Antheraea assamensis*), Eri (*Samia ricini*) and Tasar (*Antheraea Mylitta* and *Antheraea proylei*). A Chinese oak silk moth (*Antheraea pernyi*) is another temperate silk moth, which is commercially exploited and their silk is produced in large numbers after mulberry silk.

The silkworm is a lepidopteran insect that belongs to the family Bombycidae and Saturniidae. Silkworm is holometabolic insect that undergoes four developmental stages i.e. egg, larva, pupa and adult; where pupa and adult are non-feeding stage. The life cycle duration of a silkworm is about 45 to 80 days approximately and female moth lays about 150 to 500 eggs approximately. The egg hatches in 7-21 days after oviposition. The larval period is the longest among the four stages of silkworm and also silkworm larva rearing is the main base for the production of good quality of silk. The pupa is non active stage, which is covered with a protective layer called cocoon. The moth emerges within 7-12 days after spinning [14-16].

In traditional sericulture, the primary goal of production is to produce a product. The term "by-product" refers to a product that is produced incidentally to the production of another product [12,13]. During the rearing of silkworms, numerous by-products are produced, such as cocoons, pupas, excreta, silk waste, etc.Despite the worldwide increase in byproduct

value aimed at surpassing the cost-benefit ratio, India has lagged behind other countries in the sericulture sector [17-20]. By-products, which are typically seen as trash, can be more effectively utilised to create valuable products, propelling the sector to a more lucrative and sustainable position.

Medicinal Value of Silkworm Egg:

Silkworm eggs are the base of sericulture. Albumin, lipids, carbohydrates, glycoproteins, vitamins B1 and B2, and other substances are present. The eggs are turned into a proteic extract, which is then utilised in the food and pharmaceutical industries to make medications with hepatoprotein-stimulating, hypolipidic, and hypoglycemic effects as well as for male sexual stimulation [7].

After hatching, silkworm egg shells are mostly discarded. Silkworm egg shells is also known for major source of chitin with as high as 74% in chicken eggs. Chitin is one of the most widely used polymers next only to cellulose. Rather than chitin, its deacetylated form chitosan is more widely used for commercial applications. Silkworm egg shell chitosan has antibacterial and anti-fungal activity similar or better than commercially available chitosan. With large availability and limited applications, egg shells can be used as renewable and sustainable sources for chitosan [2]. The proteic extract of egg shell is sold as the Humanofort B product in Romania. There is a belief in Bulgaria that if silkworm eggs eaten by alcohol drinkers, give up drinking completely because, they start feeling disgust. But the fact has not been proved scientifically.

Medicinal Value of Silkworm Larva:

Silkworm larva goes into four moult and five instars, with the late instar being used more frequently in the pharmaceutical business. Numerous medical benefits of silkworm include anti-diabetic, anti-cancer and hepatoprotective effects in addition to its use in surgery. It is well known that the freeze-dried silkworm larvae powder has potent anti-diabetic properties. Studies have discovered that the nitrogen molecule 1-deoxynojirimycin, which was isolated from silkworm larvae as well as mulberry leaves, exerting blood glucose lowering effect. [4]. Additionally, fatty liver disease is treated with silkworm powder. An increase in liver serum triglycerides is what causes fatty liver disease. The mature silkworm powder greatly reduced the hepatic buildup of triglycerides caused by ethanol treatment [5]. Traditional Chinese medicine in China employs dried silkworm larvae infected with muscardine to treat a range of underlying conditions, including spasms and flatulence. Silkworm larvae that are sick are frequently tossed in India. *Beauveria bassiana* infection causes white spores to appear in the body of the silkworm, which are then dried and utilized as treatments.The intestine of silkworm larvae is used to produce a unique kind of thread that is utilized in surgery. The intestine of silkworms and their glands are used to prepare the surgical gut. The braided scaffolds revealed higher tensile strength and strain at break values in the case of *Samia cynthiaricini* and *Bombyx mori* materials with a potential application in tissue engineering [6].

Medicinal value of Silkworm Pupa:

A significant by-product of the silk reeling business, silkworm pupa has excellent medicinal and nutritional value and can be utilized as a substitute food supplement. Silkworm pupa are mostly used as animal feed and fertilizer in South East Asia and are also used as food insects. Asian nations either consume it directly as food or in the form of powder or oil. A silkworm pupa's nutritional makeup is composed of 50–60% proteins, 25–35% fats, 8–10% carbohydrates, a small amount of vitamins B1, B2, and E, as well as minerals including calcium, phosphorus, copper, and iron. It also contains n-3 omega fatty acids, with α-linolenic acid serving as a main component. As a result, silkworm pupae are regarded as a high-quality source of protein and a vital nutrient. The active components in silkworm pupa have a wide range of pharmacological purposes and have a strong therapeutic impact on various disorders. The potent pharmacological effects of silkworm pupae have been demonstrated in both in vivo and in vitro studies. Examples of these actions include anti-tumor, anti-oxidant, antibacterial, anti-apoptotic, hypotensive, lipid and blood sugar-regulating, immunomodulatory, and hepatoprotective [11].

Potential applications as natural antioxidants in functional meals to help prevent disease brought on by oxidative stress were demonstrated by significant ROS scavenging activity in silkworm pupae of *Bombyx mori, Antheraea mylitta,* and *Antheraea assamensis* functional components [3].

Animal studies have shown that utilising silkworm pupal oil can help prevent ethanol-induced stomach ulcers. The models were pretreated with silkworm pupal or chrysalis oil, then treated with ordinary diet, saline, medications, a high dose of pupal oil, and a low dose of pupal oil. As a result, bigger doses of pupal oil cause less stomach ulcers than smaller amounts [6].

Medicinal value of Silk Moth

The silk moth likewise goes through a non-feeding stage before emerging from its cocoon to mate and deposit eggs for the following generation. Unused silk moth for seed production and the dead moths are typically thrown in a pit and allowed to decompose without any ulterior intent. In accordance with traditional Chinese medicine, silk moths that are discarded after emerging or mating are now used to make therapeutic wines. The Shaanxi Sericultural Technology Station's male silkworm moth wine is the most well-known. Impotence, irregular menstruation, and menopausal symptoms

can all be treated with this drink. The silkworm moths are used to produce another form of special oil that is 75% fatty oils. Superior soaps and textile dyes can be made from the oil. The leftovers from the extraction process can be fed to animals as hay. The moths are also capable of producing cellular cytochrome C, uric acid, and a few hormones, all of which are vital ingredients in the creation of pharmaceuticals.

Medicinal Value of Cocoon silk

Late stage larvae spin a protective coating known as a cocoon in order to mature into non-motile pupae. Fibroin, sericin, and other impurities (pigments, waxes, sugars, and phytochemicals) account up the majority (75.38%), a small minority (17-25%), and a tiny minority (about 1-4%) of cocoon components, respectively. The cosmetics industry has also benefited from cocoons. The cocoon is divided into one portion and soaked in hot water before being massaged onto the face with the aid of fingers because sericin, which is considered to have moisture-retaining characteristics in it.Cocoon powder is used in a variety of cosmetic products, including face wash and masks. Cocoon powder is used as a wound dressing for third-degree burns [4]. Silk proteins are utilised in a range of cosmetic goods, including silk lotion, silk cream, silk night cream, silk hand cream, silk baby cream, and silk toothpaste, as research has shown that they may retain moisture and prevent UV radiation. Silk extracts are also used in health drinks [7].

Medicinal Value of silkworm excreta

Silkworm excreta or faeces are regarded as the primary waste product of silkworm production. Silkworm excreta are primarily used as compost due to the amount of nitrogen, phosphate, and potassium present; however, the litter can be used as raw materials in a biogas plant alongside cow manure to make fuel. It is also used to feed livestock and fish. Bombyx mori excrement has long been employed in the pharmaceutical industry as a natural colourant. Large amounts of silkworm excreta are collected and used as a raw material to make a range of new products, with chlorophyll being particularly important because it is sought after in the pharmaceutical and food processing industries. Chlorophyll is extracted from forage grass and pine needles and used to colour soaps, food, waxes, and toothpaste. It is also used as a deodorant, healing agent, and pharmaceutical to stop bleeding from the teeth and gums caused by dental and gum diseases. Traditional Chinese medicine uses chlorophyll from silkworm dung to cure hepatitis and leukaemia. This drug is 95.6% effective for cancer patients who have lost white blood cells as a result of chemotherapy and radiotherapy.

There is less information available about the bioactivity of pounds of silkworm excreta. The researchers recovered 1-tritriacontanol, a long-chain fatty alcohol, lupeol, a phytosterol, and β-sitosterol. Following polarity separation with numerous solvent mixtures, the compound was isolated from a crude acetone extract of silkworm excreta using vacuum liquid column chromatography. Silkworm excrement's anti-inflammatory qualities are due to lupeol and β-sitosterol, which are produced by mulberry leaves rather than silkworms.It is thus safe to investigate the safety of silkworm excreta for eating. Silkworm excreta have been utilised as food and dietary supplements. Vero cells, which represent a normal cell group, were used in the study to assess the cytotoxicity of the crude extract and 1-tritriacontanol on cancer cells as well as vero cells. The extract was found to be safe for all cell types examined.Silkworm drops are now again used to produce healthy alcoholic beverages such as Sansha and tea powder[10].

Conclusion

The ancient silk industry has traditionally focused solely on the manufacture of silk. Silk, a byproduct of sericulture, is greatly sought after both domestically and globally. Silkworm leftovers such as pupa, cocoons, and litter have been used as dietary supplements for both humans and animals. People's health beverages are produced with a proteic extract generated from vitamin and mineral-rich silkworm eggs. Although silkworms were first raised primarily for their silk, their larvae are now being examined as prospective laboratory animals for the development of numerous human medications, including anti-diabetic and anti-cancer ones. Silkworm pupae are the principal byproduct of the textile business once the silk is removed. These pupae contain more fatty acids than sunflower oil and amino acids than a chicken egg. These pupae are exceptionally valuable and nutrient-dense. Silkworm pupa are ingested medicinally in powder and oil form, as well as uncooked. Silk is used for surgical sutures and wound dressings. Silkworm excrements are used medicinally and as fertiliser in teas and alcoholic beverages, among other things. Silk moths are used in traditional Chinese remedies and wines, despite a dearth of research on the topic. Functional sericulture, based on a new paradigm, has replaced silk-producing sericulture to better serve patients. In the future, sericulture's functional features will be refined and finally reborn into a true biotechnology-based sericulture, which will surely help the sector as a whole.

Reference

1. Aznar-Cervantes, S. D., Pagán, A., Candel, M. J., Pérez-Rigueiro, J., and Cenis, J. L. (2022). Silkworm Gut Fibres from Silk Glands of *Samia cynthiaricini*—Potential Use as a Scaffold in Tissue Engineering. *International Journal of Molecular Sciences*, *23*(7), 3888.

2. Battampara, P., Sathish, T. N., Reddy, R., Guna, V., Nagananda, G. S., Reddy, N., … and Radhakrishna, P. G. (2020). Properties of chitin and chitosan extracted from silkworm pupae and egg shells. *International Journal of Biological Macromolecules*, *161*, 1296-1304.

3. Deori, M., Boruah, D. C., Devi, D., and Devi, R. (2013). Antioxidant and antigenotoxic effects of pupae.

4. Kim, M. K., Yoo, K. Y., Kwon, K. J., Kim, S. G., Park, Y. W., Lee, K. G., ... and Kweon, H. Y. (2014). Powdered wound dressing materials made from wild silkworm Antheraea pernyi silk fibroin on full-skin thickness burn wounds on rats. *Maxillofacial Plastic and Reconstructive Surgery*, *36*(3), 111.

5. Lee, D. Y., Hong, K. S., Song, M. Y., Yun, S. M., Ji, S. D., Son, J. G., and Kim, E. H. (2020). Hepatoprotective effects of steamed and freeze-dried mature silkworm larval powder against ethanol-induced fatty liver disease in rats. *Foods*, *9*(3), 285.

6. Long, X., Zhao, X., Wang, W., Zhang, Y., Wang, H., Liu, X., and Suo, H. (2019). Protective effect of silkworm pupa oil on hydrochloric acid/ethanol-induced gastric ulcers. *Journal of the Science of Food and Agriculture*, *99*(6), 2974-2986.

7. Nazim, N., Buhroo, Z. I., Mushtaq, N., Javid, K., Rasool, S., and Mir, G. M. (2017). Medicinal values of products and by products of sericulture. *Journal of Pharmacognosy and Phytochemistry*, *6*(5), 1388-1392.

8. Ryu, K. S., Lee, H. S., and Kim, I. (2002). Effects and mechanisms of silkworm powder as a blood glucose-lowering agent. *International Journal of Industrial Entomology*, *4*(2), 93-100.

9. Sathe, T. V., and Desai, A. S. (2014). Economical and distributional status of Uzi fly, *Exoristasorbillans* Wied. (Diptera: Tachinidae) in sericulture in India. *Indian J Appl. Res*, *4*(8), 10-13.

10. Vimolmangkang, S., Somkhanngoen, C., and Sukrong, S. (2014). Potential pharmaceutical uses of the isolated compounds from silkworm excreta. *Chiang Mai J Sci*, *41*, 97-104.

11. Zhou, Y., Zhou, S., Duan, H., Wang, J., and Yan, W. (2022). Silkworm Pupae: A Functional Food with Health Benefits for Humans. *Foods*, *11*(11), 1594.

12. Nazim N, Buhroo ZI, Mushtaq N, Javid K, Rasool S, Mir GM. Medicinal values of products and by products of sericulture. Journal of Pharmacognosy and Phytochemistry. 2017;6(5):1388-92.

13. Sharma V, Rattan M, Chauhan SK. Potential use of sericultural by products: A review. Pharma Innov. 2022:1154-8.

14. Javali UC, Padaki NV, Das B, Malali KB. Developments in the use of silk by-products and silk waste. InAdvances in silk science and technology 2015 Jan 1 (pp. 261-270). Woodhead Publishing.

15. Reddy RM. Value addition span of silkworm cocoon-time for utility optimization. International Journal of Industrial Entomology. 2008;17(1):109-13.

16. Reddy RM. Silkworm food plants apply dimension under Indian condition-time for utility optimization and value addition. Sericologia. 2010;50(1):1-7.

17. Roy C, Mukherjee S. An analytical study on determinants of income generation in rural sericulture sector of West Bengal. Indian Journal of Economics and Development. 2015 Feb 1;3(2):168-80.

18. Bhattarcharjya D, Alam K, Bhuimali A, Saha S. Status, potentials, constrains and strategies for development of sericulture farming system in West Bengal state of India. Bulgarian Journal of Agricultural Science. 2020 Jul 1;26(4).

19. Sengupta M, Biswas S, Saha S. Factor and Constraints Involved in Income Generation from Sericulture: A Study in three Districts of West Bengal, India. Journal of Experimental Agriculture International. 2023 Dec 4;45(11):219-28.

20. Sadat A, Biswas T, Cardoso MH, Mondal R, Ghosh A, Dam P, Nesa J, Chakraborty J, Bhattacharjya D, Franco OL, Gangopadhyay D. Silkworm pupae as a future food with nutritional and medicinal benefits. Current Opinion in Food Science. 2022 Apr 1;44:100818.